HKDSE Chemistry Pastpaper Collection

Paper I

By Topic

Section 1 - 5

HKAL/HKASL Paper 1996-2013

HKCEE Paper 1990-2011

HKDSE Sample Paper 2011

HKDSE Practices Paper 2012

HKDSE Paper 2012-2022

Content

Remarks:

Directions: Decide whether each of the two statements is true or false: if both are true, then decide whether or not the second statement is a correct explanation of the first statement. Then select one option from A to D according to the following table:

A. Both statements are true and the 2nd statement is correct explanation of the Misstatement.

B. Both statements are true but the 2nd statement is NOT a correct explanation of the 1st statement.

C. The 1st statement is false but the 2nd statement is true.

D. Both statements are false.

SECTION 0 Laboratory Safety and Precautions

Multiple-Choice Questions

CE88_39

Which of the following hazard warning labels should be attached to a bottle of liquid bromine?

(1) 

(2) 

(3) 

(4) 

A. (1) and (2) only
B. (1) and (4) only
C. (1), (3) and (4) only
D. (2), (3) and (4) only

CE89_27

Which of the following combinations would cause "striking back" in a Bunsen flame?

	Air hole	Gas supply
A.	Fully closed	Too weak
B.	Fully closed	Too strong
C.	Fully open	Too weak
D.	Fully open	Too strong

CE91_05

Tetrachloromethane is a common solvent in the chemistry laboratory. Which of the following hazard warning labels should be displayed on a bottle of tetrachloromethane?

(1) 

(2) 

(3) 

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE94_32

Which of the following label(s) should be placed on a bottle containing tetrachloromethane

(1) 

(2) 

(3) 

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE97_10

Which of the following combinations is INCORRECT?

	Chemical	Method of storage
A.	Calcium	Under water
B.	Potassium	Under paraffin oil
C.	Ethanol	In a cool place
D.	Solution	In a brown bottle

CE99_35

The label below is displayed on a container for chemical **X**:

Which of the following chemicals may **X** be?

(1) Bromochlorodifluoromethane
(2) Ethanol
(3) Potassium

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE01_02

The hazard warning label shown below is found on a compressed gas cylinder.

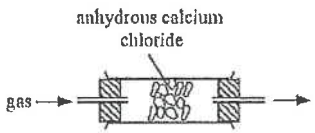
Which of the following gases may be contained in the cylinder?

A. hydrogen
B. oxygen
C. chlorine
D. argon

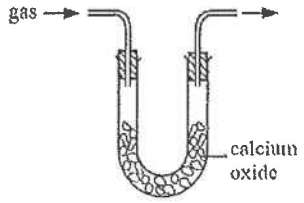
CE02_38

Which of the following set-ups can be used to dry moist sulphur dioxide gas?

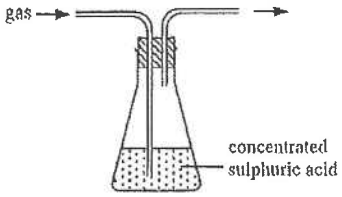
(1)



(2)



(3)



A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE04_05

Which of the following statements concerning nitric acid is correct?

A. Nitric acid can be used as fertilizer.
B. Nitrogen monoxide is a raw material in the manufacture of nitric acid.
C. In the laboratory, concentrated nitric acid is commonly stored in brown bottles.
D. The following hazard warning label should be displayed on a bottle of concentrated nitic acid.

CE05_18

The following hazard warning labels are displayed on the reagent bottle of an acid.

What information about this acid can be obtained from the labels?

A. It is very concentrated and flammable.
B. It is very concentrated and oxidizing.
C. It is flammable and corrosive,
D. It is corrosive and oxidizing.

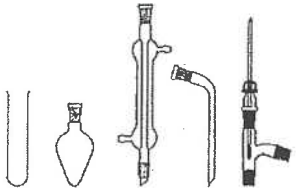
CE06_11

Which of the following statements about acids is correct?

A. Nitric acid is used in car batteries.
B. Hydrochloric acid is produced in human stomach.
C. Ethanoic acid is strong oxidizing agent.
D. The following hazard warning label should be displayed on a bottle of concentrated sulphuric acid.

CE08_26

Consider the following pieces of apparatus:



Which of the following process can be performed by normal use of some or all of the above apparatus?

(1) Refluxing a reacting mixture
(2) Separating two immiscible liquids
(3) Performing a simple distillation

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE09_25

Which of the following hazard warning labels should be displayed on the reagent bottle of methanol?

(1)

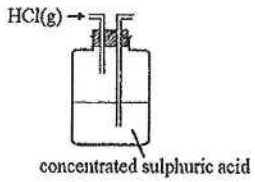
(2)

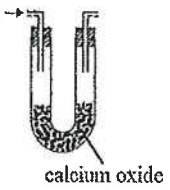
(3)

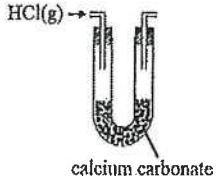
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

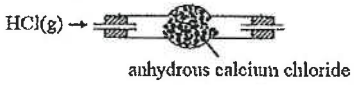
CE10_05

Which of the following set-ups can be used to dry hydrogen chloride gas?

A. 

B. 

C. 

D. 

CE10_26

Which of the following safety measures should be taken when investigating the reaction between sodium and water?

(1) Use forceps to pick sodium.
(2) Use a small piece of sodium.
(3) Use a small amount of water.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE10_42

Which of the following hazard warning labels should be displayed on a bottle of concentrated hydrochloric acid?

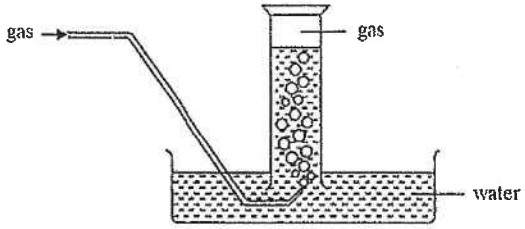

(1)


(2)


(3)

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE11_10



The set-up shown in the above diagram can be used to collect

A. ethene.
B. ammonia.
C. sulphur dioxide.
D. hydrogen chloride.

CE11_19

What is / are the potential hazard(s) of mixing an acidic toilet cleaner with chlorine bleach?

(1) A toxic gas is liberated.
(2) A large amount of heat is given.
(3) A flammable substance is produced.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE11_20

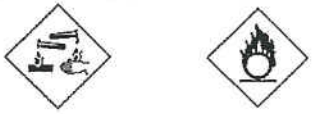
Which of the following gases can be dried by using concentrated sulphuric acid?

(1) Ammonia
(2) Sulphur dioxide
(3) Hydrogen chloride

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE11SP_08

The following hazard warning labels are displayed on the reagent bottle of an acid.



What information about this acid can be obtained from the labels?

A. It is very concentrated and flammable.
B. It is very concentrated and oxidizing.
C. It is flammable and corrosive,
D. It is corrosive and oxidizing.

DSE14_15

Which of the following hazard warning labels should be displayed on both the reagent bottle storing concentrated sulphuric acid and the reagent bottle storing concentrated hydrochloric acid?

(1) (2) (3)

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE15_01

Which of the following statements is correct?

A. All aqueous solutions contain $H^+(aq)$ ions.
B. The pH of all acid solutions is greater than zero.
C. All acidic compounds contain hydrogen as their constituent elements.
D. A 'corrosive' hazard warning label must be displayed on all reagent bottles containing acid solution.

DSE16_19

The hazard warning label below is displayed on a bottle containing chemical Z:

Which of the following chemicals may Z be?

(1) Sodium
(2) Trichloromethane
(3) Concentrated aqueous ammonia

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE18_20

Which of the following hazard warning labels should be displayed on a bottle containing propan-2-ol?

(1) (2) (3)

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

Structural Questions

AL99(I)_08a(ii)

Suggest how to extinguish

(I) Burning cyclohexane in a conical flask, and

(1 mark)

(II) Burning sodium

(1 mark)

AL00(I)_07c(ii)

What hazard warning label should be displayed on a bottle of ammonium nitrate(V) solid?

(1 mark)

AL03(I)_08b

The following compounds can be used as drying agents:

$Na_2SO_4(s)$, $NaOH(s)$, $CaCl_2(s)$ and $P_2O_5(s)$

Choose, from the above, one compound which is most suitable and effective

(i) for drying a solution of $C_6H_5CO_2H$ in $CHCl_3$.

(1 mark)

(ii) for drying a moist solid sample of $C_6H_5CO_2H$.

(1 mark)

AL04(I)_07

A student proposed a method to determine the concentration of citric acid in a sample of lemon juice by titration with standard sodium hydroxide solution. The method proposed consists of the following experimental procedures:

1. Prepare a standard sodium hydroxide solution by dissolving a known mass of sodium hydroxide pellets in deionized water and then make it up to 250.0 cm^3.
2. Transfer a known volume of the sample of lemon juice to a clean conical flask.
3. Fill a burette, which has been well rinsed with deionized water beforehand, with the standard sodium hydroxide solution.
4. Titrate the lemon juice in the flask with the sodium hydroxide solution using methyl orange as the indicator.
5. Using this titration result, calculate the concentrate of citric acid in the sample.

Point out four inappropriate practices in the method. Explain why they are inappropriate and suggest corrections for them.

(6 marks)

AL04(I)_08c

The following passage about an explosion involving hydrogen-oxygen balloons was adapted from a chemical journal.

Hydrogen-Oxygen Balloon Hazards

An accident occurred prior to the performance of a hydrogen-oxygen balloon demonstration, seriously injuring a demonstrator, who suffered painful second-degree burns.

To prepare for the demonstration, 15 balloons (pre-filled with a hydrogen-oxygen gas mixture) in a large, black polyethene garbage bag were transported to the site and kept there for a few hours. While setting up the demonstration, the demonstrator opened the bag and removed a single balloon for stringing and floating. Suddenly, the entire bag of balloons exploded violently...

(Source: Journal of Chemical Education, July 2003)

Using your knowledge of science, suggest why the explosion occurred.

(3 marks)

AL04(I)_08d

(i) Explain why carbon dioxide extinguishers must not be used to put out a piece of burning sodium.

(1 mark)

(ii) Suggest a proper way to put out a piece of burning sodium in the laboratory.

(1 mark)

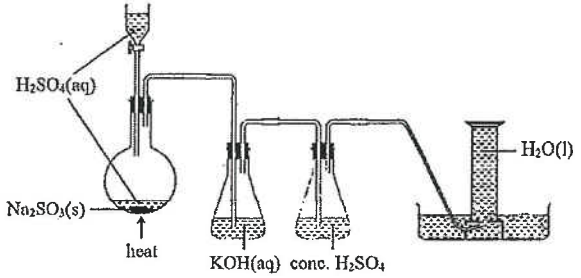
AL04(I)_07a

(ii) Suggest one hazard warning label which should be displayed on a bottle of propan-2-ol.

(1 mark)

AL04(I)_07b

(ii) A student suggested to use the set-up shown below to prepare a dry sample of sulphur dixodee from sodium sulphate(VI) solid.



Point out two mistakes in the above set-up, and suggest the corresponding rectifications.

(4 marks)

AL05(I)_08

The photograph below shows a person conducting a test in a laboratory to detect the presence of ammonium ions in a solid sample. He is holding a test tube containing a hot mixture of the sample and sodium hydroxide solution, and is trying to smell.

State three inappropriate laboratory practices of the person and suggest the proper actions that should be taken.

(3 marks)

AL06(I)_07b

(i) Circle the hazard warning label(s) below that should be displayed on a bottle of liquid bromine.

(1 mark)

(ii) A few drops of liquid bromine are spilt on a laboratory bench. Suggest a chemical method to treat the splite liquid bromine.

(1 mark)

AL06(I)_08b

State a possible consequence from each of the following poor laboratory techniques:

(i) Draining the lower layer from a separating funnel without removing the stopper.

(ii) Determining the melting point of a compound without completely removing the solvent after recrystallization.

AL07(I)_07

In a chemistry laboratory, students are required to wear laboratory coat, plastic gloves and safety spectacles. Which of these safety measures do you consider the most important? Explain.

(2 marks)

AL08(I)_07b

(ii) Suggest why the following hazard warning labels should be displayed on a bottle of $LiAlH_4(s)$.


EXPLOSIVE 爆炸性


CORROSIVE 腐蝕性

AL08(II)_04

Suggest ONE safety precaution when shaking the liquid mixture in the separating funnel.

(1 mark)

AL09(I)_07c

Explain why water should NOT be added to concentrated H_2SO_4 in order to dilute the acid.

(1 mark)

AL09(I)_07d

Suggest the most appropriate hazard warning label that should be displayed on a bottle of $NaClO_3(s)$.

(1 mark)

AL10(I)_07b

State under what circumstances each of the following practices would be adopted and explain your answer.

(i) The use of an air condenser instead of a water condenser in reflux.

(2 marks)

(ii) The use of concentrated H_3PO_4 instead of concentrated H_2SO_4 in the preparation of hydrogen halides from the corresponding sodium halides.

(2 marks)

DSE12PP_08

(b) A concentrated aqueous methanol solution is used as the fuel in DMFC.

(ii) Circle TWO of the following hazard warning labels that should be displayed on the container of a concentrated aqueous methanol solution.


CORROSIVE 腐蝕性


TOXIC 有 毒


FLAMMABLE 易 燃


OXIDISING 氧化性

(1 mark)

DSE12_07

A fertilizer only contains ammonium nitrate (NH_4NO_3) and potassium chloride (KCl). An experiment was performed to determine the percentage by mass of NH_4NO_3 in this fertilizer.

The KOH(aq) was added slowly to the fertilizer and the mixture formed was heated gently. The ammonia liberated from the reaction between NH_4NO_3 and KOH was first cooled in a condenser, and then passed through an inverted funnel to a solution containing 0.0485 mol of HCl. The solution was finally made up to 100.00 cm^3 and labelled as 'S'.

(b) Suggest the potential hazard of one of the chemicals used.

(1 mark)

DSE13_04

(c) Solid sodium hydroxide is available in school laboratories. However, a standard NaOH(aq) CANNOT be directly prepared by weighing NaOH(s) and then dissolving it in water. Explain why.

(1 mark)

(e) The following were considered as INAPPROPRIATE practices when carrying out the titration experiment. For each of them, explain why it would lead to inaccurate titration results:

(i) Rinsing the conical flask with the standard $H_2C_2O_4(aq)$ before transferring 25.00 cm^3 of the acid solution to it.

(1 mark)

(ii) Carrying out the titration with the filter funnel remained on top of the burette after using it to fill the burette with the NaOH(aq).

(1 mark)

DSE13_10

(a) An oxygen cylinder can be used to provided oxygen for the fuel cell. From the hazard warning labels shown below, circle the label that should be displayed on the oxygen cylinder.

(1 mark)

DSE14_05

Concentrated acids are common reagents found in laboratories.

(a) State a safety measure in handing concentrated acids in laboratories.

(1 mark)

DSE14_07 (modified)

(c) Suggest a possible reason why the concentration of the concentrated hydrochloric acid in the bottle obtained from volumetric analysis would be smaller than that actual value.

(1 mark)

DSE15_03

(b) A compound contains iron and oxygen only. In an experiment for determining the empirical formula of this compound, 2.31 g of the compound was heated with carbon monoxide. Upon complete reaction, carbon dioxide and 1.67 g of iron were formed.

(iii) As carbon monoxide is poisonous, suggest one necessary safety precaution in carrying out the experiment.

(1 mark)

DSE15_04

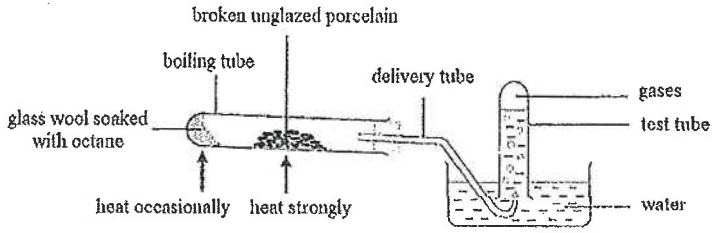
(d) A student diluted a sample of concentrated sulphuric acid for making a lead-acid accumulator.

(i) Describe how concentrated sulphuric acid can be diluted in a laboratory. State a safety precaution needed during the dilution process.

(3 marks)

DSE16_03

The diagram below shows an experimental set-up in which the glass wool soaked with octane is heated occasionally and the broken unglazed porcelain is heated strongly. Some gases are collected in the test tube over water.



(d) When no more gas can be collected, what should be done to end the experiment for safety consideration? Explain your answer.

(2 marks)

DSE17_01

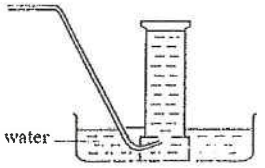
Barium (Ba) is an element in Group II of the Periodic Table. Its chemical properties are similar to those of calcium.

(b) A gas with a pungent smell is formed when $Ba(OH)_2(s)$ is heated with $NH_4Cl(s)$. State the reason why the gas CANNOT be collected by each of the following methods.

(i)

Reason: (1 mark)

(ii)



Reason: (1 mark)

DSE17_06

Concentrated sulphuric acid is a reagent commonly found in laboratories.

(a) Circle TWO hazard warning labels that should be displayed on a bottle of concentrated sulphuric acid:

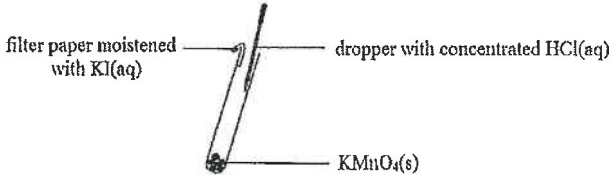
(1 mark)

(b) (i) Explain why concentrated sulphuric acid should NOT be titrated directly with NaOH(aq).

(1 mark)

DSE18_08

Refer to the experimental set-up as shown below:

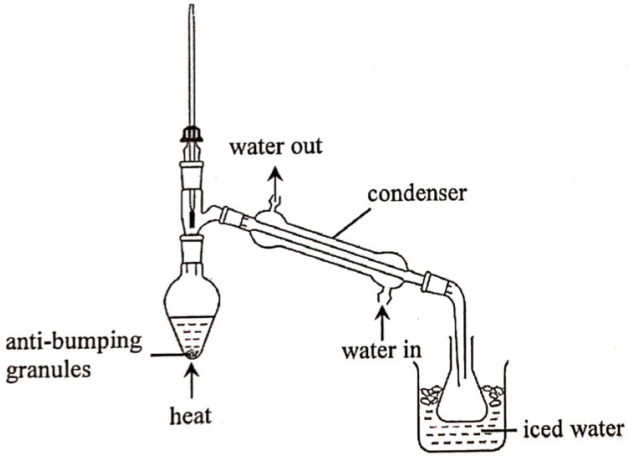


(d) In consideration of laboratory safety, explain where the experiment should be performed.

(1 mark)

2022

17. Refer to the following set-up :

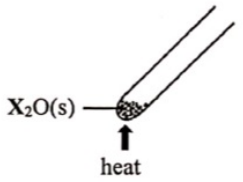


Which of the following processes can be performed by using the above set-up ?

(1) obtaining pure water from sea water
(2) obtaining propane from diesel oil
(3) obtaining oxygen from liquefied air

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

2. The diagram below shows an experimental set-up in which a metal oxide $X_2O(s)$ is decomposed upon strong heating. A silvery metal **X** and a colourless gas **Z** are formed.

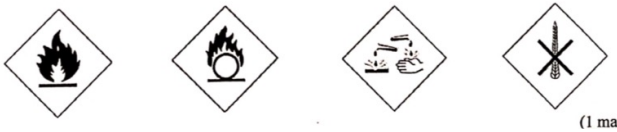


(a) State what **Z** is and suggest a test for it.

(2 marks)

(1 mark)

6 (e) From the hazard warning labels shown below, circle a label that should be displayed on a gas cylinder containing methane.



(1 mark)

Marking Scheme

MCQ

CE88_39	C	CE89_27	C	CE91_05	B	CE94_32	A
CE97_10	A	CE99_35	D	CE01_02	A	CE02_38	B
CE04_05	C	CE05_18	D	CE06_11	B	CE08_26	B
CE09_25	A	CE10_05	D	CE10_26	A	CE10_42	A
CE11_10	A	CE11_19	A	CE11_20	D	DSE11SP_08	D
DSE14_15	B (70%)	DSE15_01	A (46%)	DSE16_19	C (27%)	DSE18_20	A (63%)

Structural Questions

AL99(I)_08a(ii)

(I) Cover the flask with wet towel / fire blanket [1]
OR, use foam / carbon dioxide / BCF / BTM type extinguisher
(II) Use powder tyupe extinguisher / sand [1]

AL00(I)_07c(ii)

Oxidizing / explosive [1]

AL03(I)_08b

(i) $Na_2SO_4(s)$ [1]
(ii) $Na_2SO_4(s)$ / $CaCl_2(s)$ / $P_2O_5(s)$ [1]

AL04(I)_07

Step 1: A standard NaOH(aq) should not be prepared using the method as described. [½]
Explanation: NaOH(s) is not a primary standard / is hygroscopic / NaOH(s) reacts with [½]
$CO_2(g)$ in air. [½]
Correction: it is necessary to standardize the NaOH(aq) before use.
Step 3: The burette should not be rinsed with water only. [½]
Explanation: Water that remains in the burette will cause a dilution of the NaOH(aq). [½]
Correction: The burette needs to be rinsed with deionized water and then with the NaOH(aq) [½]
prepared.
Step 4: Methyl orange is not a suitable indicator. [½]
Explanation: The experiment involves a titration of a weak acid with a strong alkali, pH at the [½]
end point is about 8 to 9.
Correction: Phenolphthalein should be used. [½]
Step 5: Calculation should not be based on the result of one titration only. [½]
Explanation: There may be errors in the titration [½]
Correction: Repeat the titration at least 3 times. Use the mean titre for the calculation. (Ignore [½]
the result of the trial titration, if necessary).

AL04(I)_08c

The garbage bag was filled with a hydrogen-oxygen mixture because $O_2(g)$ and $H_2(g)$ diffused [1]
out of the balloons.
The frictional force between balloons produces static electricity and hence sparks. [1]
The electric spark cause the $H_2(g)$ and $O_2(g)$ mixture to explode. [1]
(Accept other reasonable answers)

AL04(I)_08d

(i) The high temperature of the piece of burning sodium may cause decomposition of CO_2. [1]
The sodium will continue to burn.
(ii) Covering the piece of burning Na with sand / use dry powder extinguisher to put out the [1]
fire.

AL04(I)_07a

(ii) Flammable [1]

AL04(I)_07b

(ii) KOH(aq) should not be used as $SO_2(g)$ reacts vigorously with KOH(aq). An empty [1]
conical flask (as a trap) should be used instead. / It is not necessary to include the flask [1]
containing KOH(aq) in the set-up.
$SO_2(g)$ should not be collected over water as it is very soluble. Collect the $SO_2(g)$ [1]
produced by download delivery / upward displacement of air / using a syringe. [1]

AL05(I)_08

The person did not wear laboratory coat. Should wear a laboratory coat. [1]
The person did not have eye protection. Should weak safety spectacles / goggles. [1]
Should not detect $NH_3(g)$ by smelling while heating the reaction mixture. The mixture may [1]
shoot his face. Should detect $NH_3(g)$ by the use of a piece of wet red litmus paper that can
change it from red to blue
OR, by HCl(aq) that can form a white fumes with HCl(aq).
OR, should smell $NH_3(g)$ after turning off the Bunsen burner.

AL06(I)_07b

(i) Toxic; corrosive [1]
(ii) Treat the spilt bromine with NaOH(aq). [1]

AL06(I)_08b

(i) Withot releasing the pressure, the liquid in the separating funnel with not drain out of the [1]
funnel.
(ii) The melting point determined wil be lowered than the expected value. [1]

AL07(I)_07

Safety spectacles [1]

Eyes are the most delicate organs. Any harm on eyes cannot easily be recoved [1]

AL08(I)_07b

(ii) $LiAlH_4(s)$ reacts with water moisture in air to give $H_2(g)$. [1]

The reaction is highly exothermic. When $H_2(g)$ is mixed with air under this condition, an explosion may occur. [1]

The reaction gives LiOH of high concentration. Presence of high $[OH^-]$ is corrosive. [1]

AL08(II)_04

Release pressure in the separating funnel from time to time by inverting it and opening the tap. [1]

AL09(I)_07c

Dilution of conc. H_2SO_4 is highly exothermic process. The heat evolved can vaporize the water and cause splashing out of the acid. [1]

AL09(I)_07d

Oxidizing [1]

AL10(I)_07b

(i) If the reactant(s) / solvent used in the experiment has a high boiling point (>130 °C), the large temperature difference outside and inside the water jacket may cause cracking of the water condenser. [1] [1]

(ii) HBr and HI are reducing agents. They react with concentrated H_2SO_4 to give the corresponding halogens. In such cases, the non-oxidizing and non-volatile acid H_3PO_4 should be used. [1] [1]

Concentrated H_2SO_4 can only be used to prepare HCl and HF.

DSE12PP_08

(b) (ii) Toxic and flammable [1]

DSE12_07

(b) The KOH is (very) corrosive. / NH_4NO_3 is explosive / NH_4NO_3 is flammable / HCl is corrosive. [1]

DSE13_04

(c) NaOH(aq) is **deliquescent / hygroscopic / absorbs water from the atmosphere.** [1]

OR, NaOH(s) **reacts with $CO_2(g)$** in the atmosphere.

∴ The mass of NaOH(s) cannot be accurately determined by weighing.

(e) (i) Rinsing the conical flask with $H_2C_2O_4(aq)$: **Some $H^+(aq)$ ions / acid / $H_2C_2O_4(aq)$ remain in the flask,** and more alkali (as revealed from the burette reading) than actually required is used to reach the titration end-point. [1]

(Do not accept the concentration of $H^+(aq)$ increase.)

(ii) NaOH(aq) clinging onto the stem of funnel may **fall into the burette.** The volume of alkali used (as revealed from the burette reading) is smaller than what is expected. [1]

DSE13_10

(a)  [1]

DSE14_05

(a) Wearing protective gloves or plastic gloves or gown or safety googles or any suitable PPE [1]

OR, Adding concentrated acids into water when diluting the concentrated acids

OR, Use a fume cupboard.

Not accepted: maintain a good ventilation.

DSE14_07 (modified)

(c) Some HCl **escaped / vaporized** from the concentrated acid as HCl(g) / Concentrated hydrochloric acid is volatile. [1]

DSE15_03

(b) (iii) Perform the experiment in a **fume cupboard.** [1]

DSE15_04

(d) (i) Pour a **small amount of the concentrated sulphuric acid** to a **large amount of water.** [2]

Accept answers like "add concentrated sulphuric acid to a large amount of water."

Constant stirring is required (if the amounts of water and acid are not mentioned) [1]

Wear goggle / face shield / safety spectacles / safety glasses

DSE16_03

(d) The **delivery tube** should be taken out of the water level before **removing the heating source,** otherwise sucking back will happen / the boiling tube will be cracked. [1] [1]

DSE17_01

(b) (i) The gas (ammonia) is less dense than air. [1]
(Should be answered in terms of density. Not accept: The gas is lighter than air.)

(ii) The gas (ammonia) is soluble (in water). [1]
Accept: the gas will be absorbed by water / The gas will react with water.
(Not accept: The gas is slightly soluble in water.)

DSE17_06

(a) Oxidizing and corrosive [1]

(b) (i) The reaction between concentrated sulphuric acid and NaOH(aq) is highly exothermic. [1]
OR, Concentrated NaOH / H_2SO_4 is corrosive.
OR, Avoid to fill the burette more than once.
OR, Use less chemicals.
(Do not accept answer like "splashed out" without mentioning of "highly exothermic.")

DSE18_08

(d) The experiment should be performed in a fume cupboard as chlorine gas is toxic / toxic gas is released. [1]
(Do not accept well-ventilated benches, etc.)

SECTION 1 Planet Earth

Multiple-Choice Questions

CE94_44

Which of the following methods can be used to distinguish between solid sodium carbonate and solid calcium carbonate?

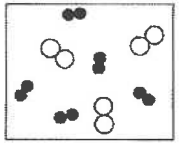
(1) Heating the solid and testing the gaseous product with lime water.
(2) Testing the solubility of the solid in water.
(3) Conducting a flame test on the solid.

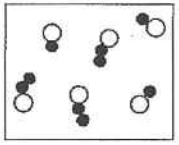
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

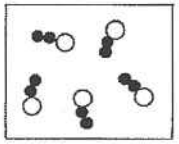
CE99_01

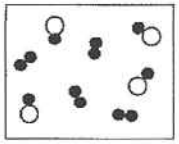
Which of the following diagrams can represent a mixture of two compounds?

(In these diagrams, ● and ○ represent a nitrogen atom and an oxygen atom respectively.)

A. 

B. 

C. 

D. 

CE99_45

1st statement	2nd statement
Sulphur is classified as a non-metal.	Sulphur does not react with dilute acids.

CE04_11

A white solid is found around the mouth of a reagent bottle containing lime water. The white solid is likely to be

A. calcium oxide.
B. calcium sulphate.
C. calcium carbonate.
D. calcium hydrogencarbonate.

CE04_29

Refer to the melting points and boiling points of four substances at 1 atm pressure as listed in the table below:

Substance	Melting point/°C	Boiling point/°C
argon	– 189	– 186
bromine	– 7	59
chlorine	– 101	– 35
sulphur dioxide	– 75	– 10

Which substance exists as a liquid at – 90°C and 1 atm pressure?

A. argon
B. bromine
C. chlorine
D. sulphur dioxide

CE05SP_02

The hazard warning label shown below is found on a compressed gas cylinder.

Which of the following gases may be contained in the cylinder?

A. hydrogen
B. oxygen
C. chlorine
D. argon

CE05SP_18

A white solid dissolves in water to give a colourless solution. The solution reacts with dilute hydrochloric acid to give a gas. The solid is probably

A. calcium oxide.
B. calcium carbonate.
C. potassium hydroxide.
D. potassium carbonate.

CE05_05

When a flame test is performed on copper(II) chloride, what is the colour of the flame observed?

A. golden yellow
B. pale purple
C. brick-red
D. bluish-green

CE05_19

Which of the following correctly describes the sequence of procedures to separate sand, salt and water from a mixture of sand and salt solution?

A. filtration, evaporation
B. filtration, distillation
C. crystallisation, filtration
D. crystallisation, filtration, distillation

CE06_25

Which of the following substances contain calcium carbonate as the main chemical constituent?

(1) limestone
(2) chalk
(3) marble

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE08_08

Nitrogen, instead of air, is used to fill the packets of potato chips. It is because

A. air supports combustion but nitrogen does not.
B. the density of air is higher than that of nitrogen.
C. argon in air contaminates the chips but nitrogen does not.
D. oxygen in air makes the chips go bad but nitrogen does not.

CE08_42

Calcium carbonate can be obtained from quicklime through two processes as shown below.

Which of the following combinations is correct?

	Process 1	Process 2
A.	adding water	adding Na_2CO_3(aq)
B.	adding Na_2CO_3(aq)	adding water
C.	adding water	heating
D.	heating	adding water

CE11_28

1st statement	2nd statement
Unpolluted rainwater can erode limestone.	Carbon dioxide in air dissolves in unpolluted rainwater to form carbonic acid.

CE11_40

An anhydrous compound Y gives a brick-red flame in flame test. Upon strong heating, Y gives out a gaseous mixture which turns blue cobalt(II) chloride paper pink and limewater milky. Which of the following compounds may Y be?

A. Na_2CO_3
B. $NaHCO_3$
C. $CaCO_3$
D. $Ca(HCO_3)_2$

DSE11SP_03

Which of the following correctly describes the sequence of procedures to separate sand, salt and water from a mixture of sand and salt solution?

A. Filtration, evaporation
B. Filtration, distillation
C. Crystallization, filtration
D. Crystallization, filtration, distillation

DSE13_19

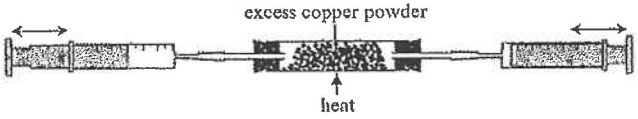
Which of the following statements about limestone is/are correct?

(1) It gives a golden yellow flame in a flame test.
(2) It gives a colorless gas when heated strongly.
(3) It dissolves in dilute sulphuric acid to give a clear solution.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE14_19

The set-up of an experiment is shown below. At room temperature, the system initially contains 40 cm^3 of $N_2(g)$, 25 cm^3 of $O_2(g)$ and 10 cm^3 of He(g).



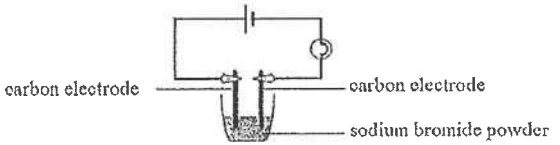
The plungers of the gas syringes are moved to and fro until there is no further change in the system. The system is then allowed to cool to room temperature. Which of the following statements concerning the experiment are correct?

(1) Some copper powder would change to a black substance.
(2) The total volume of the gases in the system would decrease by 25 cm^3.
(3) The same change in total volume of the gases would be observed if excess copper powder is replaced with excess iron powder.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE14_20

The diagram below shows the set-up of an experiment:



Which of the following methods may light up the light bulb?

(1) heating the sodium bromide powder until molten
(2) adding deionized water to the sodium bromide powder
(3) replacing the sodium bromide powder with bromine liquid

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE15_02

Which of the following processes would NOT give oxygen?

A. Heating mercury(II) oxide strongly
B. Electrolysis of dilute sulphuric acid
C. Fractional distillation of liquefied air
D. Passing steam over heated magnesium

DSE15_23

Which of the following can distinguish a sample of limestone powder from a sample of table salt?

(1) adding water
(2) performing a flame test
(3) adding dilute hydrochloric acid

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE16_01

A flame test conducted for a sample gives a brick-red flame. The sample may contain

A. chalks.
B. quartz.
C. graphite.
D. rock salts.

DSE17_14

Which of the following statements concerning oxygen gas is correct?

A. Oxygen gas relights a glowing splint.
B. Oxygen gas turns moist pH paper red.
C. Oxygen gas turns moist pH paper blue.
D. Oxygen gas gives a 'pop' sound when tested with a burning splint.

DSE18_01

Which of the following processes is most suitable for extracting sodium chloride from sea water?

A. Electrolysis
B. Crystallization
C. Simple distillation
D. Fractional distillation

DSE18_19

In an experiment, marble is heated in a boiling tube and the gas evolved is passed into a test tube with limewater. Which of the following statements concerning the experiment is/are correct?

(1) The marble turns brick red upon heating.
(2) The limewater turns milky initially but eventually becomes a colorless solution.
(3) If marble is replaced by chalk, a similar observation would be obtained.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE21_03

3. Which of the following statements is INCORRECT ?

A. Cracking of heavy oil can give ethene.
B. Electrolysis of sea water can give chlorine.
C. Strong heating of limestone can give oxygen.
D. Fractional distillation of liquefied air can give nitrogen.

Structural Questions

CE92_02c

(i) 1.0 g of calcium carbonate is added to 50.0cm^3 of 0.1M nitric acid. At the end of the reaction, 55.0cm^3 of a certain gas are collected at room temperature and pressure.

Draw a diagram of the set-up suitable for this experiment.

(2 marks)

CE92_04b

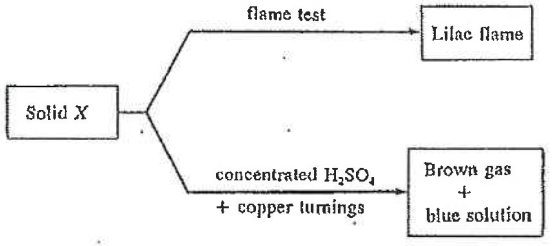
(ii) Silvery metal A reacts vigorously with water to form colourless solution B. When B is subjected to the flame test, it gives a persistent yellow flame. When B is added to copper(II) nitrate solution, precipitate C is formed. C changes to black solid D upon strong heating.

Describe how the flame test on B can be carried out in the laboratory.

(3 marks)

CE94_08b

A student carried out some tests on an ionic compound X which was a white solid. The results obtained were summarized in the following flow diagram:



(i) Based on the above information, deduce the cation present in X.

(ii) Describe how the flame test on X can be carried out in the laboratory.

(4 marks)

CE95_07a

The label on a bottle of 'Effervescent Calcium' tablets is shown below.

Effervescent Calcium

Each bottle contains 10 tablets.

Each tablet contains :

Calcium carbonate	625 mg
Vitamin C	1000 mg
Citric acid	1350 mg

Dosage : 1 tablet daily

Administration : Dissolve one tablet in a glass of water.

Warning : (1) Keep out of reach of children.
(2) Keep .....

(i) Effervescence occurs when a tablet of 'Effervescent Calcium' is added to water. Based on the information given on the label, explain why effervescence occurs.

(iii) On the label, some words are missing in the second warning statement. Complete the second warning statement, beginning with the word 'Keep'. Explain your answer.

(4 marks)

CE98_07a(iii)

Sand (an impure form of quartz) and limestone are raw materials used for making glass.

(1) Name that main chemical constituent of limestone.

(2) Suggest ONE reason why glass had been used by mankind for a long time.

(3) Suggest ONE reason why glass bottles are preferred to plastic bottles for the storage of champagne.

(3 marks)

CE99_02

(b) For each of the following experiment, state ONE observable change and write a chemical equation for the reaction involved.

A small piece of calcium is placed in a Bunsen flame.

(2 marks)

CE02_02

(a) For each of the following experiments, state an expected observation and write a chemical equation for the reaction involved.

A magnesium ribbon is placed in a Bunsen flame.

(2 marks)

CE02_06a

(i) What substance is mainly present in slaked lime?

(1 mark)

CE09_01

Limestone is an important earth resource.

(a) What is the major chemical constituent in limestone?

(1 mark)

(b) State the expected observation when dilute hydrochloric acid is added to limestone, and write the ionic equation for the reaction involved.

(2 marks)

(c) Limestone can be decomposed under strong heating.

(i) Write a chemical equation for the reaction involved.

(ii) Explain why limestone can be used as fire-proofing additive.

(2 marks)

CE10_06

In an experiment, carbon dioxide is passed into limewater until excess.

(a) State the expected observations and write the chemical equations for the reactions involved.

(3 marks)

(b) Explain whether the similar observations in (a) would be made if sodium hydroxide solution is used instead of limewater.

(1 mark)

(c) Explain whether the similar observations in (a) would be made if air is used instead of carbon dioxide.

(1 mark)

(d) Carbon dioxide can be obtained from the reaction of solid sodium carbonate with dilute hydrochloric acid. Write an ionic equation for the reaction.

(1 mark)

AL99(I)_07

Describe how to detect the presence of water of crystallization in an inorganic salt.

(1 mark)

AL00 (II)_02e

(iii) An aqueous solution of ammonium nitrate(V) was prepared by neutralization of aqueous ammonia with nitric(V) acid. Suggest how you would obtain crystalline ammonium nitrate(V) from the solution.

(2 marks)

ASL01(I)_06

Suggest tests to show the identities of the cation and anion in KCl(s), and state the expected observation.

(4 marks)

AL02(I)_08 (modified)

Draw a labeled diagram to show the set up of apparatus used in a simple distillation of mixture of 1-methylcyclopropanol and phosphoric(V) acid.

(2 marks)

AL02(II)_01

The presence of calcium in the sample can be shown by conducting a flame test. Give the essential steps in a flame test.

(3 marks)

AL04(I)_02

Consider the noble gases, He, Ne, Ar Kr and Xe. Sketch a graph to show the variation of boiling point of these noble gases and account for the variation.

(2 marks)

AL04(I)_07

You are provided with three unlabelled bottles each containing one of the white powders listed below:

KBr(s), SiO_2(s) and glucose

(a) Outline the physical tests that you would perform to distinguish unambiguously the three substances from one another.

(2 marks)

(b) Describe how you would carry out a *chemical test* to distinguish KBr(s) from glucose.

(2 marks)

AL04(I)_08

Draw a labeled diagram for the assembly of apparatus used in simple distillation.

(2 marks)

AL06(I)_08

State a possible consequence from following poor laboratory techniques. "determining the melting point of a compound without completely removing the solvent after recrystallization".

(1 mark)

AL07(I)_07

In a chemistry laboratory, students are required to wear laboratory coat, plastic gloves and safety spectacles. Which of these safety measures do you consider the most important? Explain.

(2 marks)

AL07(I)_08 (modified)

The crude product obtained can be purified by recrystallization. Suggest *three criteria* for an appropriate solvent for the recrystallization.

(3 marks)

ASL10(I)_10

(b) The crude product appears yellow due to the presence of impurities. Outline the experimental procedure for the purification of the crude product by recrystallization from an ethanol-water mixture.

(3 marks)

(c) Suggest a method to verify or not the recrystallized sample of acetanilide is pure.

(1 mark)

AL11(I)_07

(b) For each of the following pairs of species, suggest a chemical test to distinguish between them and write the chemical equation(s) of the reaction(s) involved.

(ii) Cl^-(aq) and Br^-(aq)

(2 marks)

ASL12(I)_09

Outline how you would separate NH_4Cl(s), NaCl(s) and $PbCl_2$(s) from a mixture of the three compounds.

(3 marks)

DSE12PP_02

(b) One common way of preserving wine in an opened bottle is to inject argon, a gas which is chemically unreactive, into the bottle and then stopper the bottle.

(i) Explain why argon is chemically unreactive.

(1 mark)

(ii) State the principle behind the use of argon in preserving wine.

(1 mark)

(iii) Helium gas is also chemically unreactive. Suggest why helium is NOT used for preserving wine in an opened bottle.

(1 mark)

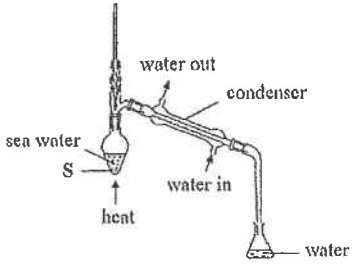
(c) Another way of wine preservation involves pumping air out from an opened bottle of wine and then stoppering the bottle. Suggest ONE possible drawback of preserving wine in this way.

(1 mark)

DSE13_01

Water is the most abundant compound on the Earth's surface. It is very important to life on Earth.

(b) Nearly 98% of the water on Earth is sea water, which is not fit for human consumption. The diagram below shows the set-up used in a simple distillation experiment for obtaining water for sea water.



(i) Outline the underlying principle of this simple distillation experiment.

(2 marks)

(ii) Insoluble solid S was placed into the flask before heating. Why?

(1 mark)

DSE15_02

For each of the following experiments, state the expected observation, and write the chemical equation(s) for the reaction(s) involved.

(a) Passing carbon dioxide gas into limewater until in excess.

(3 marks)

DSE21_01(c)

Acetylene (C_2H_2) is a fuel. It can be obtained from calcium carbide (CaC_2) by two different reactions as represented by the equations shown below :

$$CaC_2 + A \xrightarrow{2200\ ^\circ C} C_2H_2 + Ca \qquad \text{Reaction (I)}$$

$$CaC_2 + 2H_2O \xrightarrow{25\ ^\circ C} C_2H_2 + Ca(OH)_2 \qquad \text{Reaction (II)}$$

(c) Refer to Reaction (I) :

(i) A is a gas at room conditions. Suggest what A would be.

(ii) Hence, explain why the reaction is dangerous.

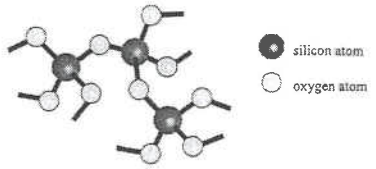
(2 marks)

DSE21_01(d)

(d) In Reaction (II), $Ca(OH)_2$ is formed. State one use of $Ca(OH)_2$ in daily life.

DSE21_03(d)

(d) Part of the structure of a mineral containing silicon and oxygen only is shown in the diagram below :

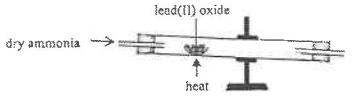


What is this mineral ?

(1 mark)

DSE21_06(a)

6. Lead can be obtained from lead(II) oxide using the experimental set-up shown below. Besides lead, nitrogen gas and steam are also formed.



(a) Suggest a reason for each of the following :

(i) The reaction tube is placed in a downward slanted position.

(ii) The experiment is performed in a fume cupboard.

(2 marks)

2022

1. Which of the following statements concerning $CO_2(g)$ is INCORRECT ?

   A. It can turn limewater milky.
   B. It can be used to make dry ice.
   C. It can be produced by adding marble to water.
   D. It generally has a higher percentage in the air in urban areas than that in rural areas.

2. How many neutrons and electrons are there in a $^{51}_{23}X^{3+}$ ion ?

	Number of neutrons	Number of electrons
A.	23	20
B.	28	23
C.	28	20
D.	51	23

3. Which of the following substances is an electrolyte ?

   A. sodium chloride
   B. silicon dioxide
   C. methanol
   D. mercury

5. Element **X** is one of the first twenty elements in the Periodic Table. **X** forms a stable $XH_4^+(aq)$ ion. Which group of the Periodic Table does **X** most likely belong to ?

   A. Group III
   B. Group IV
   C. Group V
   D. Group VI

Marking Scheme

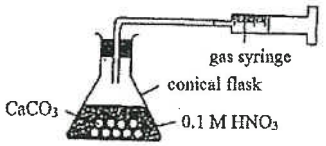
MCQ

CE94_44	D	CE99_01	B	CE99_45	B	CE04_11	C (60%)
CE04_29	C (67%)	CE05SP_02	A	CE05SP_18	D	CE05_05	D (87%)
CE05_19	B (52%)	CE06_25	D (80%)	CE08_08	D (88%)	CE08_42	A (75%)
CE11_28	A (34%)	CE11_40	D (68%)	DSE11SP_03	B	DSE13_19	B (65%)
DSE14_19	D (38%)	DSE14_20	A (63%)	DSE15_02	D (77%)	DSE15_23	D (53%)
DSE16_01	A (81%)	DSE17_14	A (97%)	DSE18_01	B (56%)	DSE18_19	D (68%)

Structural Questions

CE92_02c

(i) [2]



CE92_04b

(ii) Use a clean platinum (or nichrome) wire to carry out the flame test. [1]
Put the wire in concentrated hydrochloric acid and stick some sample solid B on it. [1]
Then heat the wire in a blue Bunsen burner flame and watch the flame colour. [1]

CE94_08b

(i) The cation is K^+ because K^+ compound burns with a lilac (purple) flame. [1]

(ii) Use a clean platinum (or nichrome) wire to carry out the flame test. [1]
Put the wire in concentrated hydrochloric acid and stick some sample solid X on it. [1]
Then heat the wire in a blue Bunsen burner flame and watch the flame colour. [1]

CE95_07a

(i) Citric acid/ vitamin C (ascorbic acid) when dissolved in water gives H^+ (aq) which reacts with calcium carbonate to give gas (CO_2) bubbles. [2]

(iii) Out of moisture (water)/ in a dry place. [1]
Reason: The amount of active ingredients will decrease/ the tablet will lose function/ the active ingredients of the tablet will react in the presence of water. [1]

OR, Out of heat/ in a cool place.
Reason: at high temperature, vitamin C deteriorate / $CaCO_3$ undergoes decomposition / the amount of active ingredients will decrease / the tablet will lose function.

OR, Away from sunlight
Reason: vitamin C may decompose. $CaCO_3$ can be decomposed by sunlight.

CE98_07a(iii)

(1) Calcium carbonate [1]

(2) The materials for making glass are easily available / abundant in the earth crust. [1]

OR, Glass can easily be manufactured by heating sand, limestone and sodium hydroxide.

(3) Champagne contains a pressurized carbon dioxide solution. Glass can withstand the pressure. [1]

OR, The ethanol solution (champagne) can dissolve unpolymerized monomers in plastic.

CE99_02

(b) Calcium burns with a brick-red flame / formation of white powder (solid). [1]

$2Ca(s) + O_2(g) \longrightarrow 2CaO(s)$ [1]

CE02_02

(a) Magnesium burns with a brilliant (very bright) flame. / A white solid (MgO) solid is formed. [1]

$2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$ (white solid) [1]

Note: in some case, a yellow solid (Mg_3N_2) may form.

$3Mg(s) + N_2(g) \longrightarrow Mg_3N_2(s)$ (yellow solid)

CE02_06a

(i) Calcium hydroxide / $Ca(OH)_2$ [1]

CE09_01

(a) Calcium carbonate / $CaCO_3$ [1]

(b) Limestone dissolves. / Gas (bubbles) given out. [1]

$CaCO_3 + 2H^+ \longrightarrow Ca^{2+} + H_2O + CO_2$ [1]

(c) (i) $CaCO_3 \longrightarrow CaO + CO_2$ [1]

(ii) Decomposition of calcium carbonate is an endothermic process. [1]

OR, Carbon dioxide evolved can extinguish fire.

CE10_06

(a) Limewater turns milky and then turns clear again. [1]

$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$ [1]

$CaCO_3 + H_2O + CO_2 \longrightarrow Ca(HCO_3)_2$ [1]

(b) No. Sodium carbonate is soluble in water. [1]

(c) No. The percentage of carbon dioxide in air is very low and similar observations would not be made in a short period of time. [1]

OR, Yes. Air contains a low percentage of carbon dioxide and similar observations would be made in a sufficiently long period of time.

(d) $Na_2CO_3 + 2H^+ \longrightarrow 2Na^+ + H_2O + CO_2$ [1]

AL99(I)_07

Heat the sample. [½]

Water vapour will turn **anhydrous $CuSO_4$(s) from white to blue / anhydrous $CoCl_2$(s) from blue to pink.** [½]

(0 M if heating is not mentioned)

AL00 (II)_02c

(iii) **Evaporate / heat / warm** the solution to obtain a **saturated / concentration solution of NH_4NO_3.** [1]

Allow the solution to cool / use an ice bath to obtain NH_4NO_3(s). [½]

Separate crystal by **filtration.** [½]

ASL01(I)_06

Dissolve the solid sample into water to give solution. [1]

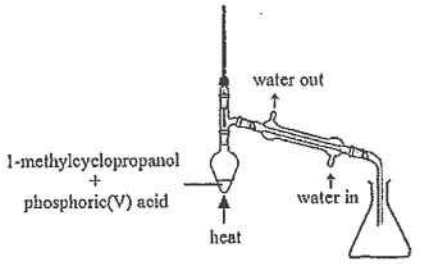
Cation: Heat the sample solution over the non-luminious Bunsen flame. Sample can burn with lilac flame. [1]

Anion: Add few drops of **acidified silver nitrate solution.** [1]

A **white precipitate**, AgCl(s), can be formed. [1]

AL02(I)_08 (modified)

[2]



(1 mark for a workable set-up; 0.5 mark for labeling the reagents and 0.5 mark for the direction of water flow in the condenser.)

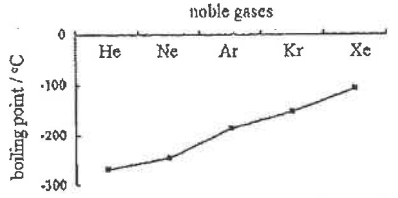
AL02(II)_01

Clean a Pt wire with concentrated HCl. [1]

Stick a sample of the salt onto the Pt wire with concentrated HCl. [1]

Heat wire with the sample in a non-luminous (Bunsen flame) [1]

AL04(I)_02



[1]

The **intermolecular attraction between noble gas molecules is van der Waals' forces.** The **strength of van der Waals' forces increases with the number of electrons / atomic size of the noble gas.** ∴ The boiling point of noble gas increases as the group is descended. [½] [½]

AL04(I)_07

(a) Add water to white powder. Only $SiO_2(s)$ is insoluble. (SiO_2 has giant covalent structure, all structures in giant covalent structure is insoluble in water) [1]

Test the electrical conductivity of the solution obtained. [1]

KBr(aq) conducts, but glucose solution does not. [1]

OR, Conduct a flame test. Only KBr(aq) gives a lilac flame.

OR, Determine the melting points of the solids, KBr(s) has a very high melting point.

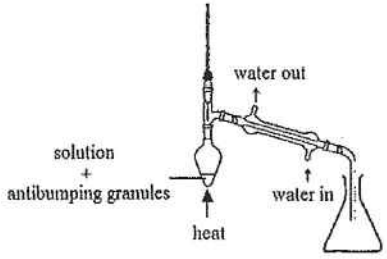
(b) Heat the solid strongly. [1]

Only glucose chars. (burns with unburned carbon) [1]

OR, Add acidified $AgNO_3(aq)$. KBr(aq) gives a pale yellow precipitate.

AL04(I)_08

[2]



(1 mark for a workable set-up; 0.5 mark for labeling the reagents and 0.5 mark for the direction of water flow in the condenser.)

AL06(I)_08

The m.p. determined will be lower than the expected value. [1]

AL07(I)_07

Safety spectacles [1]

Eyes are the most delicate organs. Any harm on eyes cannot easily be recoved. [1]

AL07(I)_08 (modified)

Any THREE of the following: [3]

- Product should have a high solubility in the solvent while the impurities should not.
- The solubility of product in the solvent should be high at elevated temperature but low at room temperature.
- The solvent should be volatile (easily to remove by evaporation / distillation)
- The solvent should not react with product.

ASL10(I)_10

(b) Dissolve the crude product in minimum volume of hot ethanol-water mixture. [1]

Heat the solution with activated charcoal (to remove the color impurities). [1]

Filter the hot mixture (using a short-stem funnel). [½]

Allow the filtrate to cool to room temperature to obtain acetanilide. [½]

(c) Any ONE of the followings: [1]

1. Determine the melting point of the product and compare the result with literature data.
2. Use the method of mixed melting point.

AL11(I)_07

(b) (ii) Add acidified $AgNO_3(aq)$. $Cl^-(aq)$ gives a white precipitate, while $Br^-(aq)$ gives a pale yellow precipitate. [1]

$Ag^+ + Cl^- \longrightarrow AgCl$ [1]

OR, Add $Cl_2(aq)$. Only $Br^-(aq)$ gives a brown solution.

$Cl_2 + 2Br^- \longrightarrow Br_2 + 2Cl^-$

OR, Treat solution wit acidified $KMnO_4(aq)$. $Cl^-(aq)$ causes decolorization slowly; $Br^-(aq)$ gives an orange solution.

$10X^- + 2MnO_4^- + 16H^+ \longrightarrow 5X_2 + 2Mn^{2+} + 8H_2O$

ASL12(I)_09

Heat the mixture. Only $NH_4Cl(s)$ will sublime. [1]

It can be collected on a cold surface. [½]

Add water to the remaining solid mixture. [½]

$PbCl_2(s)$ is insoluble. It can be collected by filtration. [½]

$NaCl(s)$ can be obtained from its solution by crystallization. [½]

OR, Add water to the mixture to **dissolve $NaCl(s)$ and $NH_4Cl(s)$.**

Remove undissolved $PbCl_2(s)$ by filtration.

Separate $NaCl(s)$ and $NH_4Cl(s)$ from the solution by **fractional crystallization / by (ion-exchange) chromatography.**

DSE12PP_02

(b) (i) The outermost shell of an argon atom is a **stable octet structure.** ∴ Ar does not readily form bonds with other atoms [1]

(ii) Ar is denser than air. It displaces air from the bottle, and thus prevents the wine from contact with air. [1]

(iii) He is less dense that air. It will not displace air / it will easily diffuse from the bottle. [1]

(c) The substances with a pleasant odour are **volatile organic compounds.** Pumping air out from the bottle may also remove these substances. [1]

DSE13_01

(b) (i) Water boils at about 100 °C, but the salts in sea water are non-volatile / boiling of water is lower than that of salt. [1]

The steam (water vapor) formed condenses on the cold surface of the condenser / cool down to give liquid water (the distillate). [1]

(ii) To prevent bumping / to prevent frothing / splash / overflow due to overheating of water. [1]

To ensure smooth boiling.

DSE15_02

(a) A white precipitate / solid is firstly formed / It turns milky; the precipitate dissolves in the presence of excess $CO_2(g)$. [1]

$Ca(OH)_2(aq) + CO_2(g) \longrightarrow CaCO_3(s) + H_2O(l)$ [1]

$CaCO_3(s) + CO_2(g) + H_2O(l) \longrightarrow Ca(HCO_3)_2(aq)$ [1]

SECTION 2 Microscopic World I

Multiple-Choice Questions

CE90_02

A cation of a certain element has 22 electrons and a mass number of 55. If the charge on the cation is +3, the number of neutrons in the cation is

A. 19
B. 23
C. 25
D. 30

CE90_03

The atomic numbers of element X and element Y are 13 and 16 respectively. The formula of the compound formed between X and Y is likely to be

A. XY_2
B. X_2Y
C. X_2Y_3
D. X_3Y_2

CE90_04

Which of the following combinations concerning the isotopes of an element is correct?

	No. of protons	No. of neutrons	No. of electrons
A.	same	different	same
B.	same	same	different
C.	different	same	different
D.	same	different	different

CE90_25

Bromine has a low melting point because

A. it is a non-metal.
B. it is a member of the halogen family.
C. the atoms in each bromine molecule are bonded together by a covalent bond.
D. the bromine molecules are attracted together by van der Waals' forces.

CE90_26

Dry zinc chloride solid is a non-conductor of electricity because

A. it is a non-electrolyte.
B. it exists as molecules.
C. its ions are not mobile.
D. metallic bonding is not present.

CE91_01

Directions: Questions 1 and 2 refer to the following table.

Element	W	X	Y	Z
Atomic number	4	8	14	20

Which of the following elements are likely to be metals?

A. W and X
B. W and Z
C. X and Y
D. Y and Z

CE91_02

Directions: Questions 1 and 2 refer to the following table.

Element	W	X	Y	Z
Atomic number	4	8	14	20

The formula of the compound formed between X and Z is likely to be

A. XZ
B. XZ_2
C. X_2Z
D. X_2Z_3

CE91_04

Which of the following groups of ions/atoms has the same number of electrons?

A. K^+, Ca^{2+}
B. Cl^-, S
C. H^+, He
D. O^{2-}, Ar

CE92_02

X and Y are elements. The melting points of their chlorides are given below:

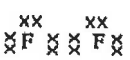
	Melting point (°C)
Chloride of X	772
Chloride of Y	– 68

Which of the following statements is correct?

A. Both X and Y are metals.
B. The chloride of Y is a solid at room temperature.
C. The chloride of X conducts electricity in the solid state.
D. The chloride of Y is a covalent compound.

CE92_03

Which of the following electron diagrams is correct?

A. 
B. 
C. 
D. 

CE92_04

Consider the following table:

Element	W	X	Y	Z
Atomic number	9	10	14	19

Which of the following elements is likely to be an oxidizing agent?

A. W
B. X
C. Y
D. Z

CE92_30

The atomic number and mass number of element E are 8 and 17 respectively. What are the number of protons and neutrons in an atom of E?

	Number of protons	Number of neutrons
A.	8	9
B.	8	17
C.	9	8
D.	9	17

CE92_45

1st statement	2nd statement
Both zinc and molten sodium chloride conduct electricity.	Both zinc and molten sodium chloride contain mobile ions.

CE93_01

Which of the following pairs of atoms/ions has the same number of electrons?

A. Mg^{2+} and F
B. Cl^- and Ne
C. K^+ and O^{2-}
D. Cl^- and S^{2-}

CE93_02

The elements, sodium to chlorine, in the third period of the Periodic Table show a gradual change in properties. Which of the following changes is correct?

A. Their melting points increase.
B. Their ability to gain electrons increases.
C. Their oxides change from acidic to basic.
D. Their chloride change from covalent to ionic.

CE93_23

Which of the following statements about a solution of hydrogen chloride in water is correct?

A. The hydrogen chloride exists as molecules in the solution.
B. The hydrogen chloride is slightly ionized in water.
C. The pH value of the solution is greater than 7.
D. The reaction between the solution and aqueous ammonia is exothermic.

CE94_01

If the atomic number of an element X is 13, the formula of its oxide is

A. XO_2
B. XO_3
C. X_2O_3
D. X_3O_2

CE94_02

Consider the information given in the table below:

Atom	Atomic number	Mass number	No. of neutrons
P	6	14	
Q	7	14	
R		13	7
S		18	10
T	10		10

Which of the following atoms are isotopes?

A. P and Q
B. P and R
C. R and S
D. S and T

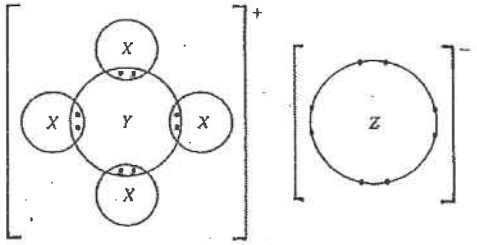
CE94_03

Which of the following molecules has the greatest number of lone pairs of electrons?

A. fluorine
B. hydrogen
C. nitrogen
D. oxygen

CE94_36

X, Y and Z are these different elements. The electronic diagram (showing electrons in the outermost shells only) of the compound formed by X, Y and Z is shown below:



Which of the following statement are correct?

(1) There is one electron in the outermost shell of an atom of X.
(2) There are five electrons in the outermost shell of an atom of Y.
(3) There are eight electrons in the outermost shell of an atom of Z.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE94_46

1st statement	2nd statement
Hydrogen chloride has a lower melting point than sodium chloride.	In each molecule of hydrogen chloride, a hydrogen and a chlorine atom are joined together by a covalent bond.

CE95_01

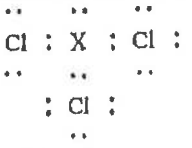
The atomic number of an element X is 18. An atom of X has a mass number of 40.

The atom has

A. 18 protons, 22 neutrons and 18 electrons.
B. 18 protons, 22 neutrons and 22 electrons.
C. 18 protons, 40 neutrons and 18 electrons.
D. 22 protons, 22 neutrons and 18 electrons.

CE95_02

The electronic structure of a compound formed between an element X and chlorine is shown below.



(Only electrons in the outermost shells are shown.)

What would be the formula of the compound formed between X and magnesium?

A. MgX
B. MgX_2
C. Mg_2X_3
D. Mg_3X_2

CE95_03

Which of the following correctly describes the structure of quartz?

A. giant covalent structure
B. giant ionic structure
C. giant metallic structure
D. simple molecular structure

CE95_04

Boron consists of two isotopes. The table below lists the relative abundance of these two isotopes.

Isotope	Relative abundance
$^{10}_{5}B$	19.7%
$^{11}_{5}B$	80.3%

The relative atomic mass of boron (correct to 1 decimal place) is

A. 10.4
B. 10.6
C. 10.8
D. 11.0

CE95_06

Which of the following fertilizers contains the largest percentage by mass of nitrogen?

(Relative atomic masses: H = 1.0, N = 14.0, O = 16.0, Na = 23.0, S = 32.0, Cl = 35.5, K = 39.0)

A. ammonium chloride
B. ammonium sulphate
C. potassium nitrate
D. sodium nitrate

CE95_26

Which of the following elements is a semi-metal?

A. Hg
B. Si
C. C
D. Be

CE95_34

Which of the following particles is/are present in a hydrogen ion?

(1) proton
(2) neutron
(3) electron

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE95_39

Which of the following substances can conduct electricity?

(1) molten zinc chloride
(2) an aqueous solution of magnesium sulphate
(3) a mixture of ethanol and water

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE96_01

Magnesium and calcium have similar chemical properties because

A. their atoms have the same atomic structure.
B. their atoms have the same number of electron shells.
C. their atoms have the same number of electron in their outermost shells.
D. their atoms have the same electronic arrangement.

CE96_02

Which of the following can represent the electronic structure of potassium sulphate?

A. $[K]_2^+ [:\ddot{S}:]^{2-}$
B. $2[K]^+ [:\ddot{S}:]^{2-}$
C. $[K]^{2+} [:\ddot{S}:]^{2-}$
D. $:\ddot{K}:\ \ddot{S}:$

CE96_03

The mass number of atom *X* is 27. *X* forms a cation with a charge of +3. If the number of neutrons in the cation is 14, what is the number of electrons in the *cation*?

A. 10
B. 13
C. 14
D. 17

CE96_39

The atomic number of element *X* is 16. Which of the following statements concerning *X* are correct?

(1) *X* can react with calcium to form an ionic compound.
(2) The oxide of *X* dissolves in water to form an acidic solution.
(3) *X* can conduct electricity in its molten state.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE96_44

Which of the following elements can react together to form a covalent compound?

(1) argon
(2) nitrogen
(3) oxygen
(4) calcium

A. (1) and (2) only
B. (1) and (4) only
C. (2) and (3) only
D. (3) and (4) only

CE96_45

1st statement	2nd statement
The melting point of hydrogen chloride is lower than that of potassium chloride.	Hydrogen chloride is a covalent compound whereas potassium chloride is an ionic compound.

CE96_50

1st statement	2nd statement
Both dry ice and quartz exist in the form of discrete molecules.	Carbon and silicon atoms have the same number of electrons in their outermost shells.

CE97_01

The chemical properties of an element depend on

A. its relative atomic mass.
B. the number of isotopes of the element.
C. the number of electron shells in its atoms.
D. the number of outermost shell electrons in its atoms.

CE97_02

Elements X and Y form a compound having the following electronic structure:

$[:\ddot{\underset{\cdot\cdot}{Y}}:]^-$ $[:\ddot{\underset{\cdot\cdot}{X}}:]^{2+}$ $[:\ddot{\underset{\cdot\cdot}{Y}}:]^-$

(Only outermost shell electrons are shown.)

Which of the following combinations is correct?

	X	Y
A.	Na	S
B.	Mg	Br
C.	Al	Cl
D.	Si	O

CE97_03

Argon exists as a gas at room temperature and pressure because

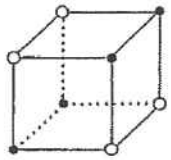
A. argon molecules are monoatomic.
B. argon is chemically inert.
C. the outermost electron shell of an argon atom has an octet structure.
D. the attractive force between argon atoms is weak.

CE97_05

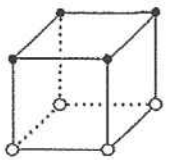
Which of the following diagrams best represents a part of the giant lattice of sodium chloride crystal?

(In these diagrams, ● represents Na^+ ion and ○ represents Cl^- ion)

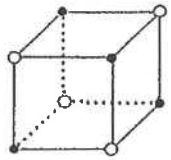
A.



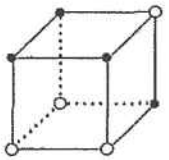
C.



B.



D.



CE97_30

M is an element in the third period of the Periodic Table. M forms a sulphate which has the formula $M_2(SO_4)_3$. The formula of the nitrate of M is

A. MNO_3. B. $M(NO_3)_2$.
C. $M(NO_3)_3$. D. $M_2(NO_3)_3$.

CE98_01

An element X exists as molecules. X has an atomic number of 7 and a molecule of X has a formula X_2. Which of the following can represent the electronic structure of X_2?

A. $:\ddot{\underset{\cdot\cdot}{X}}:\ddot{\underset{\cdot\cdot}{X}}:$ B. $:\dot{\underset{\cdot\cdot}{X}}::\dot{\underset{\cdot\cdot}{X}}:$

C. $:\ddot{\underset{\cdot\cdot}{X}}::\ddot{\underset{\cdot\cdot}{X}}:$ D. $:\underset{\cdot\cdot}{X}\vdots\vdots\underset{\cdot\cdot}{X}:$

CE98_18

Which of the following ions has the same number of protons as the hydroxide ion, OH^- ?

A. O^{2-} B. F^-
C. Na^+ D. Mg^{2+}

CE98_33

Consider the following information:

Substance	Melting point /°C	Electrical conductivity at room temperature	Solubility in water
W	−34	poor	slightly soluble
X	44	poor	insoluble
Y	232	poor	insoluble
Z	782	poor	very soluble

Which of the above substances exists as a simple molecular solid at room temperature?

A. *W* B. *X*
C. *Y* D. *Z*

CE98_45

1st statement	2nd statement
Element X (atomic number 11) reacts with element Y (atomic number 16) to form an ionic compound.	Each atom of X loses one electron and each atom of Y accepts two electrons to form a compound with X_2Y.

CE99_05

Consider the information concerning particle *X* and particle *Y* listed below:

Particle	Number of protons	Number of electrons	Number of neutrons
X	16	16	18
Y	16	18	18

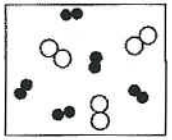
Which of the following statements is correct?

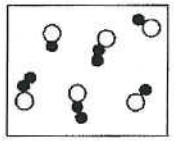
A. *X* and *Y* are atoms of the same element.
B. *X* and *Y* are atoms of different element.
C. *X* is a cation of *Y*.
D. *Y* is an anion of *X*.

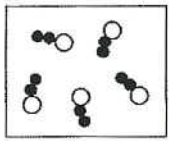
CE99_01

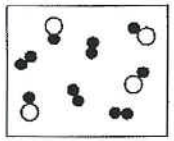
Which of the following diagrams can represent a mixture of two compounds?

(In these diagrams, ● and ○ represent a nitrogen atom and an oxygen atom respectively.)

A. 

B. 

C. 

D. 

CE99_11

The table below shows the ability of four substances *W, X, Y* and *Z* to conduct electricity.

(In the table, √ and × respectively represent 'can conductivity' and 'cannot conduct electricity'.)

Substance	Solid state	Liquid state	Aqueous solution
W	×	√	√
X	×	×	√
Y	×	×	×
Z	√	√	(insoluble in water)

Which of the substances is likely to be zinc chloride?

A. *W*
B. *X*
C. *Y*
D. *Z*

CE99_19

Ionic compound *X* has the formula AB_2, where A and B represent the cation and anion respectively. If both A and B have the same electronic arrangement, X may be

A. potassium sulphide.
B. magnesium fluoride.
C. silicon dioxide.
D. calcium bromide.

CE99_34

Iodine is a solid at room temperature and pressure. Which of the following statement concerning the structure of iodine is/are correct?

(1) Iodine has a giant covalent structure.
(2) Iodine molecules are held together by van der Waals' forces.
(3) Iodine atoms are held together in pairs by covalent bonds.

A. (1) only.
B. (2) only.
C. (1) and (3) only.
D. (2) and (3) only.

CE99_39

Element X has an isotope $^{31}_{15}X$. Which of the following statements is/are correct?

(1) X belongs to V of the Periodic Table.
(2) X can react with oxygen to form an ionic compound.
(3) $^{31}_{15}X$ has 16 neutrons.

A. (1) only.
B. (2) only.
C. (1) and (3) only.
D. (2) and (3) only.

CE99_46

1st statement	2nd statement
Metals have good thermal conductivity.	Metals are composed of giant lattices of positive ions surrounded by valence electrons which are free to move throughout the lattice.

CE00_01

A compound formed from element X and sulphur has the following electronic structure:

(Only electrons in the outermost shells are shown.)

How many electrons are there in the outermost shell of an atom of X?

A. 2
B. 4
C. 6
D. 8

CE00_07

Element X occurs in nature as two isotopes, ^{63}X and ^{65}X. If the relative atomic mass of X is 63.5, what is the relative abundance of the ^{63}X isotope?

A. 25%
B. 60%
C. 75%
D. 90%

CE00_09

The atomic number of element X is 12. X reacts with element Y to form an ionic compound with formula XY_2. To which group of the Periodic Table does Y belong?

A. Group I
B. Group IV
C. Group VI
D. Group VII

CE00_17

The melting point and boiling point of substance X are 321°C and 765°C respectively. In its molten state, X conducts electricity without decomposition. X probably has

A. an ionic structure.
B. a metallic structure.
C. a simple molecular structure.
D. a covalent network structure.

CE00_34

Which of the following statements concerning helium is/are correct?

(1) The outermost electron shell of a helium atom has an octet structure.
(2) Helium is used to fill water weather balloons.
(3) Helium exists as monatomic molecules.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE00_39

X is an element in Group VI of the Periodic Table. X can form X^{2-} ions. Which of the following statements are correct?

(1) The oxidation number of X decrease when X^{2-} ion is formed.
(2) Both X atom and X^{2-} ion have the same number of electron shells.
(3) Both X atom and X^{2-} ion have the same nuclear charge.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE00_42

Which of the following statements concerning carbon, silicon and phosphorus are correct?

(1) Carbon forms numerous compounds with hydrogen and oxygen.
(2) Silicon is used to make computer chips.
(3) Phosphorous is an essential element for plant growth.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE00_46

1st statement	2nd statement
Carbon dioxide and silicon dioxide have similar physical properties.	The atoms of carbon and silicon have the same number of electrons in their outermost shells.

CE01_01

Which of the following ions is responsible for the yellow colour of topaz?

A. Mn^{2+}
B. Mn^{3+}
C. Fe^{2+}
D. Fe^{3+}

[Note: Topaz is a yellow coloured gemstone.]

CE01_07

Which of the following statements concerning water is correct?

A. It reacts with calcium to give a colourless gas.
B. It is a strong electrolyte.
C. It turns anhydrous cobalt(II) chloride from pink to blue.
D. It is immiscible with methanol.

CE01_18

Consider the following information about four substances, W, X, Y and Z:

Substances	Melting point /°C	Electrical conductivity at room temperature
W	–23	poor
X	56	poor
Y	232	good
Z	750	poor

Which substance has a simple molecular structure and is a solid at room temperature?

A. W
B. X
C. Y
D. Z

CE01_20

The table lists some information about two elements, X and Y:

Element	Atomic number	Relative atomic mass
X	12	24.0
Y	9	19.0

The compound formed from X and Y has a formula mass of

A. 43.0
B. 62.0
C. 67.0
D. 81.0

CE01_37

Consider the information listed below:

	Substance	Attraction between particles in substance
(1)	helium	van der Waals' forces
(2)	diamond	covalent bond
(3)	magnesium oxide	ionic bond

Which of the following combination are correct?

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE01_42

Which of the following ions have the same number of electrons as neon atom?

(1) Mg^{2+}
(2) O^{2-}
(3) Cl^{-}

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE01_49

1st statement	2nd statement
Lithium is the most reactive element in Group I of the Periodic Table.	Among the Group I elements, lithium loses electrons most readily.

CE02_01

The electronic diagram of an atom of element X is shown below:

(Only electrons in the outermost shell are shown.)

The atomic number of X is probably

A. 7
B. 15
C. 17
D. 19

CE02_28

Which of the following substances does not conduct electricity in its solid state but does conduct electricity in its liquid state?

A. lithium chloride
B. phosphorous
C. platinum
D. perspex

CE02_36

Which of the following statements concerning fluorine is/are correct?

(1) It exists as monatomic molecules.
(2) It reacts with hydrogen to form a covalent compound.
(3) It reacts with calcium to form a compound with formula CaF_2.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE02_46

1st statement	2nd statement
Combustion of diamond gives carbon dioxide.	Diamond is a crystalline form of carbon.

CE02_49

1st statement	2nd statement
When iodine sublimes, it absorbs energy.	Energy is required to overcome the attractive force between iodine molecules.

CE03_01

Which of the following pairs of elements in Group I and VII of the Periodic Table would react with each other most vigorously?

	Group I	Group VII
A.	lithium	fluorine
B.	lithium	iodine
C.	potassium	fluorine
D.	potassium	iodine

CE03_12

Gallium (Ga) occurs naturally in two isotopic forms, ^{69}Ga and ^{71}Ga. The table below lists the relative abundance of each isotope.

Isotope	Relative abundance
^{69}Ga	60.2%
^{71}Ga	39.8%

What is the relative atomic mass of gallium?

A. 69.6
B. 69.8
C. 70.0
D. 70.2

CE03_25

An atom of element X has 20 protons while an atom of element Y has 7 electrons. What is the formula of the compound formed from X and Y?

A. XY_2
B. X_2Y_3
C. X_2Y_5
D. X_3Y_2

CE03_46

1st statement	2nd statement
^{35}Cl and ^{37}Cl have the same chemical properties.	The number of electrons in the outermost shell of a ^{35}Cl atom is equal to that of a ^{37}Cl atom.

CE05SP_03

Which of the following substances can conduct electricity in both solid and liquid states?

A. sulphur
B. mercury
C. quartz
D. lead(II) bromide

CE05SP_16

Which of the following natural substances is essentially a single compound?

A. air
B. coal
C. petroleum
D. quartz

CE05SP_31

Caesium (Cs) is a group I element in the Periodic Table and its relative atomic mass is greater than that of potassium. Which of the following statements concerning caesium is INCORRECT?

A. Caesium is a weaker reducing agent than potassium.
B. Caesium reacts violently with water.
C. Caesium is a soft metal.
D. Caesium reacts with oxygen to form an oxide with formula Cs_2O.

CE04_01

How many elements does ammonium dichromate consist of?

A. 2
B. 3
C. 4
D. 5

CE04_02

X, Y and Z are three consecutive elements in the Periodic Table. X forms a stable anion X^-, while Z forms a stable cation Z^+. Which of the following statements about X, Y and Z is correct?

A. X, Y and Z are elements in the same period of the Periodic Table.
B. Both X and Z are electrical conductors under room temperature and pressure.
C. Y reacts with Z readily.
D. X^- and Z^+ have the same electronic arrangement.

CE04_10

Which of the following combinations concerning the properties of gases is INCORRECT?

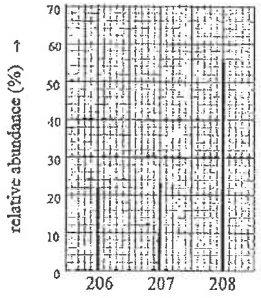
	Gas	*Property*
A.	Ammonia	has an irritating odour
B.	Methane	dissolves readily in water
C.	Carbon monoxide	can burn in air
D.	Nitrogen monoxide	changes from colourless to brown when exposed to air

CE04_23

Element X has three isotopes, ^{206}X, ^{207}X and ^{208}X. The graph below shows the relative abundances of the isotopes.

What is the relative atomic mass of *X*?

A. 206.8 B. 207.0
C. 207.3 D. 207.5



CE04_30

Refer to the melting points and boiling points of four substances at 1 atm pressure as listed in the table below:

Substance	Melting point /°C	Boiling point /°C
argon	−189	−186
bromine	−7	59
chlorine	−101	−35
sulphur dioxide	−75	−10

Which of the following chemical bonds/attractive forces exist(s) in all four substances at 25°C and 1 atm pressure?

(1) van der Waals' forces
(2) ionic bond
(3) covalent bond

A. (1) only B. (2) only
C. (1) and (3) only D. (2) and (3) only

CE04_31

The atomic number of element X is 15. It has only one isotope with a mass number of 31. Which of the following statements concerning X is correct?

A. X forms an oxide which dissolves in water to give an alkaline solution.
B. In the compound formed from X and sodium, X has an oxidation number of −3.
C. X is a gas at room temperature and pressure.
D. There are 15 neutrons in the nucleus of an atom of X.

CE05_03

The table below gives some information about certain components in a sample of liquefied air.

Component	Boiling point /°C
argon	−186
nitrogen	−196
oxygen	−183

In what order are these components distilled out when the sample undergoes fractional distillation?

A. nitrogen, oxygen, argon
B. nitrogen, argon, oxygen
C. oxygen, argon, nitrogen
D. oxygen, nitrogen, argon

CE05_06

Consider the information given in the table below:

Element	Atomic number
w	6
x	17
y	18
z	20

Which of the following pairs of elements would react with each other most readily?

A. w and y B. w and z
C. x and y D. x and z

CE05_07

Which of the following statements concerning van der Waals' forces is correct?

A. They exist in quartz.
B. They exist in limestone.
C. They exist in solid iodine.
D. They exist in solid ammonium nitrate.

CE05_09

Which of the following chlorides has the highest melting point?

A. HCl B. LiCl
C. SCl_2 D. CCl_4

CE05_13

Consider the information given in the table below:

	Particle			
	X	Y	Z	W
No. of protons	8	8	8	10
No. of electrons	10	10	8	10
No. of neutrons	8	10	10	10

Which of the following statements about the particles is correct?

A. W and Z are isotopes.
B. X and Z have the same mass.
C. Y and Z have the same charge.
D. X and W have the same electronic arrangement.

CE05_27

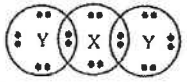
Which of the following properties of sodium chloride is/are evidence(s) to support that ionic bonds are strong?

(1) It is soluble in water.
(2) It has a high melting point.
(3) It can conduct electricity in molten state.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE06_01

The electronic diagram of a compound formed between element X and element Y is shown below:



(Only electrons in the outermost shells are shown.)

Which of the following combinations concerning X and Y is correct?

	X	Y
A.	carbon	oxygen
B.	silicon	oxygen
C.	oxygen	sodium
D.	oxygen	chlorine

CE06_02

Which of the following statements about the Periodic Table is correct?

A. The elements are arranged in order of increasing relative atomic mass.
B. The reactivity of the elements in Group II decreases down the group.
C. The boiling point of the elements in Group VII decreases down the group.
D. All elements in Group 0 exist in gaseous state at room temperature and pressure.

CE06_04

Which of the following combinations concerning the change of physical state of a substance is INCORRECT?

	Change of physical state	Process
A.	liquid to gas	evaporation
B.	liquid to solid	precipitation
C.	solid to gas	sublimation
D.	gas to liquid	condensation

CE06_05

$^{56}_{26}Fe$ is an isotope of iron. Which of the following correctly describes the number of subatomic particles in an Fe^{2+} ion formed from this isotope?

	No. of electrons	No. of neutrons
A.	23	26
B.	23	30
C.	24	26
D.	26	30

CE06_06

Which of the following substance exist(s) in liquid state at room temperature and pressure?

Substance	Melting point /°C	Boiling point /°C
W	–92	7
X	7	81
Y	56	197
Z	–95	69

A. W only
B. X only
C. X and Z only
D. Y and Z only

CE06_14

Element X has two isotopes, ^{39}X and ^{41}X. The table below lists the percentage abundance of the two isotopes:

Isotope	Percentage abundance
^{39}X	93.2
^{41}X	6.8

What is the relative atomic mass of X?

A. 39.0
B. 39.1
C. 40.0
D. 40.9

CE06_24

In which of the following atoms or ions is the outermost shell an octet?

(1) Li^+

(2) Ne

(3) S^{2-}

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE07_03

X is an element in the Periodic Table and X^+ ion has an electronic arrangement of 2, 8, 8. Which of the following statements concerning X is correct?

A. X is a halogen
B. X is a transition element
C. X is a group 0 element
D. X is a period 4 element

CE07_12

Which of the following pairs of elements would form a covalent compound?

A. mercury and neon
B. neon and nitrogen
C. mercury and fluorine
D. fluorine and nitrogen

CE07_13

M is an element in the Periodic Table. M^{2-} ion possesses 45 neutrons and 36 electrons. What is M?

A. Se
B. Kr
C. Sr
D. Rh

CE07_18

Consider the information below:

Solid	Melting point	Electrical conductivity	Solubility in water
W	High	Good	Insoluble
X	High	Non-conducting	Soluble
Y	Low	Non-conducting	Soluble
Z	Very high	Non-conducting	Insoluble

Which of the following solids is likely to be an ionic compound?

A. W
B. X
C. Y
D. Z

CE07_28

1st statement	2nd statement
Molten sulphur is a good conductor of electricity.	Sulphur molecules are mobile in molten sulphur.

CE07_29

1st statement	2nd statement
Isotopes of an element have the same mass.	Isotopes of an element have the same number of protons.

CE07_43

Which of the following bonds or attractive forces exist in ammonium nitrate?

(1) ionic bond

(2) covalent bond

(3) van der Waals' forces

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE08_02

J and Q are two alkaline earth metals in the Periodic Table. If the atomic number of J is x, then the atomic number of Q could be

A. $x-2$
B. $x+6$
C. $x-10$
D. $x+18$

CE08_18

In which of the following groups of substances there exists a difference in bonding type among the substances?

A. iodine, oxygen, nitrogen
B. chromium, mercury, aluminium
C. methane, ethyl ethanoate, sulphur dioxide
D. potassium chloride, hydrogen chloride, silver chloride

CE08_19

Which of the following statements concerning a water molecule is/are correct?

(1) The number of bonding electrons contributed by each hydrogen atom in the molecule is 2.

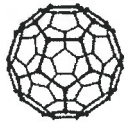
(2) The number of bonding electrons contributed by the oxygen atom in the molecule is 2.

(3) The total number of electrons in the molecule is 8.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE08_46

A certain form of solid carbon is composed of C_{60} molecules. Each C_{60} molecule is formed by 60 carbon atoms bonded together like a football as shown in the diagram below:



Which of the following statements is/are correct?

(1) The molar mass of C_{60} is 12.0 g.
(2) The solid gives carbon dioxide upon complete combustion.
(3) The melting point of the solid is higher than that of diamond.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE09_01

The electronic arrangements of three chemical species are shown below:

W : 2, 1
X^{2+} : 2, 8
Y^- : 2, 8, 7

Which of the elements W, X and Y are in the same period of the Periodic Table?

A. W and X only
B. W and Y only
C. X and Y only
D. W, X and Y

CE09_07

A colorless aqueous solution of compound Z can conduct electricity and turns blue litmus paper red. It can be deduced that

A. Z must be an ionic compound.
B. Z must contain hydrogen in its chemical formula.
C. Solution of Z must contain more ions than molecules.
D. Solution of Z must contain more H^+ ions than OH^- ions.

CE09_18

Which of the following statements concerning the Periodic Table is/are correct?

(1) Ni is an example of transition elements.
(2) The elements are arranged in increasing order of neutron number.
(3) The lower the element located in each group, the more reactive the element is.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE09_19

Which of the following substances can exist in the form of simple molecules?

(1) iodine
(2) nylon
(3) dry ice

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE09_22

A substance has a high melting point and does not conduct electricity when in solid state. It may be

(1) a compound with giant molecules.
(2) an element with giant covalent structure.
(3) A compound with giant ionic structure.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE09_28

1st statement	2nd statement
Ammonium chloride is an ionic compound.	Ammonium chloride can conduct electricity in aqueous state.

CE10_01

How many electrons and neutrons are there in a doubly charged cation formed from $^{55}_{25}Mn$?

	Number of electrons	Number of neutrons
A.	23	30
B.	23	32
C.	25	28
D.	25	30

CE10_13

Which of the following combinations shows a correct matching of a molecule and its structural formula?

	molecule	structural formula
A.	nitrogen	N=N
B.	helium	He–He
C.	carbon dioxide	O–C–O
D.	hydrogen peroxide	H–O–O–H

CE10_17

Which of the substances listed in the following table has a giant ionic structure?

Substance	Electrical conductivity in solid state	Electrical conductivity in molten state
W	not conducting	not conducting
X	not conducting	conducting
Y	conducting	not conducting
Z	conducting	conducting

A. W
B. X
C. Y
D. Z

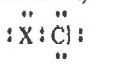
CE11_01

Element Q forms a stable Q^{2+} ion. What may the atomic number of Q be?

A. 6
B. 11
C. 14
D. 20

CE11_02

The atomic number of element X is 15. X reacts with chlorine to form a chloride. Which of the following can represent the electronic diagram of the chloride? (Only electrons in the outermost shells are shown.)

A.


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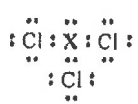

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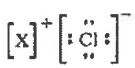
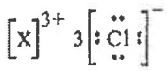


D.


CE11_03

Which of the following substances is a single compound?

A. graphite
B. vinegar
C. ethanol
D. Petrol

CE11_31

X, Y and Z are three different elements. X^{2+} ion, Y^- ion and argon atom have the same electronic arrangement. Z belongs to the same period as X and the same group as Y in the Periodic Table. What is Z?

A. Mg
B. Cl
C. Ca
D. Br

AL10(I)_03 (modified)

^{123}I and ^{127}I are two isotopes of iodine. ^{123}I is radioactive with a half-life (time required to reduce by half of its original amount) of 13 hours, while ^{127}I is not radioactive. Which of the following statements about these two isotopes is/are correct?

(1) ^{123}I is chemically more reactive than ^{127}I.
(2) ^{123}I has a greater proton-to-neutron ratio than ^{127}I.
(3) The number of ^{123}I atoms in a sample drops to ¼ of its original value after 26 hours.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE11SP_07

The atomic number of an element X is 18. An atom of X has a mass number of 40. The atom has

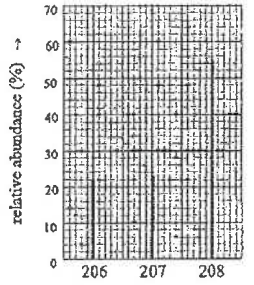
A. 18 protons, 22 neutrons and 18 electrons.
B. 18 protons, 22 neutrons and 22 electrons.
C. 18 protons, 40 neutrons and 18 electrons.
D. 22 protons, 22 neutrons and 18 electrons.

DSE11SP_11

Element X has three isotopes, ^{206}X, ^{207}X and ^{208}X. The graph (on the right) shows the relative abundances of the isotopes.

What is the relative atomic mass of X?

A. 206.8
B. 207.0
C. 207.3
D. 207.5



DSE11SP_22

Iodine is a solid at room temperature and pressure. Which of the following statements concerning the structure of iodine is/are correct?

(1) Iodine has a giant covalent structure.
(2) Iodine molecules are held together by van der Waals' forces.
(3) Iodine atoms are held together in pairs by covalent bonds.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE11SP_24

1st statement	2nd statement
Carbon dioxide and silicon dioxide have similar physical properties.	The atoms of carbon and silicon have the same number of electrons in their outermost shells.

DSE11SP_36

1st statement	2nd statement
The reaction of ethanoic acid with ethanol is a neutralization.	Water is one of the products in the reaction of ethanoic acid and ethanol.

DSE12PP_01

Element **X** occurs in nature in two isotopes, ^{69}X and ^{71}X. The table below lists the relative abundance of each isotope:

Isotope	Relative abundance (%)
^{69}X	60.0
^{71}X	40.0

A. 69.6
B. 69.8
C. 70.0
D. 70.2

DSE12PP_03

Which of the following species is NOT an appropriate example for illustrating dative bond formation?

A. NH_3
B. NH_4^+
C. BF_4^-
D. BF_3NH_3

DSE12PP_04

Which of the following statements about silicon dioxide is correct?

A. It consists of discrete molecules.
B. It melts upon heating in a test tube.
C. It is ductile.
D. It is a poor conductor of electricity.

DSE12PP_15

Which of the following statements best describes metallic bonding?

A. It is an attractive force between ions.
B. It is an attractive force between polar chemical species.
C. It is an attractive force between atomic nuclei and bond-pair electrons.
D. It is an attractive force between cations and delocalized electrons.

DSE12PP_18

Barium (Ba) is an element in Group II of the Periodic Table. Which of the following is/are the expected observation(s) when a small piece of barium is added to a trough of water containing a few drops of phenolphthalein?

(1) A colorless gas is liberated.
(2) The piece of barium floats on the water surface.
(3) The resulting solution in the trough is colorless.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE12_01

Which of the following substances CANNOT conduct electricity?

A. Pt(s)
B. $PbBr_2(l)$
C. C(graphite)
D. $CH_3CH_2OH(l)$

DSE12_08

Silicon and carbon react to form silicon carbide. The crystal structure of silicon carbide is similar to that of diamond. Silicon carbide is very hard because

A. It has a high melting point.
B. Silicon atoms and carbon atoms form triple bonds.
C. It has a giant network structure with strong covalent bond.
D. Both silicon and carbon atoms have four outermost shell electrons.

DSE12_15

Which of the following statements concerning an ^{131}I and a ^{131}Xe atom is/are correct?

(1) They have the same number of protons.
(2) They have different numbers of neutrons.
(3) They have different numbers of outermost shell electrons.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE13_01

Silicon is an element in Group IV of the Periodic Table. The oxide of silicon has the chemical formula SiO_2. Which of the following statement about silicon and its oxide is correct?

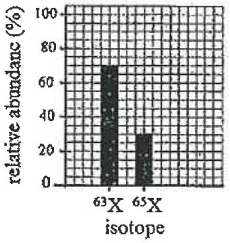
A. Silicon is a good conductor of heat.
B. Silicon exists as simple molecules.
C. SiO_2 is a hard material at room temperature.
D. SiO_2 dissolves in water to give an acidic solution.

DSE13_02

Suppose that element **X** has only two isotopes, ^{63}X and ^{65}X. The graph (on the right) shows the relative abundance of the two isotopes:

Which of the following is the relative atomic mass of X?

A. 63.3
B. 63.5
C. 63.6
D. 64.0



DSE13_04

Scandium (Sc) is a metal. Scandium, in its compounds, exhibits only one oxidation number. The chemical formula of scandium nitrate is $Sc(NO_3)_3$. Which of the following is most likely to be the chemical formula of scandium phosphate?

A. $Sc_2(PO_4)_3$
B. $ScPO_4$
C. $Sc(PO_4)_2$
D. $Sc(PO_4)_3$

DSE13_12

Both radium (Ra) and calcium (Ca) belong to the same group of the Periodic Table. Which of the following statements is INCORRECT?

A. Radium is a good conductor of electricity in the solid state.
B. Radium atoms readily donate electrons to form Ra^{2+} ions.
C. Both radium and calcium become tarnished after exposed to air for some time.
D. Radium is less reactive than calcium.

DSE14_01

Which of the following atoms has the smallest number of neutrons?

A. ^{63}Cu
B. ^{59}Co
C. ^{58}Ni
D. ^{57}Fe

DSE14_02

Which of the following compounds has a giant ionic structure?

A. N_2O_4
B. HNO_3
C. NCl_3
D. NH_4NO_3

DSE15_03

Element **Q** belongs to Group II of the Periodic Table. It combines with element **R** to give an ionic compound with chemical formula Q_3R_2 Which group of the Periodic Table does R belong to?

A. Group III
B. Group V
C. Group VI
D. Group VII

DSE15_15

Which of the following statements concerning 'atom' is correct?

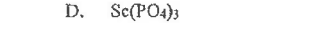
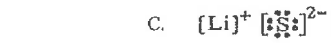
A. All atoms do not carry net charges.
B. Mass is evenly distributed within an atom.
C. All atoms consist of protons, neutrons and electrons.
D. For all elements, atoms of the same element have the same mass number.

DSE15_35

1st statement	2nd statement
The melting point of silicon is higher than that of aluminium.	The number of electrons in a silicon atom is greater than that in an aluminium atom.

DSE16_02

Which of the following is the electron diagram (only electrons in the outermost shell are shown) of lithium sulphide?

A. 
B. 
C. 
D. 

DSE17_01

Elements **X** and **Y** form an ionic compound with chemical formula X_2Y. If the ion of **X** and ion of **Y** have the same electronic arrangement, which of the following may this compound be?

A. Lithium oxide
B. Aluminium oxide
C. Potassium sulphide
D. Magnesium chloride

DSE17_16

Which of the following statements concerning helium is/are correct?

(1) Helium is chemically inert.
(2) Helium exists as diatomic molecules.
(3) The outermost electron shell of a helium atom has an octet structure.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE18_02

Neon exists as a gas at room temperature and pressure because

A. neon is chemically inert.
B. neon molecule are monoatomic.
C. the attractive force between neon atoms is weak.
D. the outermost electron shell of a neon atom has an octet structure.

DSE18_05

Quartz (SiO_2) is harder than dry ice (CO_2) because

A. the atomic size of silicon is larger than that of carbon.
B. a silicon atom has more electrons than a carbon atom has.
C. quartz has a giant network structure, but dry ice consists of discrete molecules.
D. the silicon-oxygen bond in quartz is strong, but the carbon-oxygen bond in dry ice is weak.

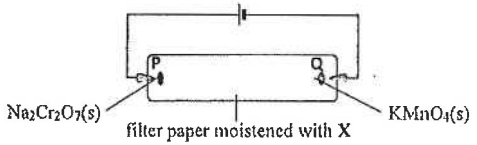
DSE19_01

Which of the following pairs of atomic numbers corresponds to elements with similar chemical properties?

A. 4, 14
B. 8, 18
C. 9, 35
D. 19, 38

DSE19_02

The set-up of an experiment is shown below :



What can be observed after the circuit is closed for a period of time ?

A. If X is dilute H_2SO_4, a purple patch migrates towards P.
B. If X is dilute H_2SO_4, a orange patch migrates towards Q.
C. If X is ethanol, a purple patch migrates towards P
D. If X is ethanol, an orange patch migrates towards X.

DSE19_24

	1st statement	2nd statement
	Mercury has good electrical conductivity at room temperature.	Mercury has delocalized electrons.

DSE2020:

2. Which of the following statements concerning quartz is correct ?

A. Quartz is soluble in hexane.
B. Quartz consists of SiO_2 molecules.
C. Quartz conducts electricity by delocalised electrons.
D. Quartz is hard because it has a giant covalent network structure.

3. What is the mass of oxygen in 24.0 g of $CuSO_4 \cdot 5H_2O(s)$?

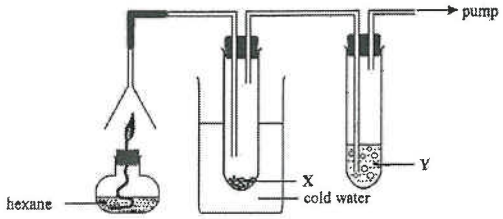
(Relative atomic masses : H = 1.0, O =16.0, S = 32.1, Cu = 63.5)

A. 6.2 g
B. 9.6 g
C. 13.8 g
D. 21.7 g

5. Which of the following statements concerning francium (atomic number = 87) is correct ?

A. Francium has a higher melting point than potassium.
B. Francium forms cations more readily than potassium.
C. Francium is a weaker oxidising agent than potassium.
D. Francium has a fewer number of occupied electron shells than potassium.

14. The set-up below is used to show that hexane (C_6H_{14}) contains carbon and hydrogen. What are X and Y ?



	X	Y
A.	$PbSO_4(s)$	limewater
B.	NaOH(s)	bromine water
C.	anhydrous $CoCl_2(s)$	limewater
D.	anhydrous $CuSO_4(s)$	bromine water

DSE2021:

1. The melting point of a chemical species is 146 °C. It is soluble in water and the solution formed does not conduct electricity. Which of the following structures would this chemical species have ?

A. giant ionic structure
B. giant metallic structure
C. giant covalent structure
D. simple molecular structure

19. The composition by mass of element X in the compound K_2XO_4 is 26.8%. Which of the following statements concerning X is / are correct ?

(Relative atomic masses : O = 16.0, K = 39.1)

(1) X is a transition metal.
(2) X is an element in Group VI of the Periodic Table.
(3) X is an element in the fourth period of the Periodic Table.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

21. Which of the following solids has / have delocalised electrons in its / their structure(s) ?

(1) graphite
(2) silicon
(3) silver

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

Structural Questions

CE90_01b

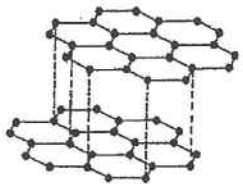


Diagram I : an allotrope of carbon

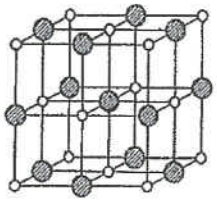


Diagram II : sodium chloride

The two diagrams above represent part of the structure of an allotrope of carbon, and sodium chloride at room temperature.

(i) What type of bonding exists in each of the substances shown above?

(ii) State a condition under which each substance can conduct electricity. Explain your answers.

(iii) Name an allotrope of carbon other than that shown above.

(iv) Which allotrope of carbon is used to
(1) make pencil lead?
(2) cut glass?
Explain your answers with reference to the different arrangements of atoms in these two allotropes.

(v) Do you agree with the statement: 'sodium chloride cannot easily be changed into sodium and chloride?' Explain your answer.

(12 marks)

CE91_01a

The following is a part of the Periodic Table:

	Group							
	I	II	III	IV	V	VI	VII	O
Second period				*a*			*b*	
Third period	*c*		*d*			*e*	*f*	*g*

Referring to the letters indicated in the above table, answer the following questions:

(i) (1) What is the name for the family of elements of which *b* and *f* are members?

(2) In what way are the electronic arrangements of the atoms of elements *b* and *f*
(I) similar to each other?
(II) different from each other?

(ii) Element *d* has a higher melting point than element *c*. Explain.

(iv) Two elements in the above table have allotropes.
(1) Explain the meaning of 'allotropes'.
(2) Suggest what the two elements are.

(v) Element *e* can form compounds with elements *a* and *c* separately.
(1) Draw the electronic structures of these two compounds, showing the outermost electrons ONLY.
(2) Which of these two compounds has a higher melting point? Explain your answer.

(10 marks)

CE92_01b

(iii) Why can metals conduct electricity?

(1 mark)

CE92_03b

Neon, a monatomic gas, occurs naturally as a mixture of three isotopes. The relative abundance of these isotopes is tabulated below:

Isotope	$^{20}_{10}Ne$	$^{21}_{10}Ne$	$^{22}_{10}Ne$
Abundance (%)	90.52	0.31	9.17

(i) State the number of electrons in the outermost shell of a neon atom.

(ii) Explain why neon gas is monatomic.

(iii) What is meant by the term 'isotope'?

(iv) Calculate
(1) the relative atomic mass of neon.

(5 marks)

CE93_02b

Physical properties of substances depend mainly on the types of binding force between their constituent particles.

(i) The melting points of diamond and tetrachloromethane are 3750°C and – 23°C respectively. Draw 3-dimentional diagrams for the structure of diamond and for a tetrachloromethane molecule. Hence explain the difference in their melting points.

(ii) In their solid states, sodium conducts electricity but sodium chloride does not. Explain.

(iii) Explain why tetrachloromethane does not conduct electricity in liquid state.

(7 marks)

CE93_04a

The following table gives some information about W, X, Y and Z which represent particles of some elements. These particles are either atoms or ions.

	Mass number	Atomic number	No. of proton	No. of electron	No. of neutron
W		12		12	12
X			12	10	12
Y	35	17			
Z			17	17	20

(i) In which group of the Periodic Table should W be placed?
Explain your answer.

(ii) (1) What is the relationship between W and X?
(2) Suggest a chemical reaction which can change W into X.

(iii) Molecules of Y and Z are both diatomic.
(1) Draw the electronic structure of a molecule of Y, showing electrons in the outermost shells only.
(2) Do molecules of Y and of Z have the same chemical properties? Explain your answer.

(iv) W can form a compound with Z. Calculate the formula mass of the compound formed.

(6 marks)

CE94_01

The table below lists some information about three metals X, Y and Z.

Metal	X	Y	Z
Atomic number	12	20	

(a) To which group in the Periodic Table does Y belong?

(1 marks)

CE94_07b

The table below lists some physical properties of lead, bromine and lead(II) bromide.

	Lead	Bromine	Lead(II) bromide
Melting point	328°C	−7°C	370°C
Electrical conductivity in the solid state	Conducting	Non-conducting	Non-conducting
Electrical conductivity in the liquid state	Conducting	Non-conducting	

(i) Explain the difference in melting points between bromine and lead(II) bromide.

(ii) Explain the difference in electrical conductivity between lead and lead(II) bromide in the solid state.

(iii) Will lead(II) bromide conduct electricity in the liquid state?
Explain your answer.

(5 marks)

CE95_02

In each of the following groups of substances, there is ONE substance which is different from the others in terms of their properties. In each group, identify the substance which is different from the others and explain your choice.

(a) argon, fluorine, helium, neon

(2 marks)

CE95_04

"When atoms combine, they tend to attain noble gas electronic structures."

Discuss how atoms can attain the noble gas electronic structures. In your answer, you should give suitable examples and the electronic structures of the products formed.

(8 marks)

CE96_07a

The boxes below show some information about two atoms, hydrogen (H) and deuterium (D):

Mass number → 1, Atomic number → 1, **H**

Mass number → 2, Atomic number → 1, **D**

(i) Suggest a term to indicate the relationship between a hydrogen atom and a deuterium atom.

(ii) State the number of neutrons in a deuterium atom.

(iii) Deuterium reacts with oxygen in the same way as hydrogen.

$2D_2(g) + O_2(g) \longrightarrow 2D_2O(l)$ $\quad \Delta H$ is negative

The product of the reaction is known as "heavy water".

(1) Explain why deuterium reacts with oxygen in the same way as hydrogen.
(2) Draw the electronic structure of "heavy water", showing electrons in the outermost shells ONLY.
(3) What is meant by 'ΔH is negative'?
(4) What is the formula mass of 'heavy water'?

(6 marks)

CE98_01

Lithium is a group I element in the Periodic Table. It occurs naturally in two isotopic forms. The relative abundance of the each of these isotopes is shown in the table below:

Isotope	^{6}Li	^{7}Li
Relative abundance (%)	7.4	92.6

(a) What is the meaning of the term 'isotope'?

(b) Calculate the relative atomic mass of lithium.

(3 marks)

CE99_04

With the help of electronic diagrams, describe the formation of magnesium chloride and tetrachloromethane from atoms of relevant elements. State, with explanation, which of the two compounds has a higher melting point.

(9 marks)

CE99_06a

(i) Draw the electronic diagram of water, showing electrons in the outermost shells only.

(1 mark)

CE00_01

Six compounds are classified into two groups as shown in the table below:

Gas	Solid
Ammonia	Iron(III) oxide
Carbon dioxide	Magnesium oxide
Nitrogen dioxide	Potassium oxide

Reclassify these compounds into two groups according to

(a) one of their physical properties, and

(2 marks)

(b) one of their chemical properties.

(2 marks)

CE00_02

The table below lists some information about four elements, W, X, Y and Z:

Element	Atomic number	Relative atomic mass
W	16	32.1
X	18	39.9
Y	19	39.1
Z	20	40.1

(a) What is the meaning of the term 'relative atomic mass'?

(b) State, with explanation, which of the above elements

(i) should be stored under paraffin oil.

(ii) is used to fill a light bulb.

(6 marks)

CE00_08c

State whether each of the following statements is true or false. Explain your answer in each case.

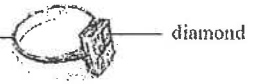
(i) The melting point of sodium chloride is much higher than that of methane because the ionic bonding in sodium chloride is much stronger than the covalent bonding in methane.

Note: methane is a simple molecule.

(2 marks)

CE01_07

(c) The photograph below shows a diamond ring:



(i) Explain why gold and diamond each has a high melting point.

(2 marks)

CE01_08a

A part of the Periodic Table is shown below:

		Group							
		I	II	III	IV	V	VI	VII	0
Period	2	Li	Be	B	C	N	O	F	Ne
	3	Na	Mg	Al	Si	P	S	Cl	Ar
	4	K	Ca					Br	Kr
	5								Xe

(i) Across a period, the elements demonstrate a gradual change in some of their physical properties. State ONE such property.

(iv) Xenon (Xe) is a Group 0 element. State, with explanation, what will happen if a balloon filled with xenon is released from the top of a tower.

(2 marks)

CE02_06a

(iii) Explain why molten magnesium chloride can conduct electricity.

(1 mark)

CE02_06b

Magnesium occurs naturally in three isotopic forms. The relative abundance of each isotope is shown in the table below:

Isotope	^{24}Mg	^{25}Mg	^{26}Mg
Relative abundance(%)	78.6	10.1	11.3

(i) State the meaning of the term 'isotopes of an element'.

(ii) Calculate the relative atomic mass of magnesium.

(iii) Is it possible to separate the isotopes of magnesium by chemical means? Explain your answer.

(4 marks)

CE02_08b

Both carbon and silicon are Group IV elements in the Periodic Table.

(i) Draw the electronic diagram of a carbon dioxide molecule, showing electrons in the outermost shells only.

(ii) Explain why carbon dioxide can be used in fire fighting.

(iii) Explain why carbon dioxide is a gas, whereas silicon dioxide is a solid at room temperature and pressure.

(iv) (2) Suggest ONE use of silicon.

(8 marks)

CE03_03

(a) The atomic numbers of sulphur and chlorine are 16 and 17 respectively.
Draw the electronic diagrams of the following atoms:
(i) sulphur atom
(ii) chlorine atom

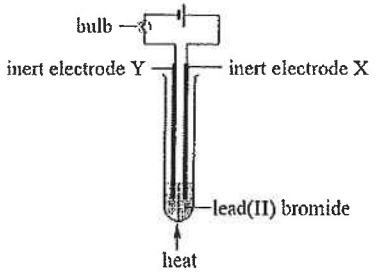
(2 marks)

(b) Chlorine reacts with sulphur to form a compound with relative molecular mass of 135.2. The compound contains 52.5% of chlorine by mass.
(i) Deduce the molecular formula of the compound.
(ii) Draw the electronic diagram of the compound, showing electrons in the outermost shells only.
(Relative atomic masses: S=32.1, Cl=35.5)

(5 marks)

CE03_07a

The set-up shown below is used to investigate the electrical conductivity of lead (II) bromide.



When the lead(II) bromide becomes molten, the bulb lights up.

(iii) State what will happen to the bulb when heating is stopped and the molten lead(II) bromide is allowed to cool down gradually to room temperature.
Explain your answer.

(3 marks)

CE04_05

Na_2O, MgO, SiO_2 and SO_2 are oxides of Period 3 elements in the Periodic Table. Discuss how the melting points of these oxides are related to the bonding and structure.

(9 marks)

CE04_09a

A portion of the Periodic Table is shown below:

		Group							
		I	II	III	IV	V	VI	VII	0
Period	2	Li	Be	B	C	N	O	F	Ne
	3	Na	Mg	Al	Si	P	S	Cl	Ar
	4	K	Ca					Br	

(i) Identify ONE semi-metal in the above table.

(ii) Suggest why Group 0 elements seldom form compounds.

(iii) Using aluminium as an example, describe the bonding in metals. Hence, explain why metals are ductile.

(iv) Which metal and non-metal in the above table would react most vigorously with each other?

(v) (1) The atomic number of bromine is 35. The electronic arrangement of a bromine atom can be represented as 2, 8, x, y. What are the values of x and y?

(2) At 5°C, the reaction of bromine with sodium hydroxide solution is similar to that of chlorine with sodium hydroxide solution.
Write a chemical equation for the reaction of bromine with sodium hydroxide solution at this temperature.

(8 marks)

CE05_01

(a) Calcium is an element in Group II of the Periodic Table.

(i) Calcium reacts with nitrogen to form calcium nitride, which is an ionic compound. Draw the electronic diagram of calcium nitride, showing electrons in the *outermost shells* only.

(ii) Suggest a test to show that marble is a calcium-containing substance.

(3 marks)

(b) Strontium (Sr) is another Group II element. It exists in several isotopic forms.

(i) What is the meaning of the term 'isotope'?

(ii) Strontium-90 (^{90}Sr) is a radioactive isotope of strontium, and is one of the dangerous by-products of nuclear fission.
Complete the table below by providing **the relevant information for a ^{90}Sr atom.**

	Number of protons	Number of neutrons
^{90}Sr		

(2 marks)

(c) (i) State the similarity between a calcium atom and a strontium atom in terms of electronic arrangement.

(ii) Children's teeth require a large amount of calcium to grow. Scientists found that in areas where nuclear weapon tests were conducted above the ground, children's teeth contained a higher level of ^{90}Sr.
Suggest a reason for the findings of the scientists.

(2 marks)

CE07_01

A is a compound formed from oxygen and magnesium, while *B* is a compound formed from oxygen and fluorine.

(a) Draw the electronic diagram of *A*, showing electrons in the *outermost shells* only.

(1 mark)

(b) Draw the electronic diagram of *B*, showing electrons in the *outermost shells* only.

(1 mark)

(c) Compare the melting points of *A* and *B*. Explain your answer.

(2 marks)

CE08_01

T, X and Z are three elements in the Periodic Table, with the sum of their atomic numbers equals to 38. Moreover, both T and X are Group VII elements, while the atomic number of T is smaller than that of X.

(a) What are elements T, X and Z?

(1 mark)

(b) Draw the electronic diagram of the compound formed from T and X, showing electrons in the outermost shells only.

(1 mark)

(c) Discuss, with explanation, the electrical conductivity of the compound formed from X and Z with reference to the type and property of the particles in it.

(2 marks)

CE08_02

Boron occurs naturally in two isotopes, ^{10}B and ^{11}B.

(a) What is meant by the term 'isotopes'?

(1 mark)

(b) With reference to the Periodic Table, calculate the percentage abundance of ^{11}B in nature.

(2 marks)

(c) $^{10}BCl_3$ and $^{11}BCl_3$ are compounds formed respectively from the two isotopes of boron with chlorine. $^{10}BCl_3$ reacts with water to give white fumes. State, with explanation, the expected observation when $^{11}BCl_3$ is added to water.

(1 mark)

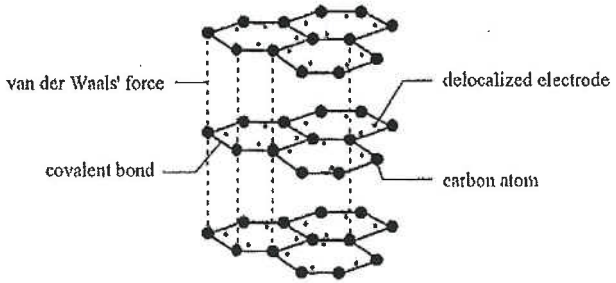
CE09_09

Discuss respectively why electrical conductivity and melting point differ among sodium chloride (NaCl), sodium (Na) and chlorine (Cl_2).

(9 marks)

CE11_03

Graphite is a form of carbon and can be used to make pencil cores and electrodes. There are layers of carbon atoms in the structure of graphite. In each layer, each carbon atom is linked to other carbon atoms by covalent bonds. Moreover, delocalized electrons exist in the layers, while van der Waals' forces exist between the layers as shown in the diagram below:



(a) Answer the following questions according to the information given above.

(i) Explain why the graphite used to make pencil cores can be easily detached to form markings on paper.

(ii) Explain why graphite can be used to make electrodes.

(2 marks)

(b) Lead metal can also be used to draw markings. With reference to the bonding of lead, explain why using lead to make pencil cores is not as good as using graphite.

(2 marks)

(c) Diamond is another form of carbon. With reference to the bonding and structure of diamond, explain why diamond is so hard.

(2 marks)

CE11_08

Write an essay on how the position of an element in the Periodic Table is determined by the electronic arrangement of its atom, and how this position determines the types of chemical bondings the atom might form.

(9 marks)

AL96(I)_01a

(i) Write down the number of neutrons, protons and electrons in one atom of carbon-12, ^{12}C, and ine one atom of carbon-13, ^{13}C.

(1 mark)

(ii) The isotopic mass of ^{12}C is 12.000 atomic mass (a.m.u.). Calculate the mass, in kg, of 1 mol of ^{12}C atoms.

(1 a.m.u. = 1.6605×10^{-27} kg; Avogadro constant, L = 6.0221×10^{23} mol^{-1})

(2 marks)

(iii) The following data were obtained from the mass spectrum of a carbon-containing compound:

Ion	Mass / a.m.u.	Relative intensity
$^{12}C^+$	12.000	100.00
$^{13}C^+$	13.003	1.12

Using the above data, calculate the relative atomic mass of carbon.

(2 marks)

AL98(II)_01 (modified)

(a) Draw the electronic diagram of BF_3.

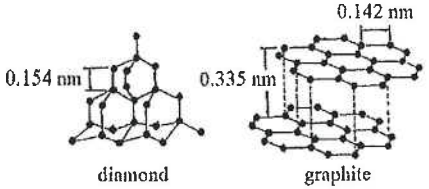
(1 mark)

(b) BF_3 reacts with NH_3 to form an adduct, $BF_3 \cdot NH_3$. Account for the formation of the adduct and draw its electronic diagram.

(3 marks)

AL98(II)_02 (modified)

The structures of two allotropes of carbon, diamond and graphite, are shown below.



(a) Comment on the three different carbon-carbon distances as indicated in the above structure.

(3 marks)

(b) With reference to the above structures, explain why diamond is hard whereas graphite is soft enough to be used as lubricant.

(3 marks)

AL99(I)_01

Account for the statement that "At 298 K and 1 atm pressure, carbon dioxide is a gas whereas silicon dioxide is a solid".

(1.5 marks)

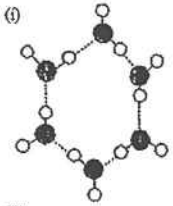
AL00(I)_01

The diagrams below show the arrangement of atoms, ions or molecules in four crystalline substances: graphite, ice, iodine and sodium chloride.

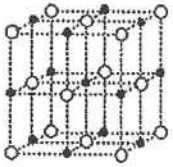
(a) Write the name of the substance of each structure in the space provided.

(b) Label, on the diagrams, the types of interactions that are present in these substances.

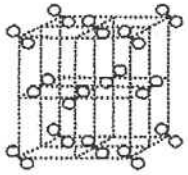
(i)



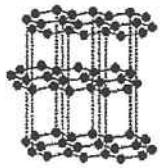
(ii)



(iii)



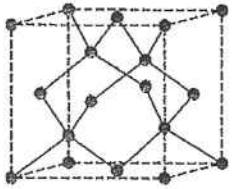
(iv)



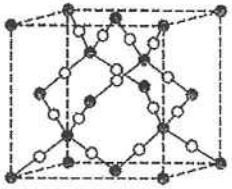
(6 marks)

ASL01(I)_05 (modified)

X is an element in Period 3 of the Periodic Table. The structures of X and one of its oxides are shown below.



● = X



O = oxygen

(a) Suggest, with explanation, what element X is.

(2 marks)

(b) Give one use of X and one use of its oxide.

(2 marks)

(c) (i) Draw the three-dimensional structure of the chloride of X.

(1 mark)

(ii) When the chloride of X is added to water, a white. State the expected observation and write the chemical equation for the reaction involved.

(2 marks)

AL02(I)_03

CO_2 and SiO_2 are oxides of Group IV elements. Account for the fact that CO_2 is a gas while SiO_2 is a high melting solid under room temperature and atmospheric pressure.

(2 marks)

ASL03(I)_07

Carbon, germanium and lead are elements in Group IV of the Periodic Table.

(a) Diamond and graphite are allotropes of carbon.

(i) Draw their three-dimensional structures.

(2 marks)

(ii) With reference to their structure, compare the hardness of diamond and graphite.

(3 marks)

(b) Germanium has the same structure as diamond. Which of these substances has a higher melting point? Explain.

(1 mark)

(c) Suggest why the density of lead (11.3 g cm^{-3}) is much higher than that of germanium (5.3 g cm^{-3})

(2 marks)

ASL04(I)_01 (modified)

(a) Write the electronic arrangement of a copper atom.

(1 mark)

(b) Copper occurs naturally in two isotopic forms, ^{63}Cu and ^{65}Cu. Estimate the relative abundance of each isotope, and show how the answer is obtained.

(2 marks)

(c) Describe the bonding in copper. Hence, explain why copper is an electrical conductor.

(3 marks)

AL04(I)_02

Consider the noble gases, He, Ne, Ar Kr and Xe. Sketch a graph to show the variation of boiling point of these noble gases and account for the variation.

(2 marks)

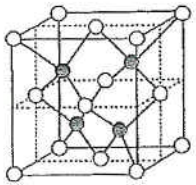
ASL04(I)_06

(a) Explain the following observation:

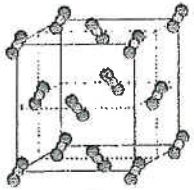
'At 298 K and 1 atm pressure, carbon dioxide is a gas whereas silicon dioxide is a solid.'

(2 marks)

(b) Which of the following diagrams, *X* or *Y*, represents the structure of silicon dioxide in solid state?



X



Y

(1 mark)

(c) With reference to its structure, explain why silicon dioxide can be used as abrasive.

(1 mark)

(d) Dry ice can be used in packaging ice-cream. Suggest TWO advantage of using ice over using ice in packaing ice-cream.

(2 marks)

AL05(I)_01 (modified)

Describe the interaction among the entities in each of the following species:

(a) Argon gas (b) Zinc metal (c) CaF_2 crystal

(4.5 marks)

AL06(I)_01 (modified)

The table below lists the melting points of three oxides of the Period 3 elements:

Oxide	Na_2O	Al_2O_3	SO_2
Melting point / °C	920	2040	−75

Account for the large difference in the melting points of the three oxides

(3 marks)

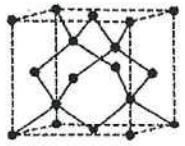
AL06(I)_02 (modified)

Draw a diagram to show the three-dimensional arrangement of carbon atoms in graphite, and indicate the interactions between the carbon atoms.

(2 marks)

ASL06(I)_05

Silicon (Si) and germanium (Ge) normally have the same crystal structure, as shown below:



(a) Identify the type of crystal structure of silicon and germanium.

(1 mark)

(b) Explain which of these two elements has a higher melting point.

(2 marks)

(c) Explain why silicon(IV) oxide has a higher melting point than silicon(IV) chloride in terms of their structures.

(3 marks)

AL08(II)_01

Both sodium and chlorine are elements in Period 3 of the Periodic Table. At room temperature and atmospheric pressure, Na_2O is a solid with a very high melting point whereas Cl_2O is a gas. Account for this difference in property between Na_2O and Cl_2O.

(2 marks)

AL08(II)_04 (modified)

Diamond and graphite show a marked difference in electrical conductivity. Account for their difference in electrical conductivity in terms of bonding and structure.

(3 marks)

ASL08(II)_04 (modified)

Account for the following observations:

The melting point of potassium bromide is lower than that of sodium bromide.

(2 marks)

AL09(I)_03

Selenium (Se) is an element in Group VI of the Periodic Table.

(a) Selenium occurs in nature in six isotopes with the percentage abundance of each isotope given on the right. Calculate the relative atomic mass of selenium.

(2 marks)

Mass number	% abundance
74	0.9
76	9.0
77	7.6
78	23.5
80	49.8
82	9.2

(b) Selenium dioxide, SeO_2, has a melting point of 315 °C. It does not conduct electricity in both solid and molten state. Deduce the type of bonding and structure of SeO_2.

(2 marks)

AL09(II)_03

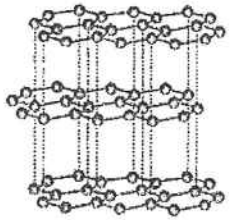
Account for the following:

"Under stress, metals deform but their ionic salts fracture."

(2 marks)

AL12(II)_08

(a) The structure of graphite is shown below:



Describe the bonding and structure of graphite. Hence, explain why graphite is considered a soft material.

(4 marks)

(b) Graphene is a flat monolayer of carbon atom tightly packed into a two-dimensional honeycomb lattice. It is the building block for graphite. Graphene can be isolated from graphite by using adhesive tape.

(i) Suggest why graphene is considered a very strong material.

(1 mark)

(ii) Scientist anticipate that graphene, after appropriate fabrication, can replace steel in making cars. Apart from strength consideration, suggest ONE reason why graphene can be a better material than steel in making cars.

(1 mark)

AL13(II)_05

Calcium and radium are elements in Group II of the Periodic Table.

(a) Would the melting point of radium be higher or lower than that of calcium? Explain.

(2 marks)

(b) Account for the difference in reactivity of Ca(s) and Ra(s) with water.

(2 marks)

(c) Predict, with explanation, the reaction of $RaCl_2(aq)$ with $H_2SO_4(aq)$.

(2 marks)

AL13(II)_08

Both arsenic and bromine are elements in Period 4 of the Periodic Table. They form fluorides with chemical formulae AsF_5 and BrF_5 respectively.

(b) Given: BrF_5 and AsF_5 react according to the following equation:

$$BrF_5 + AsF_5 \rightleftharpoons BrF_4^+ + AsF_6^-$$

Comment on the electrical conductivity of liquid BrF_5 and that of a mixture of BrF_5 and AsF_5. Explain your answer.

(2 marks)

DSE11SP_01

State whether each of the following statements is true or false. Explain your answer in each case.

(a) The melting point of sodium chloride is much higher than that of methane because the ionic bonding in sodium chloride is much stronger than the covalent bonding in methane.

(2 marks)

DSE11SP_07

Complete the table below by

(a) drawing a three-dimensional diagram for the structure of each solid substance, and

(3 marks)

(b) giving an explanation of whether the solid substance is an electrical conductor.

(3 marks)

Solid substance	Three-dimensional diagram for the structure of the solid substance	Explanation of whether the solid substance is an electrical conductor
Diamond		
Graphite		
Caesium chloride		

DSE12PP_03

(a) Nitrogen reacts with magnesium to give magnesium nitride (Mg_3N_2).

(i) Draw the electron diagram of magnesium nitride, showing electrons in the outermost shells only.

(1 mark)

(b) Consider the nitrogen compound NCl_3 .

(i) Draw the electron diagram of NCl_3, showing electrons in the outermost shells only.

(1 mark)

DSE12_01

Neon occurs naturally in three isotopes with the abundance of each isotope shown in the table below:

Isotope	Abundance / %
^{20}Ne	90.48
^{21}Ne	0.27
^{22}Ne	9.25

(a) What is meant by the term 'isotope'?

(1 mark)

(b) Calculate the relative atomic mass of neon.

(2 marks)

(c) Give one daily application of neon.

(1 mark)

(d) Explain why the boiling point of neon is lower than that of oxygen.

(2 marks)

DSE13_01

Water is the most abundant compound on the Earth's surface. It is very important to life on Earth.

(a) Draw the electron diagram for a water molecule, showing *electrons in the outermost shells* only.

(1 mark)

DSE13_02

Both BF_3 and NH_3 exist as simple molecules.

(c) BF_3 reacts with NH_3 to give F_3BNH_3. Describe the bond formation between BF_3 and NH_3.

(2 marks)

DSE13_08

Both caesium (Cs) and sodium (Na) are elements in Group I of the Periodic Table. Caesium reacts with chlorine to form caesium chloride.

(a) Write the chemical equation for the reaction caesium with chlorine.

(1 mark)

(b) Solid caesium chloride has a giant ionic structure.

(i) Draw a diagram to show the structure of caesium chloride.

(1 mark)

(ii) Explain why solid caesium chloride is brittle.

(2 marks)

(c) Predict, with ONE reason, whether sodium or caesium is more reactive towards chloride.

(1 mark)

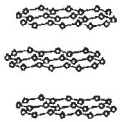
DSE13_13

Lithium, beryllium, carbon (graphite) and nitrogen are elements of the second period of the Periodic Table. Arrange them in increasing order of melting point, and explain the order in terms of structure and bonding.

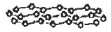
(4 marks + 1 mark)

DSE14_01

Graphite is a form of carbon and has a layer structure. Graphene is an individual single layer of graphite. Their structures are shown below:



graphite



graphene

(a) Thin sheets of graphene can be easily peeled off from graphite using adhesive tape.

(i) Explain why graphene can be easily peeled off.

(1 mark)

(ii) Explain whether graphene can conduct electricity.

(1 mark)

(iii) Draw the electron diagram for a molecule of the compound formed by complete combustion of graphene, showing *electrons in the outermost shells* only.

(1 mark)

(b) Based on the fact that graphene can be easily peeled off from graphite, a student concluded that graphite should have a low melting point due to its layer structure. Explain whether you agree with this conclusion.

(2 marks)

DSE15_01

Argon and chlorine are elements in the same period of the Periodic Table.

(a) Draw the electron diagram for a molecule of argon, showing electrons in *all shells*.

(1 mark)

(b) What is the type of intermolecular force in chlorine gas?

(1 mark)

(c) Complete the table below by stating the natural source and the method of extraction from the source for each element.

Element	Natural source	Method of extraction
Argon		
Chlorine		

(4 marks)

DSE15_10

(a) For each of the oxides below, draw its electron diagram (showing electrons in the outermost shells only), and stat its behavior in water.

(i) Na_2O

(2 marks)

(ii) Cl_2O

(2 marks)

DSE16_01

Refer to the following information of phosphorus (P) and chlorine (Cl).

	P	Cl
Atomic number	15	17
Relative atomic mass	31.0	35.5

(a) State the electronic arrangement of a phosphorus atom.

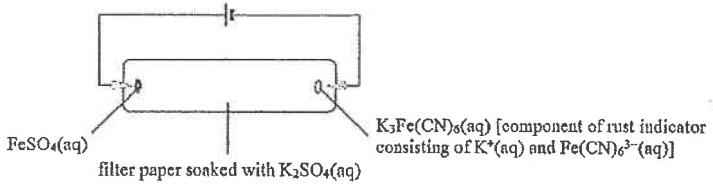
(1 mark)

(b) All chlorine atoms have the same atomic number. Explain why some chlorine atoms have different mass numbers.

(1 mark)

DSE16_02

The set-up of an experiment for studying the movement of ions is shown below.



(a) Explain why the filter paper is soaked with $K_2SO_4(aq)$ instead of water.

(1 mark)

(b) State the color of $FeSO_4(aq)$.

(1 mark)

(c) Explain what would be observed around the middle of the filter paper when the circuit is closed for a period of time.

(2 marks)

(d) The experiment is repeated, but the two poles of the cells have been reversed at the very beginning. Explain what would be observed around the middle of the filter paper when the circuit is closed for a period of time.

(2 marks)

DSE16_04

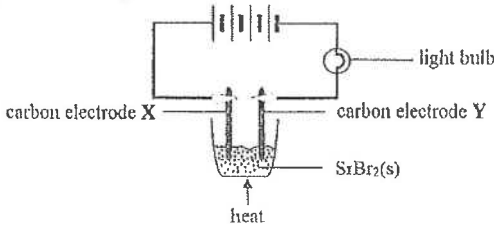
Consider the molecules CO_2, CS_2 and CH_2Br_2.

(c) Suggest why, under room temperature and pressure, CO_2 is a gas but CS_2 is a liquid.

(2 marks)

DSE16_08

Consider the experimental set-up shown below:



(a) In the above experiment, the bulb lights up when the $SrBr_2(s)$ becomes molten.
(Atomic number of Sr = 38)

(i) State the observation at carbon electrode X.

(1 mark)

(ii) Write a half equation for the change that occurs at carbon electrode Y.

(1 mark)

(b) Explain why the experiment should be performed in a fume cupboard.

(1 mark)

DSE17_01

Barium (Ba) is an element in Group II of the Periodic Table. Its chemical properties are similar to those of calcium.

(a) Describe the bonding in barium.

(2 marks)

DSE17_03

Answer the following questions.

(c) Describe the formation of dative covalent bond using H_3O^+ as example.

(3 marks)

DSE17_08

Combustion of petrol increases the concentration of carbon dioxide in the atmosphere, and may contribute to global warming. Combustion of petrol also emits poisonous air pollutants.

(b) Draw the electron diagram for a molecule of carbon dioxide, showing *electrons in the outermost shell* only.

(1 mark)

DSE18_01

Lithium occurs naturally in two isotopes, ^6Li and ^7Li. It can form lithium nitride (Li_3N) when burnt in air.

(a) (i) Calculate the percentage abundance of ^6Li in nature.
(Relative atomic mass: Li = 6.9)

(2 marks)

(ii) Draw the electron diagram for lithium nitride, *showing electrons in the outermost shells only.*

(1 mark)

DSE19_01

The table below shows some information of three atoms:

	Number of protons	Number of electrons	Number of neutrons
Protium	1	1	0
Deuterium	1	1	1
Oxygen	8	8	8

(a) Explain why protium and deuterium are isotopes.

(1 mark)

(b) Deuterium can be represented by D. It reacts with oxygen as shown in the equation below :

$$2D_2 + O_2 \longrightarrow 2D_2O$$

Draw the electron diagram for a D_2O molecule, showing ELECTRONS IN THE OUTERMOST SHELLS only.

(1 mark)

(c) A small piece of sodium metal is placed into liquid D_2O at room conditions.

(i) State TWO expected observations.

(2 marks)

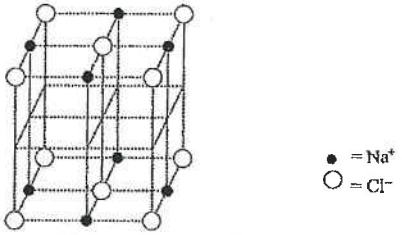
(ii) Write the chemical equation for the reaction involved.

(1 mark)

DSE19_02

Sodium chloride crystal has a giant ionic structure.

(a) The diagram below shows a part of the structure of sodium chloride crystal with some ions missing.



Complete the diagram by using ● as Na^+ ion and ○ as Cl^- ion.

DSE20_01abciii

1. The table below shows some information of elements Y and Z.

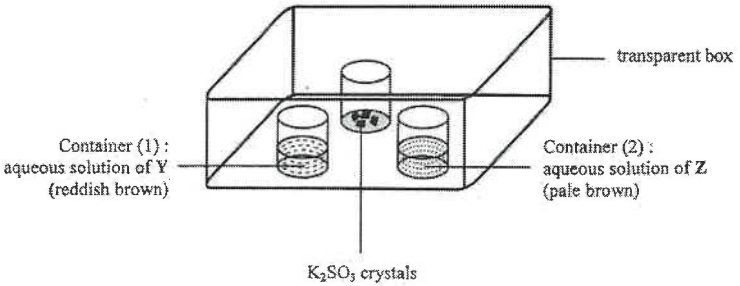
	Y	Z
Atomic number	35	53
Number of occupied electron shells in the atoms	4	5
Number of electrons in the outermost shell in the atoms	7	7

(a) State the electronic arrangement of an atom of Y.

(1 mark)

(b) Draw the electron diagram for a molecule of Z, showing ELECTRONS IN THE OUTERMOST SHELLS only.

(c) An experiment for Y and Z is performed as shown in the set-up below. Dilute hydrochloric acid is added to the K_2SO_3 crystals, then the whole set-up is covered with a lid.



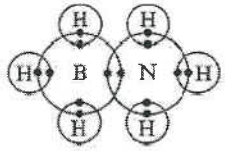
1. (c) (i) K_2SO_3 crystals react with dilute hydrochloric acid to give sulphur dioxide gas. Write a chemical equation for the reaction, showing all state symbols.

(ii) State the expected observation in Container (1) and write an ionic equation for the reaction involved.

(iii) It is expected that the observation in Container (2) is similar to that in Container (1). Suggest a reason for this expectation based on electronic arrangement.

DSE20_03bi,iii

(b) H_3NBH_3 has a structure similar to that of ethane. Its electron diagram is shown below (showing electrons in the outermost shells only).



(i) Which of the H–B, B–N and N–H bonds would be dative covalent bond(s) ? Explain your answer.

(iii) Under suitable conditions, H_3NBH_3 can decompose into boron nitride and hydrogen. The structure of solid boron nitride is similar to that of graphite. Draw the structure of ONE LAYER of solid boron nitride (Note : B and N are in alternate positions).

2022

DSE21_01(a)

(a) Draw the electron diagram for a C_2H_2 molecule, showing ELECTRONS IN THE OUTERMOST SHELLS only.

DSE21_03(a),(b),(c)(i)

3. Silicon occurs naturally in three isotopes with the abundance of each isotope shown in the table below:

Isotope	Abundance / %
^{28}Si	92.20
^{29}Si	x
^{30}Si	y

(a) What is meant by the term 'isotope' ?

(b) Calculate x.
(Relative atomic mass : Si = 28.1)

(c) Silicon dioxide is an oxide of silicon.

(i) Explain why silicon dioxide has a high melting point.

6. Copper(II) phosphate is insoluble in water. What is the number of moles of $Cu^{2+}(aq)$ ions remaining in the solution of the resulting mixture when 0.04 mol of $CuCl_2(aq)$ is mixed with 0.02 mol of $Na_3PO_4(aq)$?

A. 0.00
B. 0.01
C. 0.02
D. 0.03

7. A white solid does NOT dissolve in both water and excess aqueous ammonia. Which of the following m this solid be ?

A. $Pb(NO_3)_2$
B. $Zn(OH)_2$
C. $MgSO_4$
D. $CaCO_3$

10. 6.54 g of zinc granules are added to 100.0 cm^3 of 1.0 M $AgNO_3(aq)$. After the reaction has completed, which of the following statements is correct ?

(Relative atomic masses : Zn = 65.4, Ag = 107.9)

A. Some zinc granules have reacted and no silver ions remain in the solution.
B. All the zinc granules have reacted and no silver ions remain in the solution.
C. All the zinc granules have reacted and some silver ions remain in the solution.
D. The mass of the zinc granules reacted is equal to the mass of the solid product formed.

18. Which of the following pairs of substances, when mixed, would release hydrogen gas ?

(1) copper and concentrated HCl(aq)
(2) iron and $H_2SO_4(aq)$
(3) calcium and NaOH(aq)

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

2022

1. Iodine is a halogen. It can form potassium iodide and hydrogen iodide.

(a) Name the relationship between $^{127}_{53}I$ and $^{129}_{53}I$.

(1 mark)

(b) The electronic arrangement of an iodine atom is 2, 8, x, 18, y. What is x ?

(1 mark)

(c) Draw the electron diagram for potassium iodide, showing ELECTRONS IN THE OUTERMOST SHELLS only.

(1 mark)

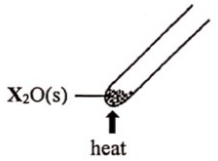
(d) Suggest why an aqueous solution of hydrogen iodide can conduct electricity.

(1 mark)

(e) In terms of bonding and structure, explain whether potassium iodide or hydrogen iodide would have a higher melting point.

(2 marks)

2. The diagram below shows an experimental set-up in which a metal oxide $X_2O(s)$ is decomposed upon strong heating. A silvery metal **X** and a colourless gas **Z** are formed.



(a) State what **Z** is and suggest a test for it.

(2 marks)

(b) When 3.028 g of $X_2O(s)$ is completely decomposed, 2.819 g of metal **X** can be obtained.

(i) Calculate the relative atomic mass of **X**.
(Relative atomic mass : O = 16.0)

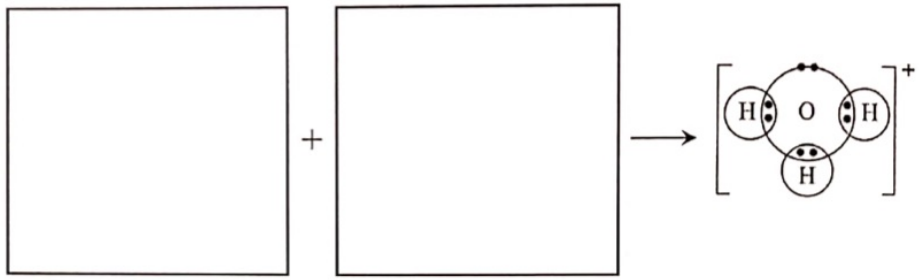
(ii) Suggest what **X** is.

(3 marks)

4. Consider the molecules H_2O, BF_3 and SF_6.

(a) H_2O molecules can form H_3O^+ ions.

(i) In each of the following boxes, draw the electron diagram (showing ELECTRONS IN THE OUTERMOST SHELLS only) for a suitable chemical species to show the formation of a H_3O^+ ion.



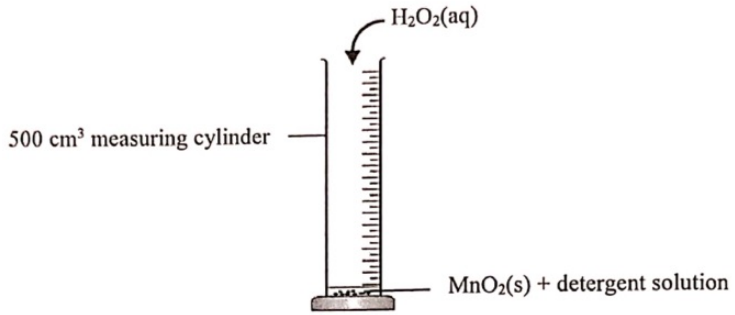
(ii) Describe the formation of dative covalent bond using H_3O^+ as an example.

(3 marks)

(b) Explain whether the boron atom in a BF_3 molecule has an octet structure.

(1 mark)

10. At room conditions, $H_2O_2(aq)$ would decompose into $O_2(g)$ and $H_2O(l)$ very slowly in the absence of $MnO_2(s)$. An experiment was performed as shown in the set-up below :



When 10.0 cm^3 of 3.00 M $H_2O_2(aq)$ was mixed with a small amount of $MnO_2(s)$ and detergent solution at room conditions, $O_2(g)$ started to be released rapidly and foam was produced. The $MnO_2(s)$ remained chemically unchanged at the end of the reaction.

(a) Write a chemical equation for the decomposition of $H_2O_2(aq)$.

(1 mark)

(b) Explain how manganese illustrates a characteristic of transition metals according to the results of this experiment.

(1 mark)

Marking Scheme

MCQ

CE90_02	D	CE90_03	C	_04	A	_25	D
CE90_26	C	CE91_01	B	CE91_02	A	CE92_02	D
CE92_03	C	CE92_04	A	CE92_30	A	CE92_45	C
CE93_01	D	CE93_02	B	CE93_23	D	CE94_01	C
CE94_02	B	CE94_03	A	CE94_36	A	CE94_46	B
CE95_01	A	CE95_02	D	CE95_03	A	CE95_04	C
CE95_06	A	CE95_26	B	CE95_34	A	CE95_39	A
CE96_01	C	CE96_02	B	CE96_03	A	CE96_39	A
CE96_44	C	CE96_45	B	CE96_50	C	CE97_01	D
CE97_02	B	CE97_03	D	CE97_05	B	CE97_30	C
CE98_01	D	CE98_18	B	CE98_33	B	CE98_45	A
CE99_05	D	CE99_01	B	CE99_11	A	CE99_19	B
CE99_34	D	CE99_39	C	CE99_46	A	CE00_01	B
CE00_07	C	CE00_09	D	CE00_17	B	CE00_34	D
CE00_39	D	CE00_42	D	CE00_46	C	CE01_01	D
CE01_07	A	CE01_18	B	CE01_20	B	CE01_37	D
CE01_42	A	CE01_49	D	CE02_01	C	CE02_28	A
CE02_36	D	CE02_46	A	CE02_49	A	CE03_01	C (64%)
CE03_12	B (88%)	CE03_25	D (57%)	CE03_46	B (59%)	CE05SP_03	B (67%)
CE05SP_16	D	CE05SP_31	A (60%)	CE04_01	C (67%)	CE04_02	D (54%)
CE04_10	B (47%)	CE04_23	C (84%)	CE04_30	A (45%)	CE04_31	B (64%)
CE05_03	B (67%)	CE05_06	D (76%)	CE05_07	C (67%)	CE05_09	B (53%)
CE05_13	D (70%)	CE05_27	B (66%)	CE06_01	D (68%)	CE06_02	D (53%)
CE06_04	B (72%)	CE06_05	B (59%)	CE06_06	C (79%)	CE06_14	B (87%)
CE06_24	D (54%)	CE07_03	D (52%)	CE07_12	D (80%)	CE07_13	A (66%)
CE07_18	B (64%)	CE07_28	C (31%)	CE07_29	C (82%)	CE07_43	A (24%)
CE08_02	D (76%)	CE08_18	D (49%)	CE08_19	B (43%)	CE08_46	B (63%)
CE09_01	C (71%)	CE09_07	D (63%)	CE09_18	A (79%)	CE09_19	C (72%)
CE09_22	D (17%)	CE09_28	B (48%)	CE10_01	A (53%)	CE10_13	D (53%)
CE10_17	B (83%)	CE11_01	D (92%)	CE11_02	B (85%)	CE11_03	C (16%)
CE11_31	D (58%)	AL10(I)_03	D	DSE11SP_07	A	DSE11SP_11	C
DSE11SP_22	D	DSE11SP_24	C	DSE11SP_36	C	DSE12PP_01	B
DSE12PP_03	A	DSE12PP_04	D	DSE12PP_15	D	DSE12PP_18	A
DSE12_01	D (71%)	DSE12_08	C (94%)	DSE12_15	D (63%)	DSE13_01	C (70%)
DSE13_02	C (92%)	DSE13_04	B (62%)	DSE13_12	D (80%)	DSE14_01	C (74%)
DSE14_02	D (75%)	DSE15_03	B (73%)	DSE15_15	A (60%)	DSE15_35	B (69%)
DSE16_02	C (88%)	DSE17_01	C (58%)	DSE17_16	A (66%)	DSE18_02	C (70%)
DSE18_05	C (80%)	DSE19_01	C	DSE19_02	A	DSE19_24	A

DSE2020: 2_D, 3_C, 5_B, 14_C

Structural Questions

CE90_01b

(i) carbon: covalent bond/ weak van der Waals' force [½]
sodium chloride: ionic bond [½]

(ii) carbon (graphite): can conduct electricity in solid state. [1]
[Do NOT accept: powder state, molten state and at high temperature]
because of the presence of mobile (delocalized) electrons between the carbon layers. [1]

sodium chloride: can conduct electricity in molten/ liquid state/ in aqueous solution [1]
because the ions become mobile in liquid state [1]

(iii) diamond [1]

(iv) (1) graphite (diagram I) [1]
because the layers of carbon atoms can slide easily [1]
(2) diamond [1]
because the carbon atoms are strongly bonded to form a giant structure [1]

(v) Agree, because it requires a lot of energy to melt NaCl in the laboratory. [1+1]
OR, Disagree, because melting NaCl is easy in industry, followed by electrolysis of molten NaCl to form the elements.
OR, Disagree, because the electrolysis of brine (conc. NaCl) solution using mercury cathode and graphite anode can be carried out.

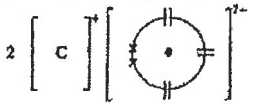
CE91_01a

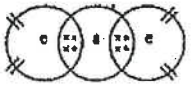
(i) (1) halogen [1]
(2) (I) each has 7 electrons in its outermost shell (or they **have the same number of electrons** in their outermost shells). [1]
(II) *f* and *b* have different numbers of electron shells / *b* occupied 2 electron shells whereas *f* occupied 3 electron shells. [1]

(ii) **because** the metallic bond in element *d* is stronger. [1]

(iv) **(1)** An allotrope is the same element with different structure. [1]
(2) *a* and *e* / carbon and phosphorous. [1]
[Note: allotrope of carbon (diamond and graphite), phosphorous (red phosphorous and yellow phosphorous)]

(v) (1) [1+1]





(2) c_2e has higher melting point because [1]
c_2e has strong ionic bond between ions but ae_2 has weak van der Waals' force between molecules. [1]

CE92_01b

(iii) Metals have delocalized (mobile) electrons for conducting electricity. [1]
[Note: Do not accept free electrons]

CE92_03b

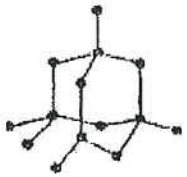
(i) 8 electrons [1]
(ii) Neon has a stable octet structure with 8 outermost shell electrons. [1]
(iii) Isotopes are atoms with same number of protons but different number of neutrons. [1]
(iv) (1) Relative atomic mass of Ne

$$= \frac{20 \times 90.52 + 21 \times 0.31 + 22 \times 9.17}{100}$$ [1]

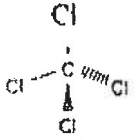
$= 20.19$ [1]

CE93_02b

(i) [1+1]



diamond



tetrachloromethane

Diamond has much higher melting point than CCl_4 because diamond has giant covalent structure with strong covalent bonds between C atoms but [1]
CCl_4 has simple molecular structure with weak van der Waals' force between molecules. [1]

(ii) In solid state, sodium has mobile (delocalized) electrons to conduct electricity but NaCl has ions that are not mobile. [1+1]

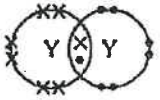
(iii) In liquid state, CCl_4 has no mobile ion or mobile electron. [1]

CE93_04a

(i) Group II [1]
because W has an electronic configuration of (2, 8, 2) that W has <u>two</u> outermost shell electrons. [1]

(ii) (1) X is the cation (or positive ion) of W. [1]
(2) W reacts with HCl(aq) to form chloride of X. [1]

(iii) (1) [1]



(2) Yes. Both Y and Z are isotopes. [1]
OR, Yes. Both Y and Z have the same electronic configuration.

(iv) Formula mass of $WZ_2 = 24 + 37 + 37 = 98$ [1]

CE94_01a

(a) Group II [1]

CE94_07b

(i) Br_2 has a much smaller melting point than $PbBr_2$ because Br_2 has only weak van [1]
der Waals' force between molecules but $PbBr_2$ has strong ionic bond between [1]
ions.

(ii) Lead has mobile electrons for conducting electricity. But solid $PbBr_2$ has ions that [1]
are not mobile. [1]

(iii) Yes, in liquid state, ions in $PbBr_2$ are mobile. [1]

CE95_02a

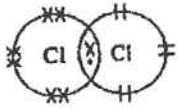
(a) fluorine [1]
fluorine is reactive/ yellow/ coloured gas [1]
OR, others are inert/ unreactive/ stable/ colourless (gases).

CE95_04

Chemical knowledge (5 marks)

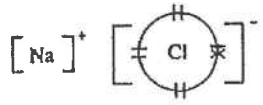
<u>Covalent bond</u>

When atoms of non-metals combine, they tend to share their (valence/ outermost) [1]
electrons to form molecules.
Electronic structure of a molecule, e.g. HCl / Cl_2 etc. [1]



<u>Ionic bond</u>

When metal and non-metal combine, atoms of the metal donate electrons to form [1+1]
positive ions while atoms of the non-metal accept electrons to form negative ions.
Electronic structure of an ionic compound e.g. NaCl etc. [1]



3 marks for presentation

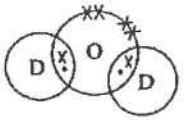
CE96_07a

(i) isotope [1]

(ii) One/ 1 [1]

(iii) (1) H and D have the same electronic structure (or electronic arrangement) [1]

(2) [1]



(3) The reaction is exothermic / gives out heat / release energy [1]

(4) Formula mass of $D_2O = 2 + 2 + 16 = 20$ [1]

CE98_01

(a) Atoms with same atomic number but different mass number. [1]
OR, atoms with the same number of protons but different number of neutrons.

(b) Relative atomic mass $= \frac{6 \times 0.074 + 7 \times 0.926}{100}$ [1]

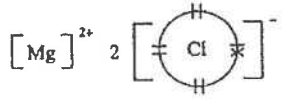
$= 6.93$ [1]

(Also accept 6.9 and 6.929)

CE99_04

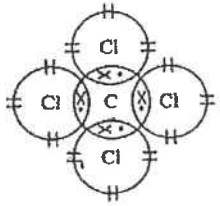
Chemical knowledge

For $MgCl_2$, each magnesium atom loses (two) electeons and each chloride atom accepts [1]
(one) electron to form an ionic compound.



[1]

In CCl_4, the carbon atom shares (a pair of) electrons with (each of the four) chloride [1]
atoms to form a covalent compound.

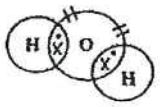


[1]

$MgCl_2$ has higher melting point than CCl_4 because the attraction, weak van der Waals' [1+1]
forces, between molecules of CCl_4 is weak and the attraction between ions, ionic bond,
in $MgCl_2$ is strong.

3 marks for presentation

CE99_06a

(i)  [1]

CE00_01

(a) **Any ONE of the** following:

Substance with colour	Substance without colour (white)
Nitrogen dioxide Iron(III) oxide	Ammonia Carbon dioxide Magnesium oxide Potassium oxide

[1+1]

OR,

Substances with an odour	Substances without an odour
Ammonia Nitrogen dioxide	Carbon dioxide Magnesium oxide Iron(III) oxide Potassium oxide

[1+1]

OR,

Water soluble substances	Water insoluble substances
Ammonia Carbon dioxide Nitrogen dioxide Potassium oxide	Iron(III) oxide Magnesium oxide

[1+1]

(b) Any ONE of the following:

Acidic substances	Basic substances
Carbon dioxide Nitrogen dioxide	Ammonia Iron(III) oxide Magnesium oxide Potassium oxide

[1+1]

OR,

Can be reduced by heating with charcoal	Cannot be reduced by heating with charcoal
Carbon dioxide Nitrogen dioxide Iron(III) oxide	Ammonia Magnesium oxide Potassium oxide

[1+1]

OR,

Can be decomposed by electrolysis	Cannot be decomposed by electrolysis
Magnesium oxide Iron(III) oxide Potassium oxide	Ammonia Carbon dioxide Nitrogen dioxide

[1+1]

OR,

Substances that react with water	Substances not react with water
Ammonia Nitrogen dioxide Carbon dioxide Potassium oxide	Iron(III) oxide Magnesium oxide

[1+1]

CE00_02

(a) Relative atomic mass is the average mass of all isotopes of the element on the $^{12}C(=12.000)$ scale. [1+1]

OR, relative atom mass $= \dfrac{\text{average mass of an atom of the element}}{\frac{1}{12} \times \text{mass of an atom of carbon} - 12}$

(b) (i) Y / potassium (K) [1]

Y is a reactive metal and reacts readily with oxygen / water in air. [1]

(ii) X / argon (Ar) [1]

X is chemically inert / is a noble gas / will not react with hot tungsten filament. [1]

CE00_08c

(i) False.

The high melting point of NaCl is due to the presence of strong ionic acid bond. [1]

The low melting point of CH_4 is not due to the existence of covalent bonding between C and H atoms but due to the weak van der Waals' forces between molecules. [1]

CE01_07c

(i) Gold has strong metallic bond between atoms. [1]

Diamond has a covalent network structure and strong covalent bonds exist between carbon atoms. [1]

CE01_08a

(i) Atomic size (atomic radius) / metallic character. [1]

(iv) The balloon falls to the ground because Xe is much denser than air. [1]

CE02_06a

(iii) Molten magnesium chloride contains mobile ions. [1]

CE02_06b

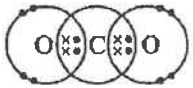
(i) Isotopes are atoms with the same atomic number but different mass number. [1]

OR, the same number of protons but different number of neutrons.

(ii) Relative atomic mass of Mg $= \dfrac{24 \times 78.6 + 25 \times 10.1 + 26 \times 11.3}{100} = 24.3$ [2]

(iii) No, because isotopes of an element have the same chemical properties. [1]
[Note: because isotopes have same electronic arrangement.]

CE02_08b

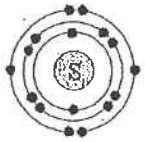
(i)  [1]

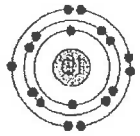
(ii) Carbon dioxide is denser than air. [1]
It can exclude air from the fuel / can blanket the fire from air. [1]

(iii) Silicon dioxide has a covalent network structure. [1]
Attraction between CO_2 molecules is weak van der Waals' forces. [1]

(iv) (1) $SiO_2 + C \longrightarrow Si + CO_2$ [1]
OR, $SiO_2 + 2C \longrightarrow Si + 2CO$
(2) Making computer chips / electronic parts / alloy / semi-conductors [1]

CE03_03

(a) (i)  [1]

(ii)  [1]

[From HKEAA:
The question asked for the electronic diagrams of a sulphur atom and a chlorine atom. Many candidates drew electronic diagrams which showed only electrons in the outermost shells. Such answers were considered as incomplete and were not accepted.]

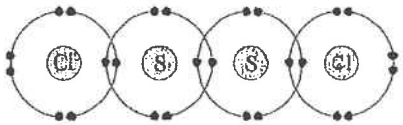
CE03_03

(b) (i)

	S	Cl
Mass / g	$135.2 - 70.98 = 64.22$	$135.2 \times 0.525 = 70.98$
Number of mole	$\frac{64.22}{32.1} = 2$	$\frac{70.98}{35.5} = 2$
Mole ratio	2	2

[1+1]

Molecular formula: S_2Cl_2 [1]

(ii)  [1]

CE03_07a

(iii) The light bulb gradually goes out. [1]
At lower temperatures, movement of ions slows down. Therefore, a smaller current flows through the external circuit and the light became dimmer. [1]
When molten lead(II) bromide becomes solid, there is no translational motion of ions. Thus no current flows through the external circuit and the light went out. [1]
[From HKEAA:
Few candidates were able to describe the gradual dimming of the light bulb as an observation of the experiment. Some candidates failed to provide an explanation for the observation in terms of the slowing down in the motion of the ions.]

CE04_05

Chemical knowledge (6 marks)
Na_2O and MgO are ionic compounds. The cations and anions pack together to form a giant ionic structure/ lattice/ crystal. [1]
The atraction between cations and anions in Na_2O and MgO is strong ionic bond/ strong electrostatic attraction exists between cations and anions. [1]
$\therefore$ Na_2O and MgO have high melting points.
SiO_2 has a covalent network structure/ giant covalent structure. [1]
Melting of SiO_2 requires the breaking of strong covalent bonds between atoms. [1]
$\therefore$ SiO_2 has a high melting point,
SO_2 has a simple molecular structure. [1]
Intermolecular attraction is weak van der Waals' forces/ dipole-dipole attraction, [1]
$\therefore$ SO_2 has a low melting point / exists as a gas at room temperature and pressure.
Effective communication [3]

CE04_09a

(i) Boron (B) / Silicon (Si) [1]
(ii) Atoms of Group 0 elements have an octet (duplet) structure in the outermost shell/ have completely filled outermost shells. [1]
(accept equivalent answers.)
(iii) Metals can be considered as making up of positive ions and a 'sea' of delocalised electrons. The attraction between the positive ions/ metallic ions and the delocalised electrons holds the particles together (metallic bond). [1]
Metallic bond is non-directional. Layers of atoms can easily slide over each another.
$\therefore$ metals have high ductility. [1]
(iv) Potassium and fluorine / K and F [1]

(v) (1) $y = 7$ [1]

$x = 18$ [1]

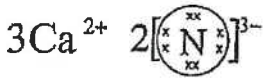
(2) $Br_2 + OH^- \longrightarrow BrO^- + Br^- + H_2O$ [1]

OR, $Br_2 + 2NaOH \longrightarrow NaOBr + NaBr + H_2O$

[Note: we know that $Cl_2 + 2NaOH \longrightarrow NaOCl + NaCl + H_2O$

Just replace Cl by Br]

CE05_01

(a) (i)  [1]

(ii) Flame test [1]

Calcium compounds give a brick-red flame. [1]

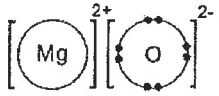
(b) (i) Isotopes are atoms of the same element with same proton number but different neutron numbers. [1]

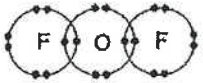
(ii) Protons = 38, neutrons = 52 [1]

(c) (i) They have the same number of electrons in their outermost shells. [1]

(ii) Sr has similar chemical properties as Ca does, thus can replace some of the Ca required. [1]

CE07_01

(a)  [1]

(b)  [1]

(c) Melting point of A is higher than that of B.

Ions of A are linked by strong ionic bonds / electrostatic force forming giant crystal lattice. [1]

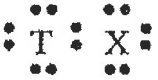
Molecules of B are attracted by weak van der Waals' forces / intermolecular forces. [1]

CE08_01

(a) T: fluorine / F [1]

X: chlorine / Cl

Z: magnesium / Mg

(b)  [1]

(c) The compound contains ions. It conducts electricity in molten/ aqueous state because the ions in it are mobile. It does not conduct electricity in solid state because the ions in it are not mobile. [1+1]

CE08_02

(a) Isotopes are atoms of the same element / atomic number / proton number that have different mass numbers / neutron numbers. [1]

(b) Let the percentage abundance of ^{11}B be X%.

$11(X) + 10(100 - X) = 10.8(100)$

$X = 80$

The percentage abundance of ^{11}B is 80%. [2]

(c) Giving out white fumes because chemical properties of isotopes are the same. [1]

CE09_09

Chemical knowledge

Electrical conductivity

a. Sodium can conduct electricity because there are delocalised electrons. [1]

b. Chlorine cannot conduct electricity because of no delocalised electrons and no mobile ions. [1]

c. Sodium chloride can conduct electricity in aqueous / molten state because there are mobile ions. [1]

Melting point

d. Chlorine has low melting point because weak intermolecular forces / weak van der Waals' forces / weak forces between molecules. [1]

e. Sodium has high melting point because strong metallic bonds / strong electrostatic forces between delocalised electrons and sodium ions. [1]

f. Sodium chloride has high melting point because strong ionic bonds / strong electrostatic forces between sodium ions and chloride ions. [1]

Effective communication [3]

CE11_03

(a) (i) The van der Waals' forces between layers are weak. [1]

(ii) The delocalised electrons can conduct electricity. [1]

(b) Lead atoms are held by metallic bonds. [1]

The metallic bonds are strong, so lead metal tears off less readily than graphite. [1]

(c) Diamond has a giant covalent structure. [1]

There are strong covalent bonds between atoms in diamond. [1]

CE11_08

Chemical knowledge

<u>The position of atom in the Periodic Table</u>

- Total number of electron shells equals to the period number. [1]
- Total number of outermost shell electrons equals to the group number. [1]

[1]

The types of chemical bondings

- Group I to III atoms may form ionic bonds with Group IV to VII atoms. / Group I to III atoms lose electrons to form ionic bonds. / Group IV to VII atoms gain electrons to form ionic bonds. [1] [1]
- Group I to III atoms may form metallic bonds within their elements.
- Group IV to VII atoms may form covalent bonds within their elements or with other Group IV to VII atoms. [1]
- Group 0/ VIII atoms or noble gases normally do not form any chemical bonds. [3]

Effective communication

AL96(I)_01a

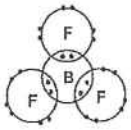
(i) ^{12}C 6n, 6p, $6e^-$ [½]
^{13}C 7n, 6p, $6e^-$ [½]

(ii) mass of 1 mole of $^{12}C = 12.000 \times 1.6605 \times 10^{-27} \times 6.0221 \times 10^{23}$ [1]
$= 0.0120$ kg [1]
(Accept answers which could round off to 0.012)

(iii) $\text{relative atomic mass} = \dfrac{12.000 \times 100 + 13.003 \times 1.12}{100 + 1.12} = 12.001$ [2]
(Accept answers which could round off to 12.01)

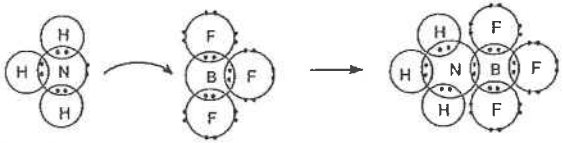
AL98(II)_01 (modified)

(a)



[1]

(b) The vacant site on the electron shell of B atom in BF_3 can accept the lone pair of [1]
electron on N atom in NH_3 to form a dative bond. [1]



[1]

AL98(II)_02 (modified)

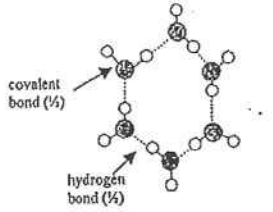
(a) In diamond, the C atoms are held by **C–C single covalent bonds**, whereas in graphite [½]
the interaction between C atoms within the same layer is **covalent bond with multiple bond character**. In graphite, the attraction between the layers of C atoms is **van der Waals' forces**. [½]
The stronger interaction will lead to a shorter C–C distance [1]
Therefore the C–C distances are:
Between layers of graphite > between C atoms in diamond > within layers of graphite [½]

(b) In diamond, the **C–C bonds are strong**. The strong directional character of [½]
covalent bond restricts the relative motion between C atoms. ∴ Diamond is hard. [1]
In graphite, the C atoms are held in **layer structure**. The **weak attraction force** [½]
between layers allows the layers to slip over each other. [1]
∴ graphite is soft and can be used as lubricant

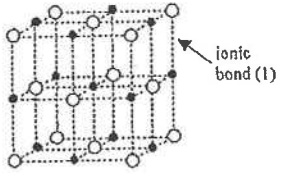
AL99(I)_01

CO_2 has a **simple molecular structure**, while SiO_2 has a **giant covalent structure**. [1]
The covalent bond between Si and O in SiO_2 is much stronger than the van der Waals' [½]
forces between CO_2 molecules. ∴ SiO_2 is a high melting point solid whereas CO_2 is a gas.

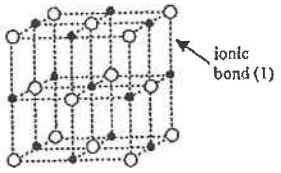
AL00(I)_01



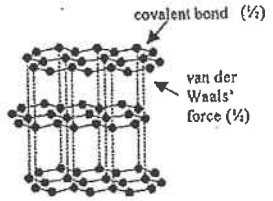
Ice (hydrogen bond)



Sodium chloride [2]



Iodine



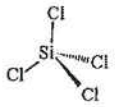
Graphite [2] [1]

ASL01(I)_05 (modified)

(a) Silicon [1]
Since element X forms covalent bonds with other 4 X atoms tetrhedrally to give a giant [1]
covalent structure.

(b) X: to make a semi-conductor [1]
Oxide of X: to make a glass [1]

(c) (i)



[1]

(ii) $SiCl_4(l) + 2H_2O(l) \longrightarrow SiO_2(s) + 4HCl(g)$ [1]

$SiCl_4(l)$ hydrolyzes in water to give white fume, $HCl(g)$. [1]

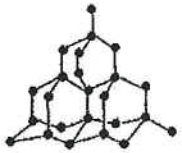
AL02(I)_03

CO_2 exists as simple molecules / has simple molecular structure and the intermolecular attraction is van der Waals' forces. [½]

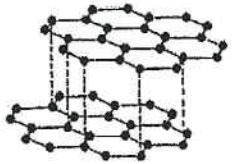
SiO_2 has a giant covalent network structure. Attraction between CO_2 molecules is weak, but attraction between Si and O atoms in $SiO_2(s)$ is strong. [½]

ASL03(I)_07

(a) (i)



diamond



graphite

[2]

(ii) **In diamond, the C–C bonds are strong. The strong directional character of covalent bond restricts the relative motion between C atoms. ∴ Diamond is harder.** [1] [½]

In graphite, the C atoms are held in layer structure. The weak attraction force between layers allows the layers to slip over each other. ∴ Graphite is soft material. [1] [½]

(b) Diamond has a higher boiling point. [1]

As the carbon atom is smaller than germanium atom, and hence C–C bonds are stronger than Ge–Ge bonds [1]

(c) The atomic mass of Pb is much higher than Ge, and Pb adopts a close-packing pattern in its lattice. [1] [1]

ASL04(I)_01 (modified)

(a) 2, 8, 17, 2 [1]

(b) Let x be the fractional abundance of ^{63}Cu

$63.5 = 63(x) + 65(1 - x)$

$x = 0.75$

% abundance of $^{63}Cu = 75$ [1]

% abundance of $^{65}Cu = 25$ [1]

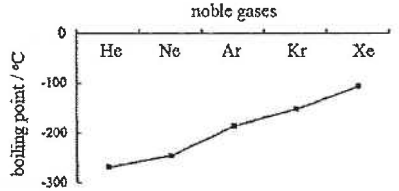
(c) Copper metal can be considered as making up of a lattice of cations and a 'sea' of delocalized electrons. [1]

The attraction between the cations and the 'sea' of delocalized electrons is responsible for the metallic bond. [1]

The deolocalized electrons can move under the influence of an electric field. [1]

∴ Cu is an electrical conductor.

AL04(I)_02



[1]

The intermolecular attraction between noble gas molecules is van der Waals' forces. [½]

The strength of van der Waals' forces increases with the number of electrons / atomic size of the noble gas. ∴ The boiling point of noble gas increases as the group is descended. [½]

ASL04(I)_06

(a) At 298 K and 1 atm pressure, CO_2 exists as simple molecules while SiO_2 exists as a giant covalent network. [½] [½]

In the lattice of SiO_2, atoms do not have translational motion. In carbon dioxide, as the intermolecular attraction between CO_2 is weak, molecules of CO_2 can have free random motion. [½] [½]

∴ CO_2 is a gas while SiO_2 is a solid.

(b) *X* [1]

(c) The strong covalent bonds in SiO_2 prevent the atoms from translational motion. [1]

SiO_2 is hard and strong.

(d) Dry ice can produce a very low temperature (–78 °C). [1]

Dry ice sublimes and no messy liquid (as in the case of ice) is produced. [1]

AL05(I)_01 (modified)

(a) Van der Waals' forces [For reference only] [½]

Owing to electron movement, uneven distribution of electron induces the polarity (instantaneous dipole) in molecules of Ar. The instantaneous polarity in a molecule attracts electrons of a neighboring molecule leading to the formation of an induced polarity (induced dipole).

Van der Waals' forces are resulted from the attraction of the instantaneous dipole and induced dipole. [1]

(b) Metallic bond [½]

In metal, the outermost shell electrons of a metal atom are weakly attracted by the nucleus. Metallic bond is resulted from the **electrostatic attraction between the metallic cations and the delocalized electron.** [Do not accept Zn 'atoms' or 'nuclei' instead of 'cation"] [1]

(c) Ionic bond [½]

Ca atoms donate electrons to F atoms, and Ca^{2+} and F^- ions are formed.

The strong electrostatic attraction between Ca^{2+} and F^- **holds the ions in a regular three dimensional structure.** [1]

AL06(I)_01 (modified)

$Na_2O(s)$ and $Al_2O_3(s)$ are ionic compounds. $SO_2(g)$ is a covalent compound and it exists as simple molecule. The attraction between $SO_2(g)$ molecule is weak van der Waals' forces. [1] [1]

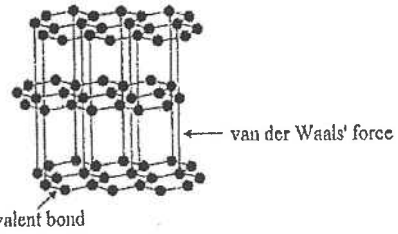
∴ $SO_2(g)$ has a very low melting point.

The charge : radio ratio of Al^{3+} is greater than that of Na^+ / Al^{3+} has a higher charge density than Na^+. ∴ $Al_2O_3(s)$ has a **much stronger ionic bond** than $Na_2O(s)$. ∴ m.p. of $Al_2O_3(s)$ > m.p. of $Na_2O(s)$ [½] [½]

[Remark: strength of ionic bond increases with the increasing charge of cations and anions AND decreases with the increasing ionic radii of the ions]

AL06(I)_02 (modified)

Diagram + labels of interatomic attractions:



[2]

ASL06(I)_05

(a) Giant covalent structure [1]

(b) Silicon would have a higher melting point than germanium. [1]

Si–Si bond is stronger than Ge–Ge bond. [1]

(c) Silicon (IV) oxide has a giant covalent structure. Silicon(IV) chloride has a simple molecular structure. [1]

Large amount of energy is required to break down numerous Si–O covalent bonds in silicon(IV) oxide during melting. [1]

Small amount of energy is sufficient to overcome weak van der Waals' forces between silicon(IV) chloride molecules. [1]

AL08(II)_01

Na_2O is an ionic solid in giant ionic structure. The strong attraction between the cations and anions makes it a high melting point solid. [1]

Cl_2O exists as simple molecules. The intermolecular attraction is weak van der Waals' force. It is much weaker than ionic bond in Na_2O. [1]

AL08(II)_04 (modified)

Diamond is a covalent crystal. All carbon atoms covalently bonded to each other and give a single bond. **The electrons are localized.** ∴ Diamond is a poor conductor / insulator of electricity. [½] [½]

In graphite, each carbon atom is covalently bonded to only three other carbon atoms in its layer, and one outer electron of each carbon atom is "free". These "free" electrons are **delocalized and moved in the direction of an electric field.** ∴ Graphite is an electrical conductor. [½] [½] [1]

ASL08(II)_04 (modified)

The size of K^+ is larger than that of Na^+. / Na^+ has a higher charge-to-radii ratio than that of K^+. [1]

For the same anion Br^-, the large the cation, the weaker is the electronic attraction between the cations and anions. [1]

∴ KBr(s) has a lower melting point.

AL09(I)_03

(a) $$\text{R.A.M.} = \frac{74 \times 0.9 + 76 \times 9.0 + 77 \times 7.6 + 78 \times 23.5 + 80 \times 49.8 + 82 \times 9.2}{100}$$ [1]

$= 79.1$ [1]

(b) The high m.p. indicates that SeO_2 is unlikely to have a simple molecular structure. [½]

Its melting point is not very high. ∴ it does not exist as covalent crystal. [½]

It does not conduct electricity in molten state. ∴ It cannot be giant ionic structure. [½]

SeO_2 has a macromolecular structure / consists of polymers of $(SeO_2)_n$ [½]

AL09(II)_03

In metals, the metal cations are surrounded by delocalized valence electrons. The attraction between the cations and electrons (metallic bond) is non-directional. If a stress is applied, the layers of metal cations will slide over one another without breaking of metallic bonds. [1]

In ionic compounds, the cations and anions occupy specific positions in the lattice. When an ionic crystal is subjected to a stress, a slight dislocation in the structure brings similar charged ions together, causing repulsion. [1]

AL12(II)_08 (modified)

(a) 3 out of 4 outermost electrons of each C atom form a C-C bond with another 3 carbon atoms on the same plane. [1]

The remaining outermost electron of each C atom is delocalized. [1]

The attraction between atoms within a layer is strong covalent bond, while that between layers is weak van der Waals' forces. [1]

Graphite is soft because the layers can slide over one another easily. [1]

(b) (i) The C atoms in graphene are bonded by strong covalent bond. [1]

(ii) Any ONE of the following: [1]

- Graphene has a smaller density.
- Graphene is not easily corroded / chemically inert.

AL13(II)_05

(a) m.p. of Ca > m.p. of Ra

For metals in the same group of the Periodic Table, their metallic bond strength depends on their atomic radius (or atomic size). [1]

Ra has a larger atomic size than Ca. ∴ metallic bond in Ca is stronger than that in Ra. [1]

(b) Ra is more reactive than Ca towards water. ($H_2(g)$ is formed.) [1]

$M(s) + 2H_2O(l) \longrightarrow M(OH)_2(aq) + H_2(g)$

Ra has a larger size and is more ready to donate its outermost electrons. [1]

(c) A white precipitate of $RaSO_4(s)$ will be formed. [1]

The solubility of sulphate(VI) of Group II elements decreases as the group is decended. As both $SrSO_4(s)$ and $BaSO_4(aq)$ are insoluble in water, it is likely that $RbSO_4(s)$ is also insoluble. [1]

AL13(II)_08

(b) $BrF_5(l)$ contains only molecules and no delocalized electrons or mobile ions. It cannot conduct electricity. [1]

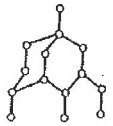
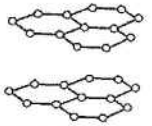
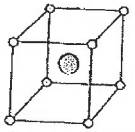
A mixture of BrF_5 and AsF_5 contains BrF_4^+ and AsF_6^- ions. These ions have translational motion in an applied electric field. Thus, the mixture can conduct electricity. [1]

DSE11SP_01

(a) False. The high melting point of NaCl is due to the strong electrostatic attraction between ions (sodium ions and chloride ion) / the presence of strong ionic bonds. [1]

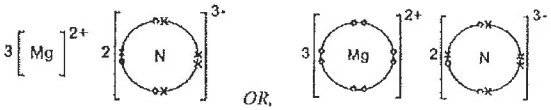
The low melting point of CH_4 is not due to the existence of covalent bond between C and H atoms, but due to the weak van der Waals' forces between the molecules / weak intermolecular forces. [1]

DSE11SP_07

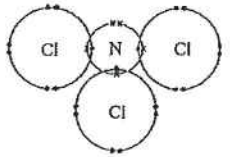
Solid substance	Three-dimensional diagram for the structure of the solid substance	Explanation of whether the solid substance is an electrical conductor
Diamond		Insulator because no delocalized electrons [2]
Graphite		Conductor because delocalized electrons are present [2]
Caesium chloride		Insulator because no mobile ions [2]

DSE12PP_03

(a) (i) [1]



(b) (ii) [1]



DSE12_01

(a) **Atoms with the same number of protons but different numbers of neutrons.** [1]

OR, Atoms with the same atomic number but different mass numbers.

(b) $20\times0.9048 + 21\times0.0027 + 22\times0.00925 = 20.19$ [1]

(c) Gas for filling luminous advertisement tubes / neon tubes / neon signs / neon light. [1]

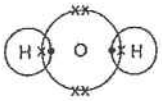
(NOT accept fluorescent tubes)

(d) Neon is monoatomic whereas oxygen is diatomic. O_2 molecule has larger molecular size than Ne molecule. (NOT accept larger molecular mass) [1]

Thus stronger van der Waals' force / strong intermolecular force among O_2 molecules. [1]

(NOT Accept VDW force)

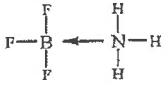
DSE13_01

(a)  [1]

DSE13_02

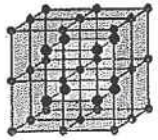
(c) In BF_3, there are three (bond) electron pairs / there is a vacant site / 6 electrons only / electron deficient in the outermost shell of the B atom. [1]

By accepting the lone pair of electrons from the nitrogen atom of NH_3 / forming dative bond with N, boron attains the stable electronic configuration of neon (a noble gas). [1]



DSE13_08

(a) $2Cs + Cl_2 \longrightarrow 2CsCl$ [1]

(b) (i)  [1]

(The drawing should be either show the correct labels for Cs^+ and Cl^-, or show clearly there are two types of ions in the lattice with correct relative positions.)

(ii) CsCl contains **Cs^+ / cations** and **Cl^- / anions**. In CsCl, ions are **strongly held by ionic bond.** [1]

Relative movement of the ions can **bring ions of the same charge close to each other, and will result in repulsion.** ∴ CsCl(s) is brittle. [1]

(c) Cs(s) is more reactive than Na(s). The **relativity of Group I metal increases down the group.** [1]

OR, The electron in the outermost shell (valence electron) of Cs is weakly bounded by the nucleus as compared with that of Na.

OR, Cs atom loses its outermost shell electron more easily than Na atom.

OR, Cs atom loses it electron more easily than Na atom because Cs has more electron shells than Na / the size of Cs atom is larger than that of Na / the atomic radius of Cs is larger than that of Na.

OR, Both Cs and Na are Grop I metals, and the size of Cs atom is larger than that of Na.

DSE13_13

Nitrogen < lithium < beryllium < carbon (graphite) [1]

N_2 has the lowest melting point as it has a **simple molecular structure**, weak **van der Waals' forces / intermolecular forces** need to be overcome. [1]

Both Li and Be have **metallic structure, metallic bond in Li is weaker than that in Be.** [1]

∴ Li < Be in melting points.

C has the highest melting point as it has a giant covalent structure, large amount of energy is needed to **break strong covalent bonds between atoms** in melting. [1]

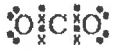
[1]

Effective communication

DSE14_01

(a) (i) Layers of graphite are held together by **van der Waals' forces / weak intermolecular forces only.** [1]

(ii) Yes, graphene has **delocalized electrons** / electrons in graphene are not localized / mobile electrons / electrons will flow. [1]

(iii)  [1]

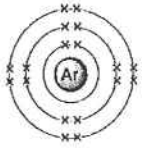
(Accept any symbols of electrons, ignore shape)

Not accepted: Showing electrons in the inner shells.

(b) No. Graphene layers are made up of a **giant covalent structure.** [1]

A large amount of energy is needed during melting to destroy the large amount of **strong covalent bonds between atoms.** [1]

DSE15_01

(a)  [1]

(b) Van der Waals' forces [1]

(c)

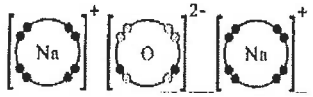
Element	Natural source	Method of extraction
Argon	Atmosphere / air	**Fractional distillation of liquefied air** (NOT accept "distillation")
Chlorine	Rock salt / sea water / ocean NOT accept "lake", "river", "salt water", etc.	Electrolysis of sea water

[2]

[2]

DSE15_10

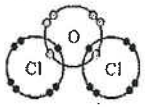
(a) (i)



[1]

It gives an alkaline / a base solution / NaOH / sodium hydroxide [1]

(ii)



[1]

It gives an acidic solution / HOCl / hypochlorous acid [1]

DSE16_01

(a) 2,8, 5 [1]

(b) Chlorine exists as isotopes. / There are chlorine atoms with same number of protons but different number of neutrons. / All chlorine atoms have 17 protons. Some chlorine atoms have 18 neutrons and some have 20. [1]

DSE16_02

(a) To increase the electrical conductivity of the filter paper / To increase the number of mobile ions / To provide mobile ions / $K_2SO_4(aq)$ is an electrolyte [1]
(Also accept: Allow ions to pass through / $K_2SO_4(aq)$ acts as a salt bridge)
(Not accept: To complete the circuit)

(b) pale green / green / light green [1]

(c) (Dark) Blue color appears around the middle of the filter paper. [1]
$Fe^{2+}(aq)$ ions move towards negative pole / move to the right and $Fe(CN)_6^{3-}(aq)$ ions move towards positive pole / move to the left (forming a blue compound). [1]

(d) The color around the middle of the filter paper remains unchanged / white / colorless. [1]
$Fe^{2+}(aq)$ ions and $Fe(CN)_6^{3-}(aq)$ ions do not migrate towards each other. [1]
OR, $Fe^{2+}(aq)$ ions and $Fe(CN)_6^{3-}(aq)$ ions move to opposite sides.
OR, $K^+(aq)$ and $SO_4^{2-}(aq)$ migrate towards each other but do not form colored compounds.

DSE16_04

(c) The intermolecular forces between CS_2, CO_2 molecules are van der Waals' forces. [1]
As CS_2 has greater molecular size than CO_2, the van der Waals' forces between CS_2 molecules are stronger than those between CO_2 molecules. [1]

DSE16_08

(a) (i) Reddish brown gas observed. [1]
Do not accept reddish brown liquid.

(ii) $Sr^{2+} + 2e^- \longrightarrow Sr$ [1]

(b) Bromine gas formed is toxic / poisonous. / Bromine is toxic. / A toxic gas is formed. [1]
Do not accept answers like "irritant", "harmful".

DSE17_01

(a) The metallic bond / electrostatic attraction between delocalized electrons / sea of electrons and metal ions / barium ions / Ba^{2+}. [1] [1]
(Not accept: free electrons / electrons / outermost electrons)
(Or diagram with correct labels)
(For diagram:
(1) The barium ions should be labelled as "Ba^{2+}"
(2) Clearly indicates sea of electrons, or delocalized electrons between metal ions.
(3) Clearly indicate metallic bond / electrostatic attraction between sea of electrons / delocalized electrons and metal ions)

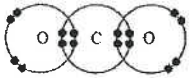
DSE17_03

(c) The O atom in H_2O has lone pairs of electrons. [1]
H^+ does not have electrons in its outermost shell. [1]
Dative covalent bond formed between the O atom in H_2O and H^+ by sharing electron pair. [1]
(Also accept graphical answer as below:)

dative covalent bond

DSE17_08

(b)



[1]

DSE18_01

(a) (i) $6x + 7(1 - x) = 6.9$ [1]
$x = 0.1 = 10\%$ (Accept answer without unit) (Accept 0.1, 10, 10.0) [1]

(ii)

[1]

The electron diagram should have brackets

DSE19_01

(a) Protium and deuterium have same number of protons but different number of neutrons. [1]

OR, Protium and deuterium have same atomic number but different mass number.

(b) [1]

(c) (i) Any TWO of the following [2]

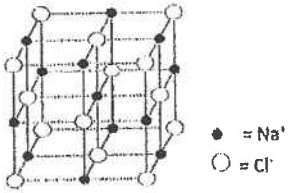
- (Colourless) gas evolves.
- Sodium metal dissolves.
- Sodium drags / moves on the surface of $D_2O(l)$.
- Sparks are observed / flame is observed / sodium burns.
- Heat evolves.
- White fume evolves.
- Hissing sound is heard.
- Sodium melts to (silvery) ball.

(ii) $2Na + 2D_2O \longrightarrow 2NaOD + D_2$ [1]

(State symbols not required) (Ignore incorrect state symbols)

DSE19_02

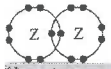
(a) [1]



DSE20_01

1. (a) 2, 8, 18, 7 1

(b) 1



(Accept answer with correct inner shell electrons)
(Not accept answer with incorrect inner shell electrons, if inner shell electrons are drawn)

(c) (i) $K_2SO_3(s) + 2HCl(aq) \rightarrow 2KCl(aq) + H_2O(l) + SO_2(g)$ / 2
$K_2SO_3(s) + 2H^+(aq) \rightarrow 2K^+(aq) + H_2O(l) + SO_2(g)$
Correct states (1 mark)
Balanced equation (1 mark)
(No mark if the chemical species shown in the equation are incorrect)

(ii) (Reddish brown / brown) changes to colourless. / The solution changes to colourless. 1
(Not accept incorrect initial colour. Not accept pale brown)
$Br_2 + SO_2 + 2H_2O \rightarrow 2Br^- + SO_4^{2-} + 4H^+$ 1
(State symbols not required) (Ignore incorrect state symbols)
OR $Y_2 + SO_2 + 2H_2O \rightarrow 2Y^- + SO_4^{2-} + 4H^+$

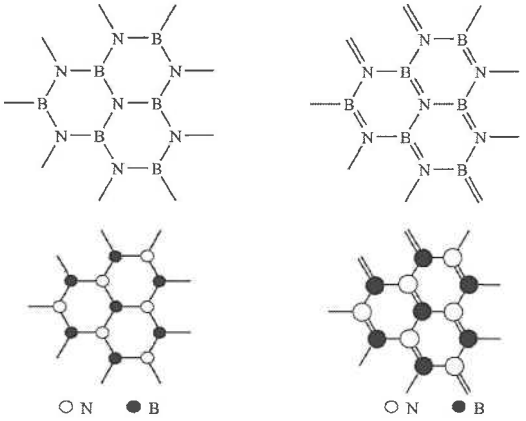
(iii) Y and Z have the same number of electrons / seven electrons in the outermost shells, hence similar chemical properties (leading to similar observation). 1
(Not accept "Same chemical properties")

DSE20_03

(b) (i) • B–N is the dative covalent bond. 1
• The lone electron pair on nitrogen atom of NH_3 is donated to form a dative covalent bond with the boron atom of BH_3. 1

(ii) • Both are van der Waals' forces between their respective molecules. 1
• As H_3NBH_3 is polar but ethane is not, the van der Waals' forces between H_3NBH_3 molecules are stronger than those between ethane molecules. 1
(Only the 2nd mark will be given if the candidate answered in terms of "intermolecular forces" instead of van der Waals' forces)
(2nd mark not accept comparison of molecular size)

(iii) 2



(1 mark for showing the fused hexagonal structure, need to show at least 2 fused rings)
(1 mark for showing alternating N and B atoms)
(Ignore the double bonds in the structure)

SECTION 3 Metals

Multiple-Choice Questions

CE90_07

The reaction between lead(II) nitrate solution and sodium hydrogencarbonate solution can be represented by the equation below:

$$Pb^{2+}(aq) + 2HCO_3^-(aq) \longrightarrow PbCO_3(x) + H_2O(y) + CO_2(z)$$

	x	y	z
A.	aq	aq	aq
B.	aq	l	g
C.	s	aq	g
D.	s	l	g

CE90_09

The molecular formula of a gas is X_3. If the Avogadro's Number is L mol^{-1}, how many molecules are there in 96g of X_3?

(Relative atomic mass of X = 16.0)

A. $\frac{1}{2}$L B. 2L

C. 3L D. 6L

CE90_10

If 2g of carbon dioxide gas contain x molecules, how many molecules are present in 2g of helium gas?

(Relative atomic masses: He = 4.0, C = 12.0, O = 16.0)

A. x B. 5.5x

C. 7x D. 11x

CE90_31

16.1g of a hydrated metal sulphate was heated to constant mass. After cooling to room temperature, the residual anhydrous metal sulphate weighed 7.1g.

How many moles of water of crystallization are there in one mole of the hydrated metal sulphate?

(Relative molecular masses: anhydrous metal sulphate = 142.0, water = 18.0)

A. 4 B. 5

C. 7 D. 10

CE90_45

1st statement	2nd statement
Magnesium chloride solution gives a white precipitate with lead(II) nitrate solution.	Magnesium is higher than lead in the metal reactivity series.

CE90_49

1st statement	2nd statement
Sea water can corrode ships more quickly than fresh water.	Sodium chloride in sea water speeds up the corrosion of iron.

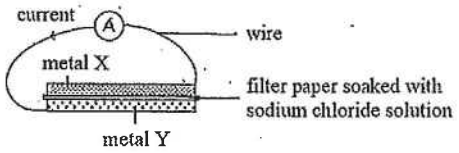
CE91_08

X, Y and Z are metals. Y can displace X from a solution of the nitrate of X. Oxides of X and Y can be reduced by hydrogen but not the oxide of Z. Which of the following arrangements represents the correct descending order of reactivity of the metals?

A. Z > Y > X B. X > Y > Z

C. Z > X > Y D. X > Z > Y

CE91_09



Which of the following combinations would produce the largest current flowing from metal X to metal Y in the external circuit?

	Metal X	Metal Y
A.	Fe	Cu
B.	Mg	Ag
C.	Ag	Zn
D.	Cu	Pb

CE91_11

2.60g of a metal X combine with 1.20g of oxygen to form an oxide in which the oxidation number of X is +3. What is the relative atomic mass of X?

(Relative atomic mass: O = 16.0)

A. 11.6 B. 34.7

C. 52.0 D. 104

CE91_31

Which of the following substances, when heated, can react with oxygen?

(1) sodium

(2) sulphur

(3) iron

A. (2) only B. (1) and (2) only

C. (1) and (3) only D. (1), (2) and (3)

CE92_01

Rubidium (Rb) is a group I element below potassium in the Periodic Table. Which of the following statements about rubidium is correct?

A. Rubidium forms an acidic oxide.
B. Rubidium is more reactive than potassium.
C. Rubidium can be obtained from its oxide by reaction with carbon.
D. The formula for rubidium chloride is $RbCl_2$.

CE92_06

0.01 mol of C_2H_5OH is burnt completely in oxygen. What are the numbers of moles of carbon dioxide and water formed respectively?

	carbon dioxide	water
A.	0.01	0.03
B.	0.02	0.03
C.	0.02	0.06
D.	0.04	0.06

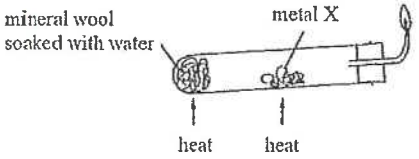
CE92_07

Which of the following gases, each having a mass of 10.0g, has the greatest number of molecules at room temperature and pressure?

(Relative atomic masses: C = 12.0; N = 14.0; O = 16.0; F = 19.0; Ne = 20.2)

A. nitrogen
B. fluorine
C. neon
D. carbon monoxide

CE92_31



In the above experiment, a gas is evolved and burns at the jet. Metal X is probably

A. zinc.
B. aluminium.
C. magnesium.
D. copper.

CE92_33

Which of the following ions is/are coloured?

(1) $Pb^{2+}(aq)$
(2) $Cr^{3+}(aq)$
(3) $MnO_4^-(aq)$

A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

CE92_34

Which of the following metals can be obtained by reducing their oxides with carbon?

(1) iron
(2) calcium
(3) lead

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE93_08

The molecular formula of a gaseous element X is X_2. If the relative atomic mass of X is 19, what is the number of molecules in 114 g of the gas?

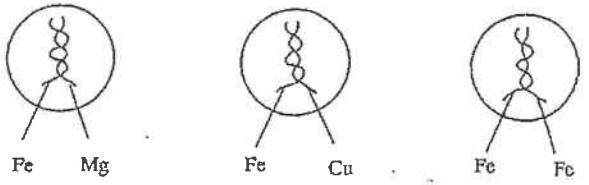
(Avogadro's number = 6.022×10^{23})

A. 3
B. 6
C. $3 \times 6.022 \times 10^{23}$
D. $6 \times 6.022 \times 10^{23}$

CE93_20

Direction: Q.20 and Q.21 refer to the following experiment:

Three different pairs of metal wires are placed separately in petri dishes (as shown in the diagram below) containing a mixture of gelatin, potassium hexacyanoferrate(III) solution and phenolphthalein solution.



Dish I Dish II Dish III

Which of the following statements are correct?

(1) The iron wire in Dish I does not corrode readily.
(2) The iron wire in Dish II corrodes readily.
(3) The iron wires in Dish III do not corrode.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE93_21

In Dish II, which of the following colours will develop around the iron wire and the copper wire?

	iron wire	copper wire
A.	pink	blue
B.	blue	pink
C.	pink	no colour
D.	blue	no colour

CE93_46

1st statement	2nd statement
Sodium carbonate is not decomposed by heat.	Sodium carbonate is an ionic compound.

CE94_08

Which of the following contains the same number of atoms as 2.20g of carbon dioxide?
(Relative atomic masses: H = 1.0, C = 12.0, N = 14.0, O = 16.0, S = 32.0, Cl = 35.5)

A. 1.70g of ammonia
B. 2.25g of nitrogen monoxide
C. 2.80g of sulphur dioxide
D. 3.55g of chlorine

CE94_18

The formula of hydrated magnesium sulphate crystals is $MgSO_4 \cdot xH_2O$. When 3.80g of the hydrated crystals are heated, 2.00g of anhydrous magnesium sulphate are produced. What is the value of x?
(Relative atomic mass: H = 1.0, O = 16.0, Mg = 24.0, S = 32.0)

A. 3
B. 4
C. 5
D. 6

CE94_44

Which of the following methods can be used to distinguish between solid sodium carbonate and calcium carbonate?

(1) Heating the solid and testing the gaseous product with lime water.
(2) Testing the solubility of the solid in water.
(3) Conducting a flame test on the solid.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE95_05

Which of the following methods can be used to extract lead from lead(II) oxide?

A. heating lead(II) oxide in the absence of air
B. heating lead(II) oxide in the presence of air
C. heating lead(II) oxide with copper at high temperature
D. heating lead(II) oxide with carbon at high temperature

CE95_18

Metal X reacts with dilute hydrochloric acid to liberate hydrogen, but metal Y and metal Z have no reaction with the dilute acid. The oxide of metal Y decomposes on heating but the oxide of metal Z does not.
Which of the following arrangements represents the order of increasing reactivity of the three metals?

A. X < Y < Z
B. Y < Z < X
C. X < Z < Y
D. Z < Y < X

CE95_45

1st statement	2nd statement
When a piece of iron wire coupled with a piece of tin wire is left in the air for a long period of time, the iron wire does not corrode.	Tin prevents iron from corrosion by sacrificial protection.

CE96_08

Zinc blocks are often attached to the steel legs of off-shore oil platforms because

A. zinc can protect steel from corrosion.
B. zinc is more resistant to corrosion than steel.
C. zinc is harder than steel.
D. zinc does not react with crude oil.

CE96_35

In which of the following processes will lead be produced?

(1) the electrolysis of molten lead(II) bromide
(2) heating lead(II) oxide strongly
(3) adding magnesium to lead(II) nitrate solution

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE96_47

1st statement	2nd statement
The resistance of aluminium to corrosion can be enhanced by anodization.	During anodization, aluminium oxide on the metal surface is reduced to aluminium.

CE97_28

What mass of copper is obtained when 0.40 mol of copper(II) oxide are completely reduced by carbon?
(Relative atomic masses: O = 16.0, Cu = 63.5)

A. 12.7 g
B. 15.9 g
C. 25.4 g
D. 31.8 g

CE97_32

Which of the following metal oxides can be reduced to the metal when heated with carbon?

(1) aluminium oxide
(2) lead(II) oxide
(3) iron(III) oxide

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE97_41

Aluminium is used to make window frames because

(1) it is strong

(2) it can resist corrosion

(3) it is the most abundant metallic element in the earth crust

Which of the above statements are correct?

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE97_47

1st statement	2nd statement
The reaction of sodium with water produce hydrogen.	The reaction of sodium with water is exothermic.

CE97_48

1st statement	2nd statement
The body of a motor car will corrode faster if common salts is sprinkled on roads after a heavy snow.	Common salt and water form a conducting solution.

CE98_02

The formula for ozone is O_3. If one mole of ozone contains x atoms, how many atoms will one mole of oxygen gas contain?

A. $\frac{x}{3}$
B. $\frac{2x}{3}$
C. $\frac{3x}{2}$
D. 3x

CE98_10

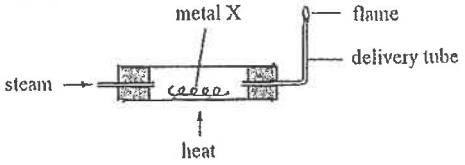
The formula for hydrated iron(II) sulphate is $FeSO_4 \cdot xH_2O$. On strong heating, 20.1g of the sulphate produces 9.1g of water. What is the value of x?

(Relative atomic masses: H = 1.0, O = 16.0, S = 32.1, Fe = 56.0)

A. 5
B. 6
C. 7
D. 8

CE98_11

Consider the following experiment.

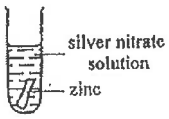


During the experiment, a gas is liberated. The gas can burn at the end of the delivery tube. X is probably

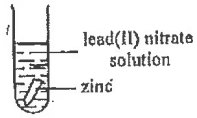
A. copper.
B. lead.
C. silver.
D. zinc.

CE98_19

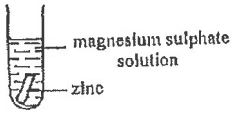
In each of the four solutions shown below, a strip of zinc is added.



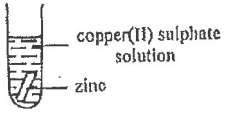
Tube I



Tube II



Tube III



Tube IV

Which of the following combinations is correct?

	Tube	Observation
A.	I	no change
B.	II	brown coating on zinc
C.	III	no change
D.	IV	grey coating on zinc

CE98_20

The following equation represents the reaction of an oxide of lead with hydrogen:

$$Pb_3O_4(s) + 4H_2(g) \longrightarrow 3Pb(s) + 4H_2O(l)$$

What mass of lead would be obtained if 68.5g of the oxide was consumed in the reaction?

(Relative atomic masses: O = 16.0, Pb = 207.0)

A. 20.7 g
B. 41.4 g
C. 62.1 g
D. 82.8 g

CE98_27

Consider the following chemical equation:

$$Zn + pMnO_2 + qNH_4^+ \longrightarrow Zn^{2+} + xMn_2O_3 + yNH_3 + zH_2O$$

Which of the following combinations is correct?

	x	y	z
A.	1	2	1
B.	1	3	2
C.	2	3	2
D.	2	2	3

CE98_44

Upon heating, a mixture of iron and sulphur gives a black substance. Which of the following statements concerning the black substance are correct?

(1) It is insoluble in water.
(2) It can be attracted by a bar magnet.
(3) It reacts with dilute hydrochloric acid to give a gas with a pungent smell.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE99_02

One mole of calcium bromide contains

A. 1 mole of molecules.
B. 2 moles of cations.
C. 2 moles of anions.
D. 3 moles of atoms.

CE99_08

Iron can be produced from iron(III) oxide by the following reaction:

$$Fe_2O_3(s) + 3CO(g) \longrightarrow 2Fe(s) + 3CO_2(g)$$

What mass of iron(III) oxide is required to produce 2.1g of iron?
(Relative atomic masses: O = 16.0, Fe = 56.0)

A. 3.0 g
B. 4.5 g
C. 6.0 g
D. 9.0 g

CE99_17

The compound X_2S contains 58.9% of X by mass. What is the relative atomic mass of X?
(Relative atomic mass: S = 32.0)

A. 11.5
B. 23.0
C. 39.0
D. 46.0

CE99_21

Consider the following chemical equation:

$$2HNO_3 + xFeSO_4 + yH_2SO_4 \longrightarrow zFe_2(SO_4)_3 + 4H_2O + 2NO$$

Which of the following combinations is correct?

	x	y	z
A.	2	1	1
B.	4	3	2
C.	6	2	3
D.	6	3	3

CE99_22

In which of the following situations is iron prevented from rusting by sacrificial protection?

A. Iron plates are jointed together with copper rivets.
B. Iron pipes are connected to lead blocks.
C. Iron sheets are plated with zinc.
D. Iron cans are coated with tin.

CE99_31

Which of the following metal oxides CANNOT be reduced by heating with carbon?

(1) magnesium oxide
(2) lead(II) bromide
(3) iron(III) oxide

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE99_46

1st statement	2nd statement
Metals have good thermal conductivity.	Metals are composed of giant lattices of positive ions surrounded by valence electrons which are free to move throughout the lattices.

CE00_03

Iron cans used for canning food are usually coated with tin instead of zinc. This is because

A. tin is more reactive than zinc.
B. tin ions are non-toxic but zinc ions are toxic.
C. tin forms an alloy with iron and this alloy is corrosion resistant.
D. tin prevents iron cans from rusting by sacrificial protection.

CE00_04

Metal X forms an oxide. 27.53g of this oxide contains 24.96g of X. What is the mole ratio of X to oxygen in the oxide?

(Relative atomic masses: O = 16.0, X = 207.0)

A. 1 : 1
B. 1 : 2
C. 2 : 3
D. 3 : 4

CE00_33

In an experiment, a piece of calcium metal was added to a beaker of water. Which of the following statements concerning the experiment is/are correct?

(1) The calcium metal sinks to the bottom of the beaker.
(2) The calcium metal burnt with brick red flame.
(3) At the end of the experiment, an alkaline solution was formed in the beaker.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE00_50

1st statement	2nd statement
Aluminium was used earlier than iron in the history of mankind.	Aluminium is more abundant than iron in the earth crust.

CE01_26

What is the percentage by mass of chromium in potassium dichromate?

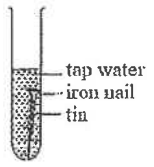
(Relative atomic mass: O = 16.0, K = 39.1, Cr = 52.0)

A. 17.7
B. 25.1
C. 35.4
D. 40.8

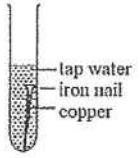
CE01_30

Which iron nail in the test tubes shown below would rust most slowly?

A.

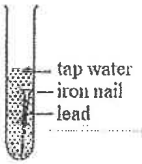


B.



C.

D.



CE01_38

In which of the following experiments would a metal be produced?

(1) heating silver oxide
(2) heating iron pyrite
(3) heating a mixture of lead(II) oxide and carbon powder

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE01_49

1st statement	2nd statement
Lithium is the most reactive element in Group I of the Periodic Table.	Among the Group I elements, lithium loses electrons most readily.

CE02_03

An oxide of element X has the formula X_2O_3. 10.2g of this oxide contains 5.4g of X. What is the relative atomic mass of X?

(Relative atomic mass: O = 16.0)

A. 12.0
B. 18.0
C. 27.0
D. 36.0

CE02_08

Which of the following statements concerning aluminium is correct?

A. Aluminium is used to make stainless steel.
B. The strength of aluminium can be enhanced by anodization.
C. Aluminium is the most abundant element in the earth's crust.
D. When aluminium is exposed to air, a layer of aluminium oxide is formed on its surface.

CE02_14

Ammonium dichromate, $(NH_4)_2Cr_2O_7$, decomposes on heating to give chromium(III) oxide, water and nitrogen. What mass of water is obtained when 126g of ammonium dichromate undergoes complete decomposition?

(Relative atomic masses: H = 1.0, N= 14.0, O = 16.0, Cr = 52.0)

A. 9 g
B. 18 g
C. 36 g
D. 72 g

CE02_23

Which of the following gases contains the greatest number of molecules at room temperature and pressure?

(Relative atomic masses: H = 1.0, N = 14.0, O = 16.0, Cl = 35.5)

A. 2.0 g of hydrogen
B. 16.0 g of oxygen
C. 18.0 g of ammonia
D. 60.0 g of chlorine

CE02_26

When a piece of copper is dropped into an aqueous solution of compound X, the copper gradually dissolve. X is probably

A. magnesium chloride
B. lead(II) nitrate
C. silver nitrate
D. ammonium chloride

CE02_27

Which of the following objects is *least* likely to contain titanium?

A. missile
B. water tap
C. bicycle frame
D. artificial hip joint

CE03_01

Which of the following pairs of elements in Group I and VII of the Periodic Table would react with each other most vigorously?

	Group I	Group VII
A.	lithium	fluorine
B.	lithium	iodine
C.	potassium	fluorine
D.	potassium	iodine

CE03_02

Which of the following substances, upon heating in a test tube, would undergo a chemical change?

A. Water
B. calcium oxide
C. sodium chloride
D. hydrated copper(II) sulphate

CE03_05

Which of the following methods can be used to obtain aluminium from aluminium oxide?

A. reducing the oxide with carbon
B. heating the oxide strongly
C. electrolysis of the molten oxide
D. heating the oxide with iron powder

CE03_11

A sample of $MgSO_4 \cdot xH_2O(s)$ of mass 123.2g contains 63.0g of water of crystallization. What is the value of x?

(Relative atomic masses: H = 1.0, O = 16.0, Mg = 24.3, S = 32.1)

A. 4
B. 5
C. 6
D. 7

CE03_28

Which of the following gases contains the greatest number of molecules?

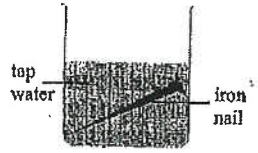
(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0, Ne = 20.2, Cl = 35.5)

A. 50.0g of neon
B. 50.0g of oxygen
C. 50.0g of hydrogen chloride
D. 50.0g of carbon monoxide

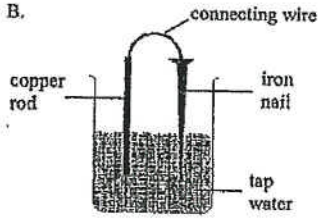
CE03_09

Which iron nail in the beakers shown below would undergo corrosion most readily?

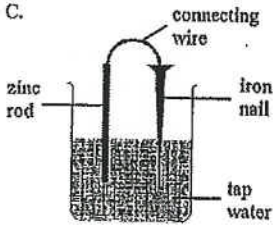
A.



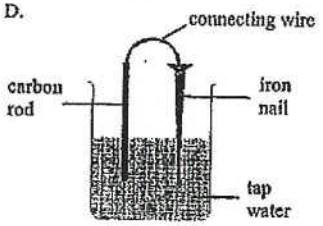
B.



C.



D.



CE03_42

Iron pyrite (FeS_2) looks like gold and its common name is "fool's gold". Which of the following methods can be used to distinguish iron pyrite from gold?

(1) comparing their densities
(2) comparing their electrical conductivity
(3) comparing the effect of heat on them

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE05SP_08

What is the formula mass of magnesium fluoride?

A. 43.3
B. 62.3
C. 67.6
D. 81.3

CE05SP_21

Both aluminium and iron can be extracted from their oxides. Which of the following combinations shows the commonly used extraction methods?

	Aluminium	Iron
A.	heating with carbon	heating with carbon
B.	heating with carbon	electrolysis
C.	electrolysis	heating with carbon
D.	electrolysis	electrolysis

CE05SP_29

1st statement	2nd statement
Iron was used earlier than copper in the history of mankind.	Iron is more reactive than copper in the earth crust.

CE05SP_32

Lead forms an oxide. 27.53g of this oxide of lead contains 24.96g of lead. What is the empirical formula of this oxide?

A. PbO
B. PbO_2
C. Pb_2O_3
D. Pb_3O_4

CE05SP_41

Which of the following statements concerning anodization of aluminium articles is/are correct?

(1) During the anodization process, aluminium articles are connected to the negative pole of the power supply.
(2) Anodization can increase the thickness of the oxide layer on aluminium articles.
(3) After anodization, aluminium articles will not easily be corroded.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE04_12

The relative atomic mass of element X is 74.9. It forms an oxide containing 24.3% of oxygen by mass. What is the mole ratio of X to oxygen in the oxide?

A. 1 : 2
B. 1 : 3
C. 2 : 3
D. 2 : 5

CE04_16

Magnesium can be obtained from magnesium oxide by

A. electrolysis of the molten oxide.
B. heating the oxide strongly.
C. heating the oxide with carbon.
D. heating the oxide with zinc powder.

CE04_26

What is the percentage by mass of nitrogen in the fertilizer $(NH_4)_2HPO_4$?

A. 10.6%
B. 12.3%
C. 21.2%
D. 24.6%

CE04_35

A piece of sodium is on fire in the laboratory. Which of the following methods can be used to put out the fire?

(1) Using sand to cover the burning sodium
(2) Spraying foam from a foam extinguisher onto the burning sodium
(3) Spraying powder from a powder extinguisher onto the burning sodium

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE04_48

1st statement	2nd statement
Lead can displace iron from iron(II) nitrate solution.	Lead occupies a higher position in the electrochemical series than iron.

CE05_10

Directions: Q.10 and Q.11 refer to the following experiment.

Rust indicator solution was poured into the following glass dishes to cover the iron nails, which were wrapped with different metal strips. The dishes were allowed to stand in air for some time.

silver strip dish 1 | zinc strip dish 2 | copper strip dish 3 | magnesium strip dish 4

If the iron nail rusts, what would the colour of the rust indicator be around the nail?

A. yellow
B. brown
C. red
D. blue

CE05_11

In which of the dishes would the iron nail rust?

A. dish 1 only
B. dish 2 only
C. dish 1 and dish 3 only
D. dish 2 and dish 4 only

CE05_23

Which of the following samples of gases contains the smallest number of molecules?
(Relative atomic masses: H = 1.0, C = 12.0, N = 14.0, O = 16.0, S = 32.1)

A. 10g of NO_2
B. 10g of CO_2
C. 10g of H_2S
D. 10g of C_2H_4

CE06_08

Consider the following equation:

$$x\ VO_2^+(aq) + y\ H^+(aq) + 2\ I^-(aq) \longrightarrow x\ VO^{2+}(aq) + z\ H_2O(l) + I_2(aq)$$

(V is the symbol for the element vanadium.)

Which of the following combinations is correct?

	x	y	z
A.	1	2	1
B.	1	4	2
C.	2	4	2
D.	3	6	3

CE06_09

Which of the following properties is considered the most important one when choosing an alloy for making fuse in electric plugs?

A. low melting point
B. high electrical conductivity
C. good ductility
D. high mechanical strength

CE06_13

X and Y are two different metals. Which of the following shows that Y is more reactive than X?

A. X forms an ion with a charge of +2 while Y forms an ion with a charge of +1.
B. X reacts with dilute hydrochloric acid but Y does not.
C. X can displace Y from an aqueous solution of a salt of Y.
D. The oxide of X undergoes decomposition upon strong heating but the oxide of Y does not.

CE06_18

Element X forms two oxides XO and XO_2. If 1 mole of XO contains n atoms, 2 moles of XO_2 would contain

A. 3/2n atoms
B. 2n atoms
C. 3n atoms
D. 6n atoms

CE06_34

Which of the following changes occur after an aluminium article has been anodized?

A. Its electrical conductivity increases.
B. Its tensile strength increases.
C. It becomes more easily dyed.
D. It becomes more easily oxidized.

CE06_37

The relative atomic mass of metal X is 55.8. 23.90 g of X is allowed to react with excess oxygen until X is completely oxidized. The mass of the metal oxides obtained is 34.18 g. What is the empirical formula of the oxide? (Relative atomic mass: O = 16.0)

A. XO
B. X_2O_3
C. X_3O_2
D. X_3O_4

CE07_05

Metal Y and calcium are both in the same group of the Periodic Table. When equal mass of Y and calcium respectively reacts with excess hydrochloric acid under the same condition, Y gives more hydrogen than calcium does. Which of the following deductions is correct?

A. The reactivity of Y is higher than that of calcium.
B. The metallic bond in Y is weaker than that in calcium.
C. The atomic number of Y is greater than that of calcium.
D. The relative atomic mass of Y is smaller than that of calcium.

CE07_07

X, Y and Z are metals. The table below shows the observations when each of them is put into copper(II) sulphate solution:

Metal	Observation
X	No observable change
Y	Brown solid formed and colourless gas evolved
Z	Brown solid formed

Which of the following arrangement correctly represents the ascending order of reactivity of the metals?

A. X < Z < Y
B. Y < Z < X
C. Z < X < Y
D. X < Y < Z

CE07_11

D, **J**, **R** and **Y** represent four different compounds. **D** and **J** react according to the following equation:

$$\mathbf{D} + 2\mathbf{J} \longrightarrow \mathbf{R} + 2\mathbf{Y}$$

d grams of **D** react with j grams of **J** to give r grams of **R** and y grams of **Y**. What is the value of y?

A. $d + j - r$
B. $d + 2j - r$
C. $2(d + j - r)$
D. $(d + 2j - r)/2$

CE07_34

What mass of iron can be obtained by complete reduction of 7.18g of iron(III) oxide?

(Relative atomic masses: Fe = 55.8, O = 16.0)

A. 2.51g
B. 3.86g
C. 5.02g
D. 5.58g

CE07_38

Which of the following methods is most suitable for preparing a sample of lead(II) sulphate?

A. Adding lead to dilute sulphuric acid
B. Adding lead to copper(II) sulphate solution
C. Adding lead(II) oxide to dilute sulphuric acid
D. Adding lead(II) nitrate solution to dilute sulphuric acid

CE07_48

1st statement	2nd statement
Galvanized iron is used for making food cans.	Zinc can prevent iron from rusting by sacrificial protection.

CE08_04

Consider the ionic equation below:

$$2MnO_4^- + x\,Sn^{2+} + y\,H^+ \longrightarrow 2Mn^{2+} + x\,Sn^{4+} + 8H_2O$$

What is the value of x?

A. 2
B. 4
C. 5
D. 7

CE08_10

Which of the following has the greatest number of ions?

A. 5 moles of iron(III) sulphate
B. 6 moles of aluminium fluoride
C. 7 moles of lead(II) nitrate
D. 8 moles of magnesium sulphate

CE08_12

Green patches appear on the surface of a metallic statue in a museum. It can be deduced that the statue may contain

A. tin.
B. iron.
C. silver.
D. copper.

CE08_15

X and Z are metals. X reacts with $Z(NO_3)_2$ solution according to the following equation:

$$X(s) + Z^{2+}(aq) \longrightarrow X^{2+}(aq) + Z(s)$$

Which of the following deductions is correct?

A. Both X and Z can react with water.
B. The reactivity of Z is higher than that of X.
C. X acts as a reducing agent in the reaction.
D. Z acts as the negative pole when X and Z are used as electrodes in a chemical cell with sodium chloride solution as electrolyte.

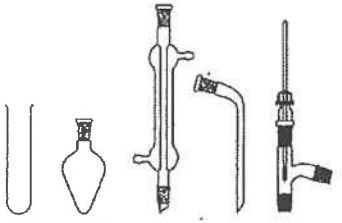
CE08_16

The oxidation number of metal M in its oxide is +2. Complete reduction of 11.9g of this oxide by hydrogen gas produces metal M and 2.7g of water. What is the relative atomic mass of M?
(Relative atomic masses: H = 1.0, O = 16.0)

A. 9.3
B. 24.3
C. 63.3
D. 137.3

CE08_26

Consider the following pieces of apparatus:



Which of the following processes can be performed by normal use of some or all of the above apparatus?

(1) refluxing a reacting mixture
(2) separating two immiscible liquids
(3) performing a simple distillation

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE08_31

Organic compound Q has the following composition by mass:

C: 37.5% H: 12.5% O: 50.0%

What is the possible chemical formula of Q?
(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0)

A. CH_3OH
B. C_2H_5OH
C. HCOOH
D. CH_3COOH

CE08_34

From which of the following processes can lead be obtained in a school laboratory?

A. Lead(II) oxide is heated strongly.
B. Lead(II) oxide is mixed with carbon.
C. Dilute lead(II) nitrate solution is electrolyzed.
D. Zinc is added to dilute lead(II) nitrate solution.

CE08_50

1st statement	2nd statement
When equal mass of Mg and Zn granules is added separately to excess dilute H_2SO_4, a greater amount of gas will be produced by Mg than Zn.	Mg is more reactive than Zn.

CE09_05

What is the percentage by mass of oxygen in $Na_2CO_3 \cdot 10H_2O$?

(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0, Na = 23.0)

A. 72.7
B. 55.9
C. 22.4
D. 16.8

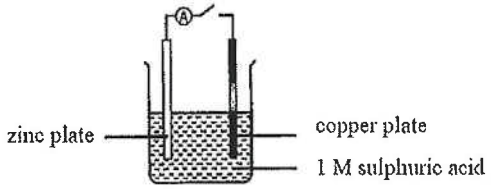
CE09_06

Which of the following rust prevention method does NOT match with the iron-made object?

	Rust prevention method	Iron-made object
A.	painting	gate
B.	greasing	machinery parts
C.	zinc plating	food can
D.	chromium plating	car bumper

CE09_08

Directions: Q.8 and Q.9 refer to the following diagram.



Which of the following observations can be made in the above set-up?

A. There is no observable change.
B. Gas bubbles appear on the zinc plate.
C. Gas bubbles appear on the copper plate.
D. The sulphuric acid gradually turns blue.

CE09_09

What will occur when the circuit is closed?

A. Both metal plates gradually dissolve.
B. The sulphuric acid gradually turns blue.
C. The hydrogen ions in the solution are reduced to hydrogen gas.
D. Electrons flow from the copper plate to the zinc plate in the external circuit.

CE09_20

Which of the following half equations are involved when iron rusts?

(1) $Fe \longrightarrow Fe^{3+} + 3e^-$
(2) $Fe \longrightarrow Fe^{2+} + 2e^-$
(3) $Fe^{2+} \longrightarrow Fe^{3+} + e^-$

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE09_33

An oxide of metal M reacts completely with carbon to give 12.6g of metal M and 2.38dm^3 of carbon dioxide measured at room temperature and pressure. What is the chemical formula of the oxide?

(Relative atomic masses: M = 63.5, O = 16.0;

Molar volume of gas at room temperature and pressure = 24dm^3)

A. MO
B. MO_2
C. M_2O
D. M_2O_3

CE09_41

Anodized aluminium is more commonly used than iron for making window frames.

This is because

(1) the cost for extracting aluminium is lower than the cost for extracting iron.
(2) anodized aluminium is more corrosion resistant than iron.
(3) anodized aluminium is harder than iron.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE09_46

Which of the following information is needed in order to deduce the molecular formula of a compound from its empirical formula?

(1) relative molecular mass of the compound
(2) percentage by mass of each constituent element
(3) relative atomic mass of each constituent element

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE09_47

Which of the following statements concerning the anodization of an aluminium object are correct?

(1) The electrolyte used can be dilute sulphuric acid.
(2) A layer of aluminium oxide is formed on the surface of the object.
(3) The aluminium object should be connected to the negative terminal of the power supply.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE10_03

X^{2+} ion has an electronic arrangement of 2, 8, 8. Which of the following statements concerning the carbonate of X is INCORRECT?

A. It is a white solid.
B. It is insoluble in water.
C. It decomposes on heating.
D. It produces a brick red flame in flame test.

CE10_04

Assuming that the total volume of 20 drops of water is 1.0 cm^3, what is the number of molecules in 1 drop of water?

(Avogadro's constant = 6.02×10^{23} mol^{-1}; density of water = 1.0 g cm^{-3};
Relative atomic masses: H = 1.0, O = 16.0)

A. 1.7×10^{21}
B. 3.3×10^{21}
C. 3.0×10^{22}
D. 3.3×10^{22}

CE10_06

Which of the following components of air is NOT obtained industrially from fractional distillation of liquid air?

A. Ar(g)
B. $CO_2(g)$
C. $N_2(g)$
D. $O_2(g)$

CE10_08

Naturally occurring magnesium has three isotopes: ^{24}Mg, ^{25}Mg and ^{26}Mg. The relative abundance of the ^{25}Mg isotope is 10%. What is the relative abundance of the ^{26}Mg isotope?

(Relative atomic mass: Mg = 24.3)

A. 10%
B. 15%
C. 23%
D. 85%

CE10_14

What mass of methane upon complete combustion gives 0.90g of water?

(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0)

A. 0.40 g
B. 0.45 g
C. 0.75 g
D. 0.80 g

CE10_16

A boiling tube contains hot saturated copper(II) sulphate solution. Large crystals of the salt can be obtained by

A. placing the boiling tube in a test tube rack on a bench.
B. placing the boiling tube under running tap water.
C. placing the boiling tube in a ice-water bath.
D. heating the solution to dryness.

CE10_21

Which of the following substances contain(s) mainly calcium carbonate?

(1) rock salt
(2) limestone
(3) oyster shell

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE10_22

Which of the following statements concerning potassium and calcium is/are correct?

(1) The reducing power of potassium is stronger than that of calcium.
(2) The hardness of potassium is higher than that of calcium.
(3) The density of potassium is greater than that of calcium.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE10_26

Which of the following safety measures should be taken when investigating the reaction between sodium and water?

(1) Use forceps to pick sodium.
(2) Use a small piece of sodium.
(3) Use a small amount of water.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE10_23

A certain oxide of manganese contains 49.5% of manganese by mass. What is the empirical formula of this oxide?

(Relative atomic masses: O = 16.0, Mn = 54.9)

A. MnO
B. MnO_2
C. Mn_2O_2
D. Mn_2O_7

CE11_04

One mole of ethane and one mole of ethane have the same

A. mass.
B. number of atoms.
C. number of molecules.
D. number of bonded electrons.

CE11_08

An ore contains 80% of the zinc sulphate by mass. Assuming that the other components in this ore do not contain zinc, what mass of the ore is required to extract 0.70g of zinc?

(Relative atomic masses: S = 32.1, Zn = 65.4)

A. 0.88 g
B. 1.04 g
C. 1.30 g
D. 1.76 g

CE11_23

In an experiment, excess zinc granules are added to a solution containing copper(II) ions and magnesium ions. After complete reaction, the reaction mixture is filtered. Which of the following statements concerning the experiment is/are correct?

(1) The residue contains magnesium metal.
(2) The residue contains copper metal.
(3) The filtrate contains zinc ions.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE11_30

1st statement	2nd statement
When excess magnesium ribbons are added to iron(II) sulphate solution, the solution gradually changes from pale green to yellow.	When magnesium ribbons are added to iron(II) sulphate solution, a displacement reaction occurs.

CE11_36

In order to prevent rusting, zinc blocks can be attached to the surface of steel ships. This is because

A. zinc is stronger oxidizing agent than iron.
B. zinc prevents iron from losing electrons.
C. zinc separates iron from air and water.
D. zinc removes oxygen from rust.

CE11_38

Hydrocarbon X contains 80% of carbon by mass. What is the empirical formula of X?
(Relative atomic masses: H = 1.0, C = 12.0)

A. CH
B. CH_2
C. CH_3
D. CH_4

CE11_46

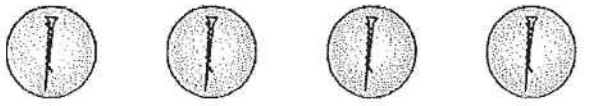
Which of the following are the advantages of using anodized aluminium to make drink cans?

(1) The drink cans can be dyed more easily.
(2) The hardness of the drink cans can be increased.
(3) The corrosion resistance of the drink cans can be enhance.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE11SP_05

Rust indicator containing potassium hexacyanoferrate(III) solution was poured into the following glass dishes to cover the iron nails, which were wrapped with different metal strips. The dishes were allowed to stand in air for some time.



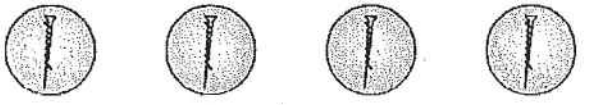
silver strip dish 1 | zinc strip dish 2 | copper strip dish 3 | magnesium strip dish 4

If the iron nail rusts, what would the color of the rust indicator be around the nail?

A. Yellow
B. Brown
C. Red
D. Blue

DSE11SP_06

Rust indicator containing potassium hexacyanoferrate(III) solution was poured into the following glass dishes to cover the iron nails, which were wrapped with different metal strips. The dishes were allowed to stand in air for some time.



silver strip dish 1 | zinc strip dish 2 | copper strip dish 3 | magnesium strip dish 4

In which pf the dishes would the iron nail rust?

A. Dish 1 only
B. Dish 2 only
C. Dish 1 and Dish 3 only
D. Dish 2 and Dish 4 only

DSE11SP_15

Which of the following samples of gases contains the smallest number of molecules?
(Relative atomic masses : H = 1.0, C = 12.0, N = 14.0, O = 16.0, S = 32.1)

A. 10 g of NO_2
B. 10 g of CO_2
C. 10 g of H_2S
D. 10 g of C_2H_4

DSE12PP_06

X, Y and Z are three different metals. When these metals are placed separately into an aqueous solution of tin(II) nitrate, a spongy layer of tin is formed only on X. When each of the oxides of these metals is heated strongly, only the oxide of Y gives a metallic lustre. Which of the following represents the arrangement of these metals in decreasing order of reactivity?

A. X > Y > Z
B. X > Z > Y
C. Y > X > Z
D. Z > X > Y

DSE12_03

In an oxide of metal M, the mass percentage of M is 55.0%. What is the chemical formula of this oxide? (Relative atomic masses : O = 16.0, M = 39.1)

A. MO_2 B. M_2O

C. M_2O_2 D. M_2O_3

DSE12_09

Which of the following statements concerning an aluminium ore consisting mainly of Al_2O_3 is correct?

(Relative atomic masses: O =16.0, Al = 27.0)

A. Carbon can be used to extract aluminium from this ore.

B. The abudance of this ore in the earth crust is very low.

C. This ore contains more than 55% of aluminium by mass.

D. Aluminium can be extracted from this ore due to the advancement of technology in apply electricity.

DSE12_16

Which of the following combinations is/are correct?

	Object	Corresponding corrosion prevention method / principle
(1)	Aluminium window frames	Cathodic protection
(2)	Galvanized iron buckets	Sacrificial protection
(3)	Tin-plated iron cans	Alloying

A. (1) only B. (2) only

C. (1) and (3) only D. (2) and (3) only

DSE13_23

1st statement	2nd statement
When iron and copper are separated immersed in hexane completely, iron corrodes faster than copper.	Iron can be oxidized more readily than copper.

DSE13_05

Which of the following methods can be used to obtain magnesium from magnesium compounds?

A. Electrolysis of a molten magnesium compound

B. Electrolysis of an aqueous solution of a magnesium compound

C. Heating magnesium oxide with carbon

D. Heating magnesium oxide strongly

DSE13_07

Both the frame and gear system of a bicycle are made of steel. Which of the following combinations can be used to prevent these parts of the bicycle from rusting?

	Frame	Gear system
A.	painting	greasing
B.	painting	galvanizing
C.	tin-plating	greasing
D.	tin-plating	galvanizing

DSE13_13

Titanium (Ti) is a metal. 2.66 g of a sample of titanium powder is heated in excess oxygen until the metal is completely oxidized. The mass of the oxide formed is 4.44 g. which of the following is the empirical formula of the oxide formed?

(Relative atomic masses : O = 16.0, Ti = 47.9)

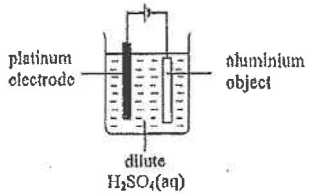
A. TiO B. Ti_2O_3

C. Ti_3O_4 D. TiO_2

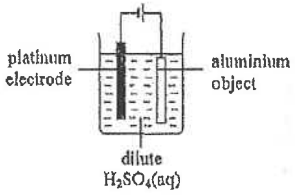
DSE13_06

Which of the set-ups shown below can best be used to anodize an aluminum object?

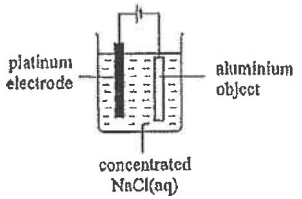
A.



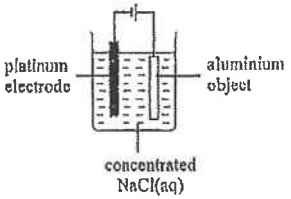
B.



C.



D.



DSE13_19

Which of the following statements about limestone is/are correct?

(4) It gives a golden yellow flame in a flame test.

(5) It gives a colorless gas when heated strongly.

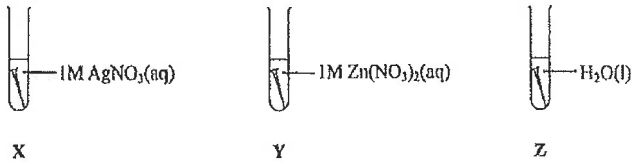
(6) It dissolves in dilute sulphuric acid to give a clear solution.

A. (1) only B. (2) only

C. (1) and (3) only D. (2) and (3) only

DSE14_03

The diagram below shows three iron nails of the same size and shape each immersed in a liquid.



Which of the following arrangements represents the ascending order of rate of corrosion of the iron nails?

A. Z < Y < X
B. Y < Z < X
C. Z < X < Y
D. X < Z < Y

DSE14_04

Refer to the following chemical equation:

$$Fe_2O_3(s) + 3CO(g) \longrightarrow 2Fe(s) + 3CO_2(g)$$

N moles of Fe_2O_3 are allowed to react with 2 N moles of CO under suitable conditions until the reaction stops. How many moles of Fe are formed?

A. N
B. 2 N
C. $\frac{2}{3}$ N
D. $\frac{4}{3}$ N

DSE14_05

Hydrated salt $X{\cdot}nH_2O$ contains 51.16% of water by mass. Given that the molar mass of X is 120.3 g, what is n?

(Relative atomic masses: H = 1.0, O = 16.0)

A. 2
B. 5
C. 7
D. 10

DSE14_18

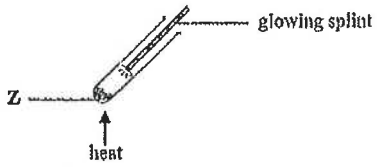
In an experiment, a small piece of potassium is added to a trough of water containing phenolphthalein. Which of the following statements concerning the experiment are correct?

(1) An exothermic reaction occurs
(2) A colorless solution is formed.
(3) The metal burns with a lilac flame.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE14_14

As shown in the diagram below, the glowing splint relights when solid Z is heated.



Which of the following chemicals may Z be?

A. HgO
B. Al_2O_3
C. $CaCO_3$
D. $MgCO_3$

DSE15_02

Which of the following processes would NOT give oxygen?

A. Heating mercury(II) oxide strongly
B. Electrolysis of dilute sulphuric acid
C. Fractional distillation of liquefied air
D. Passing steam over heated magnesium

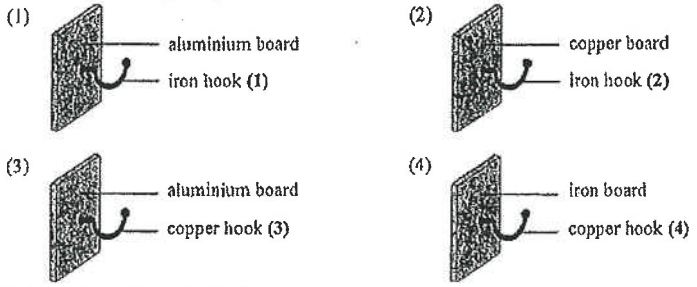
DSE15_05

A gel containing NaCl(aq), $K_3Fe(CN)_6$(aq) and phenolphthalein is yellow in color. An iron nail is put into the gel and corrodes after a period of time. Which of the following colors would NOT be observed in the gel after the iron nail corrodes?

A. Blue
B. Pink
C. Grey
D. Yellow

DSE15_07

Consider the following set-ups:



Which hook would corrode first?

A. Iron hook (1)
B. Iron hook (2)
C. Copper hook (3)
D. Copper hook (4)

DSE15_21

Which of the following observations would be expected when some calcium granules are put in cold water inside a test tube?

(1) A cloudy mixture is formed.
(2) The test tube becomes warm.
(3) Colourless gas bubbles are formed.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE16_03

Consider the following information concerning metal Y:

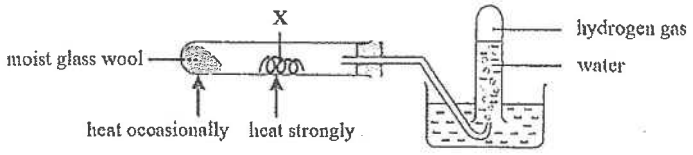
(1) Y reacts vigorously with water.
(2) Y forms an oxide with chemical formula Y_2O.
(3) An atom of Y has five occupied electron shells.

Y may be

A. silver (Ag).
B. caesium (Cs).
C. strontium (Sr).
D. rubidium (Rb).

DSE16_04

Consider the following experimental set-up:



Which of the following would NOT be X?

A. Iron
B. Zinc
C. Copper
D. Magnesium

DSE16_05

Tin plating is used to prevent iron cans from rusting because

A. tin provides sacrificial protection to iron.
B. tin layer prevent iron from exposure to air.
C. tin is higher than iron in the metal reactivity series.
D. tin and iron form an alloy which does not corrode.

DSE16_09

1 mol of a hydrocarbon requires 9 mol of oxygen for complete combustion. Which of the following may be this hydrocarbon?

A. C_6H_6
B. C_6H_{10}
C. C_6H_{12}
D. C_6H_{14}

DSE16_23

1st statement	2nd statement
During anodization, the aluminium oxide on the surface of aluminium is reduced to metal.	The corrosion resistance of aluminium can be enhanced by anodization.

DSE17_03

A hydrocarbon burns completely in oxygen to give 17.6 g of carbon dioxide and 3.6 g of water. Which of the following is the empirical formula of the hydrocarbon?

A. CH
B. CH_2
C. C_2H_2
D. C_2H_5

DSE17_09

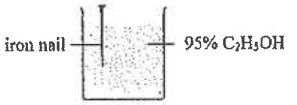
Which of the following processes would NOT produce metal?

A. Heating zinc oxide
B. Heating copper(II) oxide with carbon
C. Electrolysis of molten lithium chloride
D. Heating iron(III) oxide with carbon monoxide

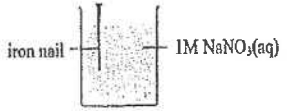
DSE17_13

In which of the following cases would the iron nail corrode fastest?

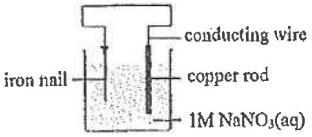
A.



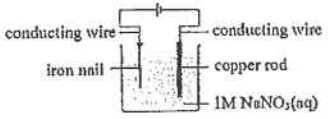
B.



C.



D.



DSE17_19

Which of the following statements concerning anhydrous copper(II) sulphate powder are correct?

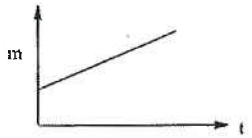
(1) It is white in color.
(2) It dissolves in water to give a blue solution.
(3) It can be obtained from heating hydrated copper(II) sulphate crystals

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

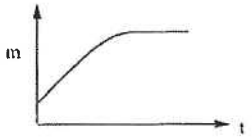
DSE18_03

A certain mass of a sample of $Ag_2O(s)$ is strongly heated in a test tube. Which of the following shows the relationships of the mass of the contents (m) in the test tube with time (t) from the start of heating?

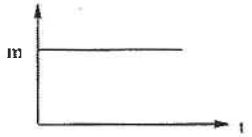
A.



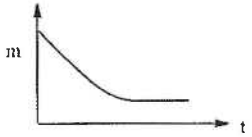
B.



C.



D.



DSE18_04

If 8.0 g of sulphur dioxide gas contains n molecules, how many molecules does 2.0 g of oxygen gas contain?

A. 2.0 n
B. 4.0 n
C. 0.25 n
D. 0.50 n

DSE18_06

Dilute sodium hydroxide solution is added to a 0.1 M solution until in excess. Which of the following combinations is correct?

	Solution	Observation
A.	Zinc sulphate	White precipitate formed
B.	Calcium nitrate	White precipitate formed
C.	Lead(II) nitrate	Yellow precipitate formed
D.	Iron(III) sulphate	Dirty green precipitate formed

DSE18_07

Which of the following statements concerning iron and magnesium is correct?

A. Iron is ductile but magnesium is not.
B. Iron corrodes less readily than magnesium.
C. The abundance of magnesium is higher than that of iron in the earth crust.
D. Both magnesium and iron can have more than one oxidation number in their oxides.

DSE18_09

X, Y and Z are different metals. When they are placed separately in NaCl(aq), only Y gives colorless gas bubbles. When each of their oxides is heated strongly, only the oxide of X gives a colorless gas. Which of the following shows the decreasing order of reactivity of these three metals?

A. Y > Z > X
B. X > Y > Z
C. Y > X > Z
D. Z > Y > X

DSE19_06

2.53 g of $NaHCO_3(s)$ was heated until no further changes and 1.59 g of a solid remained. Which of the following equations matches with the experimental result?
(Relative atomic masses : H = 1.0, C = 12.0, O = 16.0, Na = 23.0)

A. $NaHCO_3(s) \longrightarrow NaOH(s) + CO_2(g)$
B. $2NaHCO_3(s) \longrightarrow Na_2O_2(s) + 2CO_2(g) + H_2(g)$
C. $2NaHCO_3(s) \longrightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$
D. $2NaHCO_3(s) \longrightarrow Na_2O(s) + H_2O(g) + 2CO_2(g)$

DSE19_08

39.2 g of an oxide of rubidium (Rb) contains 28.5 g of rubidium. What is the empirical formula of this oxide ?
(Relative atomic masses : O = 16.0, Rb = 85.5)

A. RbO
B. RbO_2
C. Rb_2O
D. Rb_2O_2

DSE19_15

Which of the following methods can slow down the corrosion of an iron-made object ?
(1) Connect it to a piece of lead.
(2) Plate a layer of copper coating completely onto its surface.
(3) Connect it to the cathode of a chemical cell.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE19_17

Which of the following metal oxides can be reduced to a metal when heated with carbon using a Bunsen burner?
(1) Lead(II) oxide
(2) Magnesium oxide
(3) Copper(II) oxide

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE2020:

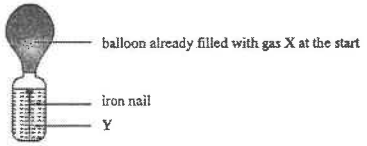
7. Refer to the information in the table below:

Material	Rank order of Hardness (1 = hardest)	Density / g cm^{-3}	Rank order of Price (1 = cheapest)
P	4	8.9	4
Q	3	7.8	1
R	2	10.5	3
S	1	2.7	2

Which is the best material to make aircraft body ?

A. P
B. Q
C. R
D. S

8. Consider the following experimental set-up :



In which of the following combinations would the iron nail rust the fastest ?

	X	Y
A.	hydrogen	petrol
B.	hydrogen	distilled water
C.	oxygen	petrol
D.	oxygen	distilled water

15. The observations of heating three metal carbonates are shown below :

Metal carbonate	Observation
X_2CO_3	A gas was given out and a shiny silvery solid was formed.
Y_2CO_3	There was no observable change.
ZCO_3	A gas was given out and a yellow solid was formed.

Which of the following shows the decreasing order of reactivity of the metals ?

A. Z > Y > X
B. Y > X > Z
C. Z > X > Y
D. Y > Z > X

17. Which of the following ways is / are acceptable in the storage of the chemical concerned ?

(1) Store concentrated $H_2SO_4(l)$ in a copper container.
(2) Store concentrated $AgNO_3(aq)$ in a brown glass container.
(3) Store concentrated $Pb(NO_3)_2(aq)$ in an iron container.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE21_04

4. M, Q and R are three different metals. When their oxides are separately heated, only the oxide of M gives a metallic lustre. When their carbonates are separately heated with a Bunsen burner, only the carbonate of R gives no observable changes. Which of the following shows the increasing order of reactivity of the metals ?

A. R < Q < M
B. R < M < Q
C. M < R < Q
D. M < Q < R

DSE21_18

18. Both aluminium and iron form oxides on their surfaces when they are exposed in air. The oxide of aluminium can prevent the aluminium from further corrosion, but the oxide of iron cannot prevent the iron from further corrosion. What is / are the reason(s) ?

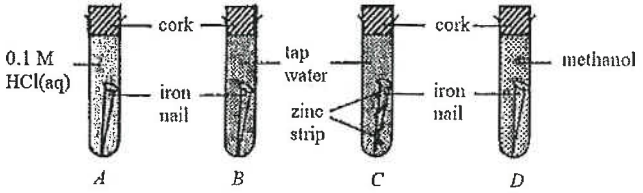
(1) The oxide of aluminium adheres firmly on the aluminium surface while the oxide of iron adheres loosely on the iron surface.
(2) The oxide of aluminium is insoluble in water while the oxide of iron is soluble in water.
(3) The oxide of aluminium has a giant ionic structure while the oxide of iron does not.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

Structural Questions

CE90_05a

The set-up below was used to investigate the corrosion of iron:



After some time, the solution from each tube was tested with potassium hexacyanoferrate(III) solution. It was found that corrosion of iron occurred only in tubes A and B.

(i) State the colour change when the solution from tube A was tested with potassium hexacyanoferrate(III)solution.

(ii) When the iron nail in the tube B corroded,

(1) indicate what cation and anion were produced, and

(2) write the half equation to show the formation of each ion.

(iii) In which of the tubes would bubbles of gas be observed?
Write an equation for the reaction involved.

(iv) Explain why corrosion of iron did not occur in

(1) tube C.

(2) tube D.

(9 marks)

CE91_02c

Iron sheets can be tin-plated by electrolysis of either tin(II) or tin(IV) compounds before they are used to make food cans.

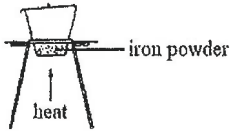
(iii) Give one reason to explain why iron is first tin-plated before food cans are made from it.

(iv) If the tin-plated iron sheet has been scratched to expose the iron, can it still be used to make a food can? Explain.

(3 marks)

CE91_04a

A student used the following set-up to determine the empirical formula of an oxide of iron.



Before the experiment, the student was instructed to see whether the iron powder was rusty and to remove any rust from it.

After weighing a sample of pure iron powder, the student then heated it strongly in a crucible, opening and closing the lid from time to time until the reaction was complete. He then reweighed the content after cooling.

The following results were obtained:

Mass of crucible + lid	25.27g
Mass of crucible + lid + iron powder before heating	26.16g
Mass of crucible + lid + content after cooling	26.50g

(i) If the iron powder were rusty, describe briefly how the rust could be removed chemically, Write an appropriate equation for the reaction.

(ii) Give TWO reasons why the crucible lid was opened and closed from time to time during heating.

(iii) Calculate the empirical formula of the oxide of iron from the above data.
(Relative atomic mass: O = 16.0, Fe = 56.0)

(9 marks)

CE92_01b

The table below gives some information about three metals A, B and C:

Metal	Rate of corrosion in moist air	Electrical conductivity	Strength of metal	Cost per tonne
A	Fast	Very good	Moderate	$13400
B	Fast	Good	Good	$13800
C	Slow	Very good	Moderate	$37000

(i) Based on the information given above, explain which metal is most suitable for making

(1) electrical cable.

(2) window frames.

(ii) Suggest one method to reduce the rate of corrosion of metal in moist air.

(iii) Why can metals conduct electricity?

(7 marks)

CE92_04b

Silvery metal **A** reacts vigorously with water to form colourless solution **B**. When **B** is subjected to the flame test, it gives a persistent yellow flame. When **B** is added to copper(II) nitrate solution, precipitate **C** is formed. **C** changes into black solid **D** upon strong heating.

(i) What is metal **A**? Write a balanced equation for the reaction between **A** and water.

(ii) Describe how the flame test on **B** can be carried out in the laboratory.

(iii) Write an ionic equation for the formation of **C**.

(iv) Give the name for **D**.

(6 marks)

CE93_01a

Aluminium and iron can be used in making window frames.

(i) Describe an experiment to show that aluminium is more reactive than iron.

(ii) Although aluminium is more reactive than iron, explain why most window frames are now made of anodized aluminium instead of painted iron.

(5 marks)

CE93_05a

The following table lists some reactions of iron(III) nitrate solution:

Reaction	Observation	Equation
(1) Zinc powder was added to iron(III) nitrate solution.	–	$Zn(s) + 2Fe^{3+}(aq) \longrightarrow Zn^{2+}(aq) + 2Fe^{2+}(aq)$

(i) What would be observed in reaction (1)? Explain your answer.

(2 marks)

CE94_01

The table below lists some information about three metals X, Y and Z.

Metal	X	Y	Z
Atomic number	12	20	–
Action of cold water	No apparent change	A colourless gas slowly evolves	No apparent change
Action of 0.1M hydrochloric acid	A colourless gas evolves	–	No apparent change

(a) To which group in the Periodic Table does Y belong?

(b) (i) Write an equation for the reaction between X and 0.1M hydrochloric acid. (An ionic equation will NOT be accepted for this question.)

(ii) Draw electronic structures for the TWO products formed in (i) above, showing electrons in the outermost shell ONLY.

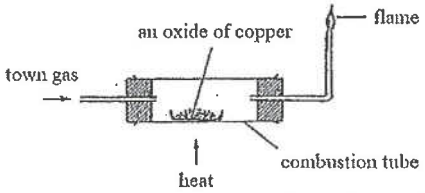
(c) What would be observed when Y is added to 0.1M hydrochloric acid?

(d) Based on the results of the reaction given in the above table, arrange the three metals in descending order of reactivity. Explain your answer.

(8 marks)

CE94_06a

The following experiment set-up was used to determine the empirical formula of an oxide of copper.



In the experiment, 8.58 g of an oxide of copper, after complete reaction, produced 7.62 g of copper.

(i) Deduce the empirical formula of the oxide of copper.

(ii) Write an equation for the reaction that occurred in the combustion tube.

(iii) State TWO potential hazards associated with this experiment, and suggest a safety precaution for each hazard.

(iv) At the end of the reaction, heating was stopped. However, it was necessary to continue pass the town gas through the combustion tube until the tube had cooled down. Explain why.

(Relative atomic masses: Cu = 63.5, O = 16.0)

(8 marks)

CE95_01

Rubidium (Rb) and potassium belong to the same group in the Periodic Table. The relative atomic mass of rubidium is larger than that of potassium.

(a) Explain whether rubidium is more reactive than potassium.

(b) Write a chemical equation for the reaction between rubidium and water. (State symbols should be given.)

(c) Suggest how rubidium can be stored safely in the laboratory.

(d) Suggest ONE safety precaution for handling rubidium in the laboratory.

(5 marks)

CE95_06b

The table below gives some information about five metals.

Metal	Abundance in the earth's crust (%)	Price per kg ($)	Relative resistance of corrosion (1 = least resistant 4 = most resistant)	Relative strength of metal (1= lowest 3= highest)
Al	8.1	170	3	1
Cu	0.0055	140	3	3
Au	0.0000004	1100000	4	2
Fe	5.0	20	1	3
Zn	0.007	160	2	2

(i) Although gold has a very low abundance in the earth's crust, gold was discovered by man a long time ago. Why?

(ii) Which of the metals in the above table is the most suitable to make pipes for hot water? Explain your answer.

(iii) (1) Aluminium does not corrode easily. Why?

(2) Aluminium is a principal material for making aircraft but its strength is relatively low. Suggest how the strength of aluminium can be improved to make it suitable for making aircraft.

(iv) (1) Based on the information given in the table, suggest ONE factor that affect the price of a metal.

(2) Suggest ONE other factor (not indicated in the table) that can also affect the price of a metal.

(9 marks)

CE96_04

Briefly describe an experiment, using the following apparatus and materials, to show that air is necessary for the rusting of iron.

2 test tubes, a test tube holder, a Bunsen burner

2 clean iron nails, paraffin oil and tap water

(8 marks)

CE97_01

For each of the tasks listed in the table below, decide which substance on the right is the best to use to **accomplish the task.** Explain your answer in each case.

Task	Substances
(a) To attach a substance to the iron hull of a tanker to prevent the full from rusting 	Calcium, Copper, Zinc

CE98_01

Lithium is a group I element in the Periodic Table. It occurs naturally in two isotopic forms. The relative abundance of each of these isotopes is shown in the table below:

Isotope	^{6}Li	^{7}Li
Relative abundance (%)	7.4	92.6

(c) A piece of freshly cut lithium metal is placed in air.

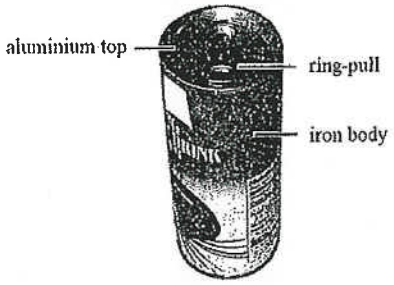
(i) What would be observed on the surface of the metal after some time? Write the relevant chemical equation.

(ii) Draw the electronic diagram of the product in (i), showing electrons in the *outermost shells* only.

(3 marks)

CE98_08b

The photograph below shows a can of fruit juice. The body of the can is made of iron coated with another metal. The top of the can and the right-pull are made of aluminium.



(i) (1) Suggest ONE reason why the iron body is coated with another metal.

(2) Name ONE metal commonly used for coating the iron body.

(ii) Suggest ONE reason why aluminium, rather than iron, is used for making the top of the can and the ring-pull.

(iii) Explain why it is not advisable to buy cans of fruit juice

(1) if the cans have scratches on the iron body;

(2) if the cans are swollen.

(iv) There is an increasing tendency for manufacturers to use cans made entirely of aluminium for the storage of fruit juice. Suggest ONE advantage and ONE disadvantage of using aluminium cans for the storage of fruit juice.

(9 marks)

CE99_02

For each of the following experiments, state ONE observable change and write a chemical equation for the reaction involved.

(b) A small piece of calcium is placed in a Bunsen flame.

(c) A mixture of copper(II) oxide and carbon powder is heated in a test tube.

(4 marks)

CE00_03

Consider the following materials:

Aluminium, bronze, copper, lead, mild steel and titanium

For each of the tasks listed below, choose the ONE material which is best to accomplish the task. Explain your choice in each case.

(a) making electrical wiring

(b) making overhead high voltage cables

(4 marks)

CE00_09a

X, Y and Z are three different metals. The table below shows the results of two experiments carried out using the metals or their oxides.

Experiment	X	Y	Z
Adding the metal to water	Effervescence	No observable change	No observable change
Heating the metal oxide	No observable change	Metal produced	No observable change

(i) Based on the above information, arrange the three metals in order of increasing reactivity. Explain your answer.

(3 marks)

CE01_05

Explain why anodization, sacrificial protection and tin-plating can protect metals from corrosion.

(9 marks)

CE01_07c

The photograph below shows a diamond ring:

(i) Explain why gold and diamond each has a high melting point.

(ii) 18-carat gold is an alloy of gold. Suggest ONE reason why 18-carat gold instead of pure gold is used in making the ring.
(You are NOT required to consider the price of the materials.)

(3 marks)

CE01_08a

(ii) A part of the Periodic Table is shown below:

		Group							
		I	II	III	IV	V	VI	VII	0
Period	2	Li	Be	B	C	N	O	F	Ne
	3	Na	Mg	Al	Si	P	S	Cl	Ar
	4	K	Ca					Br	Kr
	5								Xe

For each of the following pairs of elements, suggest ONE reaction in which both elements behave similarly. In each case, write a chemical equation for the reaction involving either one of the elements.

(1) magnesium and calcium

(2 marks)

CE02_01

Both ammonium dihydrogenphosphate and ammonium sulphate are nitrogenous fertilizers.

(b) List all the elements in ammonium dihydrogenphosphate.

(1 mark)

(c) (i) Calculate the percentage by mass of nitrogen in ammonium sulphate.

(2 marks)

CE02_02

For each of the following experiments, state an expected observation and write a chemical equation for the reaction involved.

(a) A magnesium ribbon is placed in a Bunsen flame.

(2 marks)

CE02_06a

Magnesium can be extracted from sea water which contains magnesium ions. The extraction of magnesium from sea water involves three stages.

Stage 1: Add slaked lime to sea water to precipitate magnesium ions as magnesium hydroxide.
Stage 2: Heat the magnesium hydroxide obtained in a stream of hydrogen chloride gas to give magnesium chloride.
Stage 3: Extract magnesium by electrolysis of the molten magnesium chloride.

(i) What substance is mainly present in slaked lime?
(ii) Write a chemical equation, with state symbols, for the reaction in *Stage 2*.
(iii) Explain why molten magnesium chloride can conduct electricity.

(3 marks)

CE02_07a

Calcite is a mineral which contains mainly calcium carbonate. An experiment, consisting of the following five stages, was conducted to determine the percentage by mass of calcium carbonate in a sample of calcite.

Stage 1: Weigh the sample. Add dilute nitric acid to it until the acid is in excess.
Stage 2: Filter the mixture obtained in Stage 1 to remove any undissolved solid.
Stage 3: Add excess sodium sulphate solution to the filtrate to precipitate out calcium sulphate.
Stage 4: Collect the calcium sulphate precipitate and wash it with distilled water.
Stage 5: Allow the calcium sulphate to dry and weigh it.

(i) Write a chemical equation for the reaction of calcium carbonate with dilute nitric acid. Suggest how one can know that excess acid has been added in *Stage 1*.
(ii) Draw a labelled diagram of the set-up used in the filtration process in *Stage 2*.
(iii) Write the ionic equation for the reaction in *Stage 3*.
(iv) Explain why it is necessary to wash the precipitate with distilled water in *Stage 4*.

(v) The results obtained in the experiment are listed below:

Mass of the calcite sample = 7.98g

Mass of the calcium sulphate obtained = 10.52g

(1) Calculate the percentage by mass of calcium carbonate in the sample of calcite.

(2) State ONE assumption in the calculation.

(Relative atomic masses: C = 12.0, O = 16.0, S = 32.0, Ca = 40.0)

(10 marks)

CE02_08b

Both carbon and silicon are Group IV elements in the Periodic Table.

(iv) Silicon can be obtained by heating silicon dioxide with carbon strongly.

(1) Write a chemical equation for the reaction involved.

(2) Suggest ONE use of silicon.

(2 marks)

CE03_02

X, **Y** and **Z** are three different metals. The table below lists the results of three experiments carried **out using** the metals or their oxides.

Experiment	X	Y	Z
Adding metal to cold water	Formation of a colourless gas	No observable change	No observable change
Adding metal to copper(II) sulphate solution	Formation of a colourless gas and a reddish brown solid	Formation of reddish brown solid	No observable change
Heating metal oxide with carbon powder	No observable change	Formation of a solid with metallic lustre	Formation of a solid with metallic lustre

(a) What is the colourless gas formed when **X** is added to cold water? Suggest a test for the gas.

(b) Name the type of reaction that occurs when the oxide of **Y** is heated with carbon powder.

(c) Arrange the three metals in order of increasing reactivity. Explain your answer.

(d) Why is a colourless gas formed when **X** is added to copper(II) sulphate solution?

(7 marks)

CE04_01

Calcium reacts with cold water to give a colourless gas.

(a) Write a chemical equation for the reaction.

(b) In a practical lesson, a student added a few pieces of calcium granules into a beaker of cold water.

(i) Draw a labelled diagram to show how the student could collect the gas produced.

(ii) The student recorded the following observation in his laboratory report:

'Evolution of the colourless gas was at first slow but became faster after some time.'

Suggest an explanation for the student's observation.

(c) Potassium also reacts with cold water. State TWO differences in observation when potassium and calcium are added separately to cold water.

(7 marks)

CE04_08b

Corrosion of iron often results in the formation of rust on its surface.

(i) What is the chemical nature of rust?

(ii) State the essential conditions for the rusting of iron.

(iii) For each of the following iron objects, suggest a suitable method to protect it from corrosion:

(1) bicycle gear wheel

(2) underground water pipe

(iv) Explain why connecting the body of a car to the negative terminal of the car battery can help protect the car body from corrosion.

(v) Although aluminium occupies a higher position than iron in the electrochemical series, it is more resistant to corrosion than iron.

(1) Provide an explanation for the phenomenon.

(2) Suggest a method to enhance the corrosion resistance of aluminium.

(7 marks)

CE05_02

(a) Upon strong heating, silver oxide (Ag_2O) undergoes decomposition as represented by the following word equation:

silver oxide $\longrightarrow$ silver + oxygen

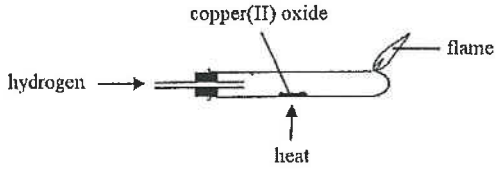
(i) Transcribe the word equation into a chemical equation.

(ii) Explain why the decomposition is a redox reaction.

(iii) Calculate the mass of silver that would be obtained when 3.50 g of silver oxide undergoes complete decomposition.

(5 marks)

(b) Copper(II) oxide can be reduced to copper using the set-up shown below:



(i) State an expected observation change in this experiment.

(ii) Suggest ONE way to show that a metal is formed in this experiment.

(iii) Write a chemical equation for the reaction of copper(II) oxide with hydrogen.

(iv) Suggest why it is necessary to burn the residual hydrogen in the set-up.

(4 marks)

(c) Is it possible to deduce from the results of the experiments in (a) and (b) that copper occupies a higher position in the metal reactivity series than silver does?
Explain your answer.

(1 mark)

CE05_08

Lead (Pb) is an element in Group IV of the Periodic Table.

(a) An oxide of lead, X, contains 90.6% of lead by mass. Calculate the empirical formula of X.

(2 marks)

(b) X is known to be a mixed oxide composed of PbO and PbO_2. Based on your answer in (a), deduce the mole ratio of PbO to PbO_2 in X.

(2 marks)

CE07_06

Read the paragraph below and answer the questions that follow.

> Magnesium is a useful metal. Scientists adopt different methods to extract magnesium from magnesium oxide. In 1828, a scientist obtained magnesium in two steps. In the first step, magnesium oxide reacts with chlorine and carbon to form magnesium chloride. In the second step, the magnesium chloride formed reacts with potassium to give magnesium. In 1951, some scientistis adopted another chemical process to obtain magnesium from magnesium chloride. Potassium is not used in this process, and there is even no need to use any other chemicals.

(a) Write a chemical equation for the reaction that occurred in the first step of the method used by the scientist in 1828.

(1 mark)

(b) Name the type of reaction between potassium and magnesium chloride. Why can potassium react with magnesium chloride to give magnesium?

(2 marks)

(c) (i) What would be the chemical process that can obtain magnesium from magnesium chloride, without using potassium or other chemicals, in 1951?

(ii) What property does magnesium chloride possess so as to make the chemical process possible?

(2 marks)

(d) Suggest one use of magnesium in daily life.

(1 mark)

CE08_03

Four iron-made objects are placed separately in gel with rust indicator solution containing potassium hexacyanoferrate(III), and allowed to stand in air for some time. Complete the following table by writing down the observation and giving the relevant explanation for each of the cases.

Case	Observation	Explanation
Iron-made object fully plated with zinc		
Iron-made object fully plated with tin		
Iron-made object fully plated with zinc, but part of the zinc scratched to expose the iron underneath		
Iron-made object fully plated with tin, but part of the tin scratched to expose the iron underneath		

(5 marks)

CE09_02

(a) Magnesium can burn in air under strong heating.

(i) State the expected observation when magnesium burns in air.

(ii) Magnesium nitride is also formed when magnesium burns in air.

(1) State the chemical formula of magnesium nitride.

(2) Draw the electronic diagram of magnesium nitride, showing electrons in the outermost shells only.

(3 marks)

(b) Carbon can be used to extract metals from certain metal oxides.

(i) Suggest how copper can be extracted from copper(II) oxide using carbon. State the expected observation.

(ii) Explain whether carbon can also be used to extract magnesium from magnesium oxide.

(3 marks)

CE09_03

Iron powder can be used to make 'warm packs' for keeping users warms. A kind of warm pack is made by putting iron powder in a package which allows air to pass through. The package also contains other substances for speeding up the production of heat.

(a) According to the given information, suggest why this kind of warm pack can produce heat.

(2 marks)

(b) Explain why iron powder, instead of a piece of iron with the same mass, is put in the warm pack.

(1 mark)

(c) The other substances in the package include moist sodium chloride. Suggest why it can speed up the production of heat.

(1 mark)

CE09_13

For question 13, candidates are required to give answers in paragraph form. For this question, 6 marks will be awarded for chemical knowledge and 3 marks for effective communication.

Electrolysis can be applied to enhance the corrosion resistance of iron. Describe the chemical principle involved in this application. Your description should include the chemical reactions involved, and the use of appropriate electrodes and electrolyte.

(Diagrams are NOT required.)

(9 marks)

CE10_01

Both bromine (Br) and chlorine (Cl) are Group VII elements in the Periodic Table.

(a) What is the name commonly given to this group of elements?

(1 mark)

(b) The electronic arrangement of bromine is 2, 8, p, q.
p is _____; q is _____.

(1 mark)

(c) Explain, in terms of bonding and structure, why the boiling point of bromine is higher than that of chlorine.

(2 marks)

(d) Rubidium (Rb) is a Group I element in the Periodic Table. It reacts with bromine to form an ionic compound.

(i) Write a chemical equation for the reaction involved.

(ii) Write the electronic arrangement of a rubidium ion.

(2 marks)

CE10_04

M_2O is an oxide of metal M. Upon heating, M_2O decomposes to give M and oxygen only.

(a) Suggest a method for testing oxygen, and state the expected observation.

(1 mark)

(b) In an experiment, 3.48g of M_2O completely decomposes to give 3.24g of M. Calculate the relative atomic mass of M.

(2 marks)

(c) Explain whether M can react with dilute hydrochloric acid.

(1 mark)

CE11_02

Under same experimental conditions, the same mass of 'expired' and 'fresh' calcium granules were separately put into water as shown in the diagrams below. The 'expired' calcium granules have been exposed in air for a long time, while the 'fresh' calcium granules are newly brought.

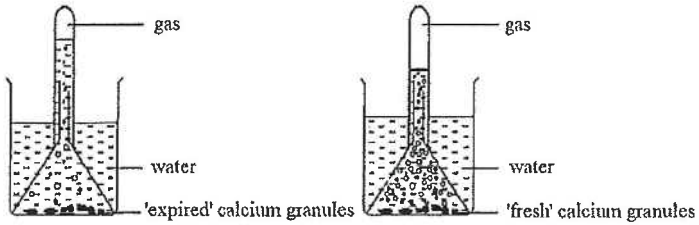


Diagram 1 Diagram 2

(a) Name the gas collected, and write a chemical equation for the reaction involved.

(2 marks)

(b) Suggest why less gas was collected in the set-up of Diagram 1 than in that of Diagram 2.

(1 mark)

(c) Would the pH of the content in the beaker increase, decrease or remain unchanged after the calcium granules were put into the water in Diagram 2? Explain your answer.

(2 marks)

(d) Suggest TWO potential hazards in performing the above experiment.

(2 marks)

AL02(II)_01

Devise an experiment, using chemicals and apparatus commonly available in a school laboratory, to determine the number of water of crystallization per formula unit of $CaSO_4$ in the sample of blackboard chalk.

(4 marks)

AL04(I)_08d

(i) Explain why carbon dioxide extinguishers must not be used to put out a piece of burning sodium.

(1 mark)

(ii) Suggest a proper way to put out a piece of burning sodium in the laboratory.

(1 mark)

AL04(II)_01 (Modifieid)

A gaseous compound **A** has the following composition by mass:

N 21.6%, O 49.2% and F 29.2%

(a) Deduce the empirical formula of **A**.

(2 marks)

(b) If the molecular mass of **A** is in the range of 60 to 70 and hence deduce its molecular formula.

(2 marks)

AL11(I)_07

(a) Copper(II) sulphate(VI) crystallizes from its aqueous solution as $CuSO_4 \cdot 5H_2O(s)$.

(i) The water of crystallization of the salt can be liberated upon heating. Suggest a chemical test to show that water is being liberated.

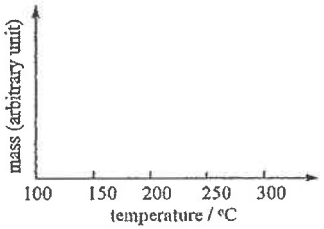
(1 mark)

(ii) Outline an experimental method to establish that the salt is pentahydrate.

(3 marks)

(iii) When $CuSO_4 \cdot 5H_2O(s)$ is heated slowly such that the temperature rises steadily, it will lose four water molecules at about 110 °C, and then the last water molecule at about 250 °C.

Using the axes below, sketch the change of mass when a sample of $CuSO_4 \cdot 5H_2O(s)$ is heated slowly.



(2 marks)

AL12(I)_01

The potassium salt of the iron(III) ethanedioate complex has the following composition by mass:

K, 26.8%; Fe, 12.8%; C, 16.5%; O, 43.9%

(ethanedioate: $C_2O_4^{2-}$)

Calculate the emipirical formula of this potassium salt.

(2 marks)

ASL12(II)_02

Metal **M** forms a water-soluble bromide MBr_2. The following gravimetric analysis experiment was conducted to determine the formula mass of MBr_2.

A solution of MBr_2 was prepared by dissolving 0.400 g of $MBr_2(s)$ completely in deionized water. The solution was acidified with $HNO_3(aq)$ and then treated with excess $AgNO_3(aq)$. The $AgBr(s)$ formed was separated from the mixture by filtration, washed and dried. Its mass was found to be 0.816 g.

(a) Given that the cation of **M** in MBr_2 does not react with $Ag^+(aq)$ ions, calculate the formula mass of MBr_2.

(3 marks)

(b) Calculate the relative atomic mass of **M**, and deduce what **M** is.

(2 marks)

AL13(II)_05

(b) Account for the difference in reactivity of Ca(s) and Ra(s) with water.

(2 marks)

DSE11SP_03

X, **Y** and **Z** are three different metals. The table below lists the results of three experiments carried out using the metals or their oxides.

Experiment	X	Y	Z
Adding metal to cold water	formation of a colorless gas	no observable change	no observable change
Adding metal to copper(II) sulphate solution	formation of a colorless gas and a reddish brown solid	formation of a reddish brown solid	no observable change
Heating metal oxide with carbon powder	no observable change	formation of a solid with metallic lustre	formation of a solid with metallic lustre

(a) What is the colourless gas formed when **X** is added to cold water? Suggest a test for the gas.

(2 marks)

(b) Name the type of reaction that occurs when the oxide of **Y** is heated with carbon powder.

(1 mark)

(c) Arrange the three metals in order of increasing reactivity. Explain your answer.

(3 marks)

(d) Why is a colorless gas formed when **X** is added to copper(II) sulphate solution?

(1 mark)

DSE11SP_08

For each of the following experiments, state an expected observation and write a chemical equation for the reaction involved.

(a) adding dilute hydrochloric acid to zinc granules

(2 marks)

DSE12PP_05

The fuel used in the torch for the Beijing 2008 Olympic Games was an alkane **X** with the following composition by mass:

C, 81.8% H, 18.2%

(a) Deduce what **X** could be.

(3 marks)

DSE12_05

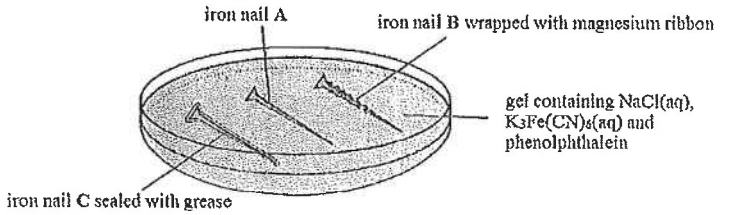
In order to prepare 50 dm^3 of 0.1 M $CuSO_4(aq)$, an inexperienced electroplating worker added the required exact amount of $CuSO_4 \cdot 5H_2O(s)$ to water in a plastic container. He then stirred the mixture with an iron rod until the $CuSO_4 \cdot 5H_2O(s)$ dissolved completely. Finally, he sent a sample of the solution to the Quality Control Laboratory for analysis, but found that the concentration of $CuSO_4(aq)$ was lower than 0.1 M.

(a) With the aid of a chemical equation, explain why the concentration of the $CuSO_4(aq)$ prepared was lower than 0.1 M.

(2 marks)

DSE12_09

The diagram below shows an experimental set-up for investigating the factors affecting rusting.



(a) What would be observed if an iron nail in the above set-up rusts?

(1 mark)

(b) Suggest which of the iron nails in the above set-up would NOT rust during the experiment. Explain your answer.

(3 marks)

DSE13_03

Compound **W** contains carbon, hydrogen and oxygen only. The relative molecular mass of **W** is 88.0. Complete combustion of 1.32 g of **W** gives 2.64 g of carbon dioxide and 1.08 g of water.

(a) Deduce the molecular formula of **W**.
(relative atomic masses : H = 1.0, C = 12.0, O = 16.0)

(3 marks)

DSE13_07

Thermite reactions broadly refer to exothermic oxidation-reduction reactions between a metal powder and a metal oxide. One example is the reaction of finely divided iron(III) oxide with aluminium powder. This reaction results in a very high temperature, and is commonly used in the welding of rail tracks for trains. At this very high temperature, the molten iron formed joins the rail tracks together.

(a) (i) Complete and balance the chemical equation for the following thermite reaction.

____$Fe_2O_3(s)$ + ____$Al(s)$ ⟶

(1 mark)

(ii) Sketch a labelled enthalpy level diagram for this reaction.

(1 mark)

(b) Copper powder CANNOT be used to replace aluminium powder in carrying out the thermite reaction with iron(III) oxide. Explain why.

(1 mark)

(c) The extraction of iron from its ores also involves the reduction of iron oxides.

(i) Suggest why aluminium is NOT used as the reducing agent in iron extraction.

(1 mark)

(ii) Suggest ONE reducing agent commonly used in iron extraction.

(1 mark)

DSE14_04

With reference to the methods of obtaining copper, magnesium and silver from their oxides, deduce the order of reactivity of these three metals.

(4 marks + 1 mark)

DSE15_03

Aluminium and iron are commonly used construction materials.

(a) Suggest why iron was used earlier than aluminium in history.

(1 mark)

(b) A compound contains iron and oxygen only. In an experiment for determining the empirical formula of this compound, 2.31 g of the compound was heated with carbon monoxide. Upon complete reaction, carbon dioxide and 1.67 g of iron were formed.

(i) Calculate the empirical formula of this compound.

(2 marks)

(ii) Write the chemical equation for the reaction involved in the experiment.

(1 mark)

(iii) As carbon monoxide is poisonous, suggest one necessary safety precaution in carrying out the experiment.

(1 mark)

(c) Explain why a galvanized iron object does not easily rust even if the zinc layer is broken.

(2 marks)

(d) Explain why anodization can prevent aluminum object from corrosion.

(2 marks)

DSE16_01

Refer to the **following information of phosphorus** (P) and chlorine (Cl).

	P	Cl
Atomic number	15	17
Relative atomic mass	31.0	35.5

(c) A compound of phosphorus and chlorine has a relative molecular mass smaller than 250. It contains 22.6% of phosphorus by mass.

(i) Deduce the molecular formula of the compound.

(2 marks)

(ii) Draw the electron diagram for the compound, *showing electrons in the outermost shells only*.

(1 mark)

DSE17_02

Water pipes used to carry drinking water are commonly made of copper instead of iron. Although lead-containing solder can be used to join these water pipes, such use is prohibited.

(a) Suggest one chemical property of copper that makes it more suitable than iron for making water pipes. Explain your answer.

(2 marks)

(b) (i) Suggest one reason of adding lead to soldering materials.

(1 mark)

(ii) Explain why lead-containing solder is prohibited in joining these water pipes.

(1 mark)

DSE18_01

(b) In an experiment, 1.25 g of lithium nitride is formed when a piece of lithium is burnt in air.

(i) Write a chemical equation for the reaction involved.

(1 mark)

(ii) Calculate the mass of lithium that reacted with nitrogen,
(Relative atomic masses: Li = 6.9, N = 14.0)

(2 marks)

(c) Name another compound which will also be formed when lithium is burnt in air.

(1 mark)

DSE18_05

Electroplating and rust prevention are common applications of electrochemistry.

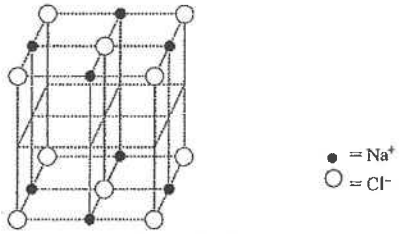
(b) Suggest a method, besides painting or electroplating, that can prevent underground iron-made pipelines from rusting. Explain your answer.

(2 marks)

DSE19_02

Sodium chloride crystal has a giant ionic structure.

(a) The diagram below shows a part of the structure of sodium chloride crystal with some ions missing.



Complete the diagram by using ● as Na^+ ion and ○ as Cl^- ion.

(b) From an experiment, it was found that there are 4 Na^+ ions and 4 Cl^- ions in a cube of sodium chloride crystal of volume 1.80×10^{-22} cm^3.

(i) Express the total mass of 4 Na^+ ions and 4 Cl^- ions in terms of the Avogadro's constant L. (Relative atomic masses : Na = 23.0, Cl = 35.5)

(ii) Hence, calculate the Avogadro's constant L, given that 1.00 cm^3 of sodium chloride crystal weighs 2.17 g.

(3 marks)

DSE19_09

Iron cans used to store food products are commonly coated with a thin layer of tin.

(a) The thin layer of tin prevents iron cans from corrosion.

(i) Briefly describe the principle for this kind of corrosion prevention.

(1 mark)

(ii) Explain whether these iron cans would corrode more readily once their surfaces are damaged by scratching.

(1 mark)

(iii) Suggest why galvanisation is not suitable to prevent corrosion in iron cans that are used to store food products.

(1 mark)

(b) There is an increasing trend for manufacturers to use cans made entirely of aluminium for storing food products.

(i) Explain why aluminium is more resistant to corrosion than iron, although it occupies a higher position than iron in the reactivity series.

(1 mark)

(ii) Name the process that increases the corrosion resistance of aluminium cans.

(1 mark)

(iii) Other than corrosion resistance, suggest one advantage of using aluminium to make cans.

(1 mark)

DSE21_03(c)(ii)

3. (c) (ii) Under certain conditions, 1.0 g of SiO_2 is allowed to react with 1.0 g of Mg. The equation for the reaction is shown below :

$$SiO_2 + 2Mg \rightarrow 2MgO + Si$$

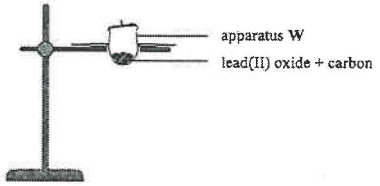
Calculate the theoretical mass of Si that can be formed.
(Relative atomic masses : O = 16.0, Mg = 24.3, Si = 28.1)

DSE21_06(d)(i),(ii)

(d) Lead can also be obtained from lead(II) oxide using carbon.

(i) Write a chemical equation for the reaction.

(ii) The diagram below shows an incomplete set-up for performing the reaction :



(1) Add suitable drawing (with label) to the diagram for completing the set-up.

(2) Name apparatus W.

(3 marks)

2022

11. In the electrolysis of 1.0 M $CuSO_4(aq)$, copper cathode and carbon anode are used. Which of the following combinations is correct ?

	Cathode	Anode
A.	Copper dissolves	Oxygen is formed
B.	Copper dissolves	Sulphur dioxide is formed
C.	Copper is deposited	Oxygen is formed
D.	Copper is deposited	Sulphur dioxide is formed

15. **P**, **Q** and **R** are three different metals. When dilute HCl(aq) is added to these metals separately, only **Q** and **R** give a colourless gas. When zinc is added to aqueous solutions of their chlorides separately, only the chloride of **R** shows no observable change. Which of the following shows the increasing order of the reducing power of the metals ?

A. **R < Q < P**
B. **Q < P < R**
C. **P < Q < R**
D. **P < R < Q**

2022

*8. Describe and explain the similarities and differences between the chemical principles involved in tin-plating and galvanising in the rusting prevention of iron-made objects.

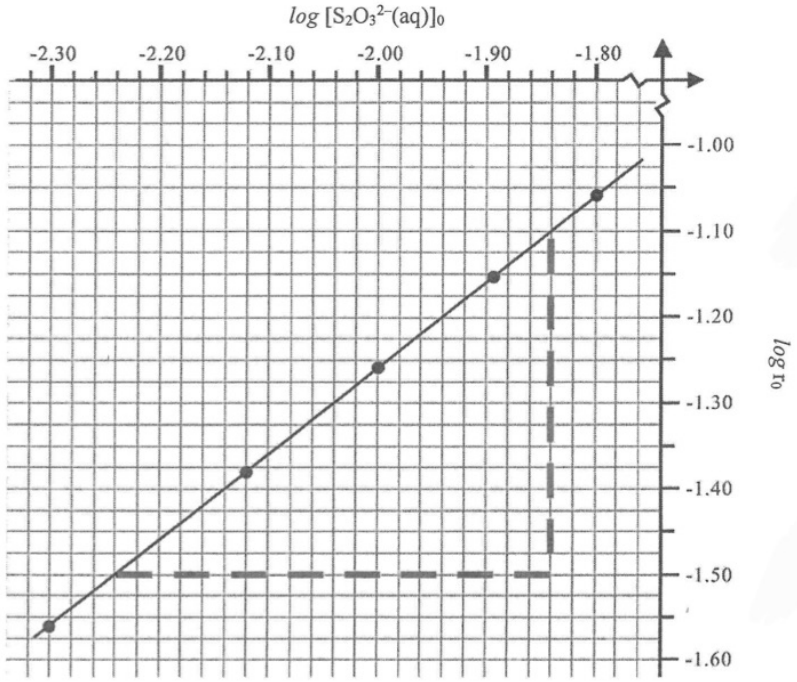
(6 marks)

2022

1. (c) The chemical kinetics of the following reaction at a certain temperature was studied :

$$S_2O_3^{2-}(aq) + 2H^+(aq) \rightarrow SO_2(g) + S(s) + H_2O(l)$$

Several trials of an experiment were performed under the same experimental conditions, except varying the initial concentration of $S_2O_3^{2-}(aq)$ (represented by $[S_2O_3^{2-}(aq)]_0$), to measure the initial rate of formation of S(s) (represented by r_0). The following graph shows the experimental results obtained from these trials :



(i) What is meant by the term 'initial rate' ?

(1 mark)

(ii) The rate equation for the reaction is shown below :

$$\text{Rate} = k\,[S_2O_3^{2-}(aq)]^a\,[H^+(aq)]^b$$

where k is the rate constant,
a is the order of reaction with respect to $S_2O_3^{2-}(aq)$
and ***b*** is the order of reaction with respect to $H^+(aq)$.

Given that the concentration of $H^+(aq)$ used was much higher than that of $S_2O_3^{2-}(aq)$ in each trial, explain why the above rate equation can be modified as shown below :

$$\text{Rate} = k'\,[S_2O_3^{2-}(aq)]^a$$

where k′ is regarded as a constant.

(2 marks)

(iii) By using the dotted lines in the graph above, deduce the order of reaction with respect to $S_2O_3^{2-}(aq)$.

(3 marks)

(iv) The experiment was repeated at 25 °C and 35 °C separately, while other experimental conditions were the same. The rate constant of the reaction at 25 °C is k_1 and the rate constant of the reaction at 35 °C is k_2. The ratio of k_2 to k_1 is 1.9 : 1.0. Calculate the activation energy of the reaction, in kJ mol^{-1}.

(Gas constant $R = 8.31$ J K^{-1} mol^{-1}; Arrhenius equation : $\log k = constant - \frac{E_a}{2.3RT}$)

(2 marks)

Marking Scheme

MCQ

CE90_07	D	CE90_09	B	CE90_10	D	CE90_31	D
CE90_45	B	CE90_49	A	CE91_08	A	CE91_09	C
CE91_11	C	CE91_31	D	CE92_01	B	CE92_06	B
CE92_07	C	CE92_31	C	CE92_33	D	CE92_34	B
CE93_08	C	CE93_20	A	CE93_21	B	CE93_46	B
CE94_08	B	CE94_18	D	CE94_44	D	CE95_05	D
CE95_06	A	CE95_18	B	CE95_45	D	CE96_08	A
CE96_35	C	CE96_47	C	CE97_28	C	CE97_32	D
CE97_41	A	CE97_47	B	CE97_48	A	CE98_02	B
CE98_10	C	CE98_11	D	CE98_19	C	CE98_20	C
CE98_27	A	CE98_44	B	CE99_02	C	CE99_08	A
CE99_17	B	CE99_21	D	CE99_22	C	CE99_31	A
CE99_46	A	CE00_03	B	CE00_04	D	CE00_33	C
CE00_50	C	CE01_26	C	CE01_30	C	CE01_38	B
CE01_49	D	CE02_03	C	CE02_08	D	CE02_14	C
CE02_23	C	CE02_26	C	CE02_27	B	CE03_01	C (64%)
CE03_02	D (51%)	CE03_05	C (61%)	CE03_11	D (51%)	CE03_28	A (41%)
CE03_09	B (70%)	CE03_42	D (59%)	CE05SP_08	B (49%)	CE05SP_21	C
CE05SP_29	C	CE05SP_32	D	CE05SP_41	D	CE04_12	C (47%)
CE04_16	A (62%)	CE04_26	C (83%)	CE04_35	B (59%)	CE04_48	D (69%)
CE05_10	D (65%)	CE05_11	C (83%)	CE05_23	A (59%)	CE06_08	C (41%)
CE06_09	A (49%)	CE06_13	D (52%)	CE06_18	C (47%)	CE06_34	C (41%)
CE06_37	B (58%)	CE07_05	D (20%)	CE07_07	A (83%)	CE07_11	A (34%)
CE07_34	C (67%)	CE07_38	D (22%)	CE07_48	C (58%)	CE08_04	C (65%)
CE08_10	A (56%)	CE08_12	D (40%)	CE08_15	C (76%)	CE08_16	C (71%)
CE08_26	B (65%)	CE08_31	A (74%)	CE08_34	D (56%)	CE08_50	B (24%)
CE09_05	A (72%)	CE09_06	C (76%)	CE09_08	B	CE09_09	C (68%)
CE09_20	C (36%)	CE09_33	A (51%)	CE09_41	B (73%)	CE09_46	B (38%)
CE09_47	A (39%)	CE10_03	B (51%)	CE10_04	A (56%)	CE10_06	B (48%)
CE10_08	A (63%)	CE10_14	A (66%)	CE10_16	A (56%)	CE10_21	D (53%)
CE10_22	A (72%)	CE10_26	A (80%)	CE10_33	D (72%)	CE11_04	C (60%)
CE11_08	C (51%)	CE11_23	D (62%)	CE11_30	C (70%)	CE11_36	B (57%)
CE11_38	C (79%)	CE11_46	D (23%)	DSE11SP_05	D	DSE11SP_06	C
DSE11SP_15	A	DSE12PP_06	B	DSE12_03	A (78%)	DSE12_09	D (81%)
DSE12_16	B (64%)	DSE13_23	C (49%)	DSE13_05	A (71%)	DSE13_07	A (66%)
DSE13_13	D (74%)	DSE13_06	B (51%)	DSE13_19	B (65%)	DSE14_03	A (19%)
DSE14_04	D (62%)	DSE14_05	C (84%)	DSE14_18	B (66%)	DSE14_14	A (68%)
DSE15_02	D (77%)	DSE15_05	C (70%)	DSE15_07	B (87%)	DSE15_21	D (55%)
DSE16_03	D (59%)	DSE16_04	C (75%)	DSE16_05	B (86%)	DSE16_09	C (77%)
DSE16_23	C (77%)	DSE17_03	A (43%)	DSE17_09	A (72%)	DSE17_13	D (55%)
DSE17_19	D (60%)	DSE18_03	D (78%)	DSE18_04	D (60%)	DSE18_06	B (65%)

DSE18_07 B (68%) DSE18_09 A (59%) DSE19_06 C DSE19_08 B
DSE19_15 D DSE19_17 C

DSE2020:
7_D 8_D 15_D 17_B

Structural Questions

CE90_05a

(i) from colourless (or pale yellow) to blue. [1]

(ii) (1) Fe^{2+} (or iron(II) ions) [1]
OH^- (or hydroxide ions) [1]

(2) $Fe(s) \longrightarrow Fe^{2+}(aq) + 2e^-$ [1]
$2H_2O(l) + O_2(g) + 4e^- \longrightarrow 4OH^-(aq)$ [1]

(iii) tube A [1]
$Fe(s) + 2H^+(aq) \longrightarrow H_2(g) + Fe^{2+}(aq)$ [1]
OR, $Fe(s) + 2HCl(aq) \longrightarrow FeCl_2(aq) + H_2(g)$

(iv) (1) zinc is more reactive than iron [1]
OR, sacrificial protection by zinc

(2) absence of water and oxygen [1]

CE91_02c

(iii) Tin protects iron from rusting because tin prevents the contact of iron with water and air. [1]

(iv) No. Iron is more reactive than tin. [1]
Iron will lose electrons and corrode faster. [1]

CE91_04a

(i) Heat the rusty iron with carbon. [2]
$2Fe_2O_3 + 3C \longrightarrow 4Fe + 3CO_2$ [1]

(ii) The lid was opened to allow coming in of air. [1]
The lid was closed to prevent leaking out of iron powder. [1]

(iii)

	Fe	O
Mass	$26.16 - 25.27$ $= 0.89$ g	$26.50 - 26.16$ $= 0.34$ g
Number of mole	$\frac{0.89}{56.0} = 0.0159$	$\frac{0.34}{16} = 0.02125$
Mole ratio	$\frac{0.0159}{0.0159} = 1$ ≈ 3	$\frac{0.02125}{0.0159} = 1.336$ ≈ 4

[3]

Empirical formula = Fe_3O_4 [1]

CE92_01b

(i) (1) A is chosen because
A conducts electricity very well; [1]
The cost of A is low; [1]
A can be protected from corrosion by adding plastic coatings. [1]
OR, C is chosen because
C conducts electricity very well;
C has a high resistance to corrosion;
Although the cost of C is high, C can be used for a long time.

(2) B is chosen because (any two):
B is very hard; [1]
The cost of B is low; [1]
B corrodes very fast but this can be prevented by painting.
OR, C is chosen because
C corrodes very slow;
Although the cost of C is high, C can be used for a long time.

(ii) Any one: [1]
- Painting
- Connecting the metals with a more reactive metal (by sacrificial protection)
- By making alloy
- Adding plastic coating
- Electroplating

(iii) Metals have mobile electrons (or 'sea' of delocalized electrons) for conducting electricity. [1]

CE92_04b

(i) A is sodium metal. [1]
$2Na + 2H_2O \longrightarrow 2NaOH + H_2$ [1]

(ii) Step 1: Put a clean platinum wire into concentrated hydrochloric acid [1]
Step 2: Dip the platinum wire into solution B [1]
Step 3: Put it to the Bunsen flame

(iii) $Cu^{2+}(aq) + 2OH^-(aq) \longrightarrow Cu(OH)_2(s)$ [1]

(iv) Copper(II) oxide [1]
[Note: when copper(II) hydroxide is strongly heated, it turns to black copper(II) oxide
$Cu(OH)_2 \longrightarrow CuO + H_2O$]
Blue black

CE93_01a

(i) Adding Al and Fe metal in dilute hydrochloric acid, [1]
Al will react and give out colourless bubbles at a faster rate than that of Fe. [1]
[Note: $2Al + 6HCl \longrightarrow 2AlCl_3 + 3H_2$ (faster)
$Fe + 2HCl \longrightarrow FeCl_2 + H_2$ (slower)]
OR, Al metal can displace iron from iron(II) sulphate solution,
the solution changes from pale green to colourless and a silvery solid is formed.
$2Al(s) + 3Fe^{2+}(aq) \longrightarrow 2Al^{3+}(aq) + 3Fe(s)$ (Displacement reaction)

(ii) Anodized aluminium contains a protective layer of Al_2O_3. [1]
But the painting on iron is easily scratched off. [1]
Therefore, iron corrodes much faster than aluminium. [1]

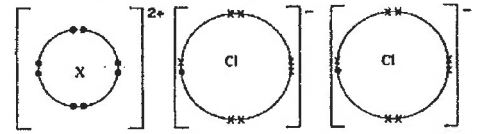
CE93_05a

(i) Fe^{3+} solution changes from yellow (or brown) to pale green. [1]
It is a redox (displacement) reaction that $Fe^{3+}(aq)$ is reduced by Zn to $Fe^{2+}(aq)$. [1]

CE94_01

(a) Group II [1]

(b) (i) $X + 2HCl \longrightarrow XCl_2 + H_2$ [1]
OR, $Mg + 2HCl \longrightarrow MgCl_2 + H_2$

(ii) 

[1]

(c) A colourless gas rapidly evolves. [1]
[Note: Y is Calcium
$Ca(s) + 2HCl(aq) \longrightarrow CaCl_2(aq) + H_2(g)$]

(d) Y > X > Z [1]
Y is most reactive because only Y can react with cold water but X and Z cannot. [1]
X is more reactive than Z because X can react with HCl but Z cannot. [1]

CE94_06a

(i) [1]

	Cu	O
Mass	7.62 g	8.58 – 7.62 = 0.96 g
Number of mole	$\frac{7.62}{63.5} = 0.12$	$\frac{0.96}{16} = 0.06$
Mole ratio	$\frac{0.12}{0.06} = 2$	$\frac{0.06}{0.06} = 1$

Empirical formula is Cu_2O [1]

(ii) $Cu_2O(s) + H_2(g) \longrightarrow 2Cu(s) + H_2O(l)$ [1]
OR, $Cu_2O(s) + CO(g) \longrightarrow 2Cu(s) + CO_2(g)$

(iii) Firstly, town gas is toxic, [1]
so the experiment should be done in fume cupboards. [1]
Secondly, burning of a mixture of town gas and air is explosive, [1]
so the combustion tube should be flush with town gas before heating. [1]

(iv) This is done to prevent the hot copper metal reacting with oxygen. [1]

CE95_01

(a) Rb is more reactive than K because Rb can release its (outermost) electron more readily. [1]

(b) $2Rb(s) + 2H_2O(l) \longrightarrow 2RbOH(aq) + H_2(g)$ [2]

(c) Store under paraffin oil [1]

(d) Any one: [1]

- Wear gloves
- Do not touch directly
- Use a pair of forceps
- Wear safety glasses
- Use a safety screen

CE95_06b

(i) Gold is very unreactive which can be found free in nature. [1]

(ii) Copper / Cu [1]
because: any two [2]

- it does not corrode easily
- has a high metallic strength
- is relatively cheap

(iii) (1) Al reacts with oxygen in air to form a layer of aluminium oxide [1]
which is not permeable to oxygen and water. So it prevents the metal from further [1]
corrosion.

(2) Alloying (with other metals e.g. Cu / Mn / Mg) [1]

(iv) (1) The price depends in its abundance in the earth's crust. [1]

(2) Any one: [1]

- cost of extraction
- cost in mining
- supply and demand of the metal

CE96_04

Chemical knowledge

Step 1: Place some tap water in a test tube to remove any undissolved oxygen (air) [1]

Step 2: Place one nail in a test tube containing some tap water (Tube 1) and the other nail [2]
in a test tube containing the boiled water (Tube 2)

Step 3: Add some paraffin oil on top of the boiled water in tube 2 to prevent air to dissolve [1]
into the water to get in contact with the nail.

After some time, reddish solid (rust) can be seen in tube 1 but no change in tube 2. [1]

Effective communication [3]

CE97_01

(a) Zinc [1]

Both zinc and calcium are more reactive than iron. They can prevent iron from rusting [2]
by sacrificial protection.

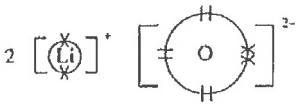
However, calcium reacts readily with water, so it cannot be used. [1]

CE98_01c

(i) The metal surface will turn dull [1]

$4Li(s) + O_2(g) \longrightarrow 2Li_2O(s)$ [1]

(ii) [1]



CE98_08b

(i) (1) To prevent iron from rusting. [1]

(2) Tin (Sn) [1]

(ii) Al is softer than iron. The ring pull can be pulled off more easily. [1]

(iii) (1) Tin (Sn) is less reactive than iron (Fe). [1]
Iron exposed to air will rust faster. [1]

(2) Fruit juice in swollen cans has already deteriorated (turn bad), [1]
gas generated by (anaerobic) respiration of bacteria causes the can to swell. [1]

(iv) Advantages: [1]

- Al is lighter
- is more resistant to corrosion than Fe
- can be recycled more easily
- can be dyed more easily

Disadvantages: [1]

- Al is more expensive
- is not so strong as Fe

CE99_02

(b) Calcium burns with a red (Brick red) flame and formation of white powder (solid) [1]

$2Ca + O_2 \longrightarrow 2CaO$ [1]

(b) Reddish brown powder (solid) [1]

$CuO + C \longrightarrow Cu + CO$ [1]

OR, $2CuO + C \longrightarrow 2Cu + CO_2$

CE00_03

(a) Copper [1]

Good electrical conductor [1]

(b) Aluminium [1]

Low density [1]

CE00_09a

(i) Reactivity: Y < Z < X [1]

Y is the least reactive because only the oxide of Y decomposes on heating. The oxides of [1]
X and Z are stable to heat.

X is the most reactive metal because only X can react with water. [1]

CE01_05

Chemical knowledge

Anodization is to thicken the layer of aluminium oxide on the surface of aluminium metal. [1]

The oxide layer is impervious (impermeable) to oxygen (water) / prevents the metal from reaction with air. [1]

Sacrificial protection is to attach a more reactive metal to a less reactive metal. [1]

The more reactive metal is more readily oxidized (forms cations) to gives out electrons. [1]

Corrosion of the less reactive metal is prevented.

Tin-plating is to coat the surface of an iron object with tin. [1]

Tin can protect the iron from rusting because tin layer prevents oxygen and water from contacting with iron for rusting to occur. [1]

Effective comunication [3]

CE01_07c

(i) Gold has strong metallic bond between atoms. [1]

Diamond has a covalent network structure and strong covalent bonds exist between carbon atoms. [1]

(ii) 18-carat gold is stronger and not easily deformed. [1]

CE01_08a

(ii) (1) Both Mg and Ca can burn in air. [1]

$2Mg + O_2 \longrightarrow 2MgO$ [1]

OR, $2Ca + O_2 \longrightarrow 2CaO$

Alternative answer:

Both Mg and Ca react with (hot) water.

$Mg + 2H_2O \longrightarrow Mg(OH)_2 + H_2$

OR, $Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$

CE02_01

(b) Nitrogen (N), hydrogen (H), phosphorus (P) and oxygen (O) [1]

[Note: ammonium dihydrogenphosphate = $NH_4H_2PO_4$]

(c) (i) Formula mass of $(NH_4)_2SO_4 = (14+4)\times2 + 32 + 16\times4 = 132$ [1]

$$\%\text{ by mass of N} = \frac{14 \times 2}{132} = 21.2$$ [1]

(Accept 21, 21.2 and 21.21)

CE02_02

(a) Magnesium burns with a brilliant flame and a white solid (MgO) is formed. [1]

$2Mg + O_2 \longrightarrow 2MgO$ (white) [1]

CE02_06a

(i) Calcium hydroxide / $Ca(OH)_2$ [1]

(ii) $Mg(OH)_2(s) + 2HCl(g) \longrightarrow MgCl_2(s) + 2H_2O(l)$ [1]

(iii) Molten magnesium chloride contains mobile ions. [1]

CE02_07a

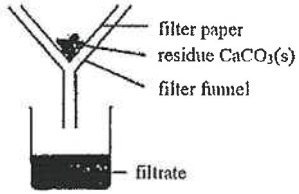
(i) $CaCO_3(s) + 2HNO_3(aq) \longrightarrow Ca(NO_3)_2(aq) + H_2O(l) + CO_2(g)$ [1]

OR, $CaCO_3(s) + 2H^+(aq) \longrightarrow Ca^{2+}(aq) + H_2O(l) + CO_2(g)$

Evolution of CO_2 stops [1]

OR, Test the pH of the solution using pH paper, the pH should be less than 7.

(ii) Diagram [2]



(iii) $Ca^{2+}(aq) + SO_4^{2-}(aq) \longrightarrow CaSO_4(s)$ [1]

(iv) To remove any soluble impurities (or appropriate example) [1]

(v) (1) $$\text{mole of } CaSO_4 = \frac{10.52}{(40 + 32 + 16 \times 4)} = 0.0774$$ [1]

Mass of $CaCO_3$ in the sample of calcite = mole × molar mass

$= 0.0774 \times (40 + 12 + 16\times3)$

$= 7.74$ g [1]

$$\%\text{ by mass of } CaSO_4 = \frac{7.74}{7.98} \times 100\% = 97.0$$ [1]

(Accept answers from 96.5 to 97.0)

(2) The sample does not contain ions which form insoluble sulphate, e.g. Ba^{2+}, Sr^{2+} [1]

OR, There is no loss of Ca^{2+} ions during the experiment

OR, $CaCO_3$ is the only calcium-containing compound present in the sample

CE02_08b

(iv) (1) $SiO_2 + C \longrightarrow Si + CO_2$ [1]

OR, $SiO_2 + 2C \longrightarrow Si + 2CO$

(2) Any one: [1]

- making computer chips
- electronic parts
- alloy
- semi-conductors
- silicone

CE03_02

(a) Hydrogen [1]

It burns with a 'pop' sound. [1]

(b) Redox. [1]

(c) Reactivity: Z < Y < X [1]

Y is more reactive than Z as Y can displace Cu from $CuSO_4(aq)$ but Z cannot. [1]

X is more reactive than Y as X can react with cold water but Y cannot. [1]

(d) X is a reactive metal. It reacts with water in the copper(II) sulphate solution and the colorless gas liberated is hydrogen. [1]

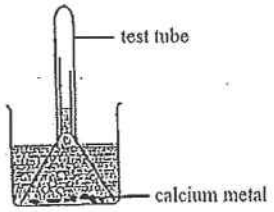
[Note: copper(II) sulphate solution contains water. And water reacts with X (Na, K or Ca) to give hydrogen.

e.g. $2Na + 2H_2O \longrightarrow 2NaOH + H_2$]

CE04_01

(a) $Ca(s) + 2H_2O(l) \longrightarrow Ca(OH)_2(aq) + H_2(g)$ [1]

(b) (i) [2]



(1 mark for a correct set-up; 1 mark for the label of an appropriate gas collecting device)

(ii) The calcium metal is covered by a layer of calcium oxide. [1]

Reaction between Ca and water starts only when the oxide layer dissolves. [1]

OR, The reaction of calcium with water is exothermic.

The reaction becomes faster at elevated temperatures.

(Accept other reasonable answers.)

(c) Any TWO of the following: [2]

- Potassium floats / moves about on the surface of water while calcium sinks.
- Potassium melts (to form a silvery ball) while calcium does not.
- Potassium burns (with a lilac flame) while calcium does not catch fire.
- The reaction of potassium with water gives a hissing sound while that of calcium and water does not.
- The reaction of calcium with water gives bubbles while that of potassium with water does not.

(Accpet other reasonable answers)

CE04_08b

(i) Hydrated iron(III) oxide / $Fe_2O_3 .xH_2O$ [1]

(ii) Conditions: oxygen (air) and water [1]

(iii) (1) Greasing / oiling [1]

(2) Connect it to a more reactive metal (e.g. Zn / Mg) [1]

(Also accept sacrificial protection.)

(iv) The battery supplies electrons to the car body to prevent it from oxidized. [1]

(v) (1) The surface of aluminium is covered by a layer of oxide which is impermeable to air and water. [1]

(2) The thickness of the oxide layer can be increased by anodization. [1]

CE05_02

(a) (i) $2Ag_2O \longrightarrow 4Ag + O_2$ [1]

(ii) The oxidation no. of Ag decreases and the oxidation no. of O increases. [1]

(iii) $\text{mole of } Ag_2O = \dfrac{3.50}{[2(107.9) + 16]}$

No. of moles of Ag = 2 × no. of moles of Ag_2O

Mass of Ag that can be obtained = 107.9 × no. of moles of Ag

$= \dfrac{2(107.9)}{231.8} \times 3.5 = 3.26 \text{ g}$ [3]

(b) (i) The black oxide changes to reddish brown metal. [1]

(ii) The metal obtained can conduct electricity. [1]

(iii) $CuO + H_2 \longrightarrow Cu + H_2O$ [1]

(iv) Hydrogen is explosive / flammable. [1]

(c) No. The reactivity of Cu and Ag can only be compared using the same reaction. [1]

CE05_08

(a)

	Pb	O
Mole ratio	$\frac{90.6}{207.2}$	$\frac{9.4}{16}$
	0.4373	0.5875
Simplest ratio	3	4

Empirical formula of X is Pb_3O_4. [2]

(b) Let mole ratio of PbO to PbO_2 be x : y

$\dfrac{\text{mole of Pb}}{\text{mole of O}} = \dfrac{x+y}{x+2y} = \dfrac{3}{4}$ [1]

X is a mixture of PbO and PbO_2 in a mole ratio of 2 : 1. [1]

OR, X is not a mixture. In X, two-third of the lead exists in an oxidation number +2, while one-third in an oxidation number +4.

CE07_06

(a) $MgO + Cl_2 + C \longrightarrow MgCl_2 + CO$ [1]

OR, $2MgO + Cl_2 + C \longrightarrow 2MgCl_2 + CO_2$

(b) Redox (reaction) / displacement (reaction) [1]

Potassium is a more powerful reducing agent / more reactive than magnesium. [1]

(c) (i) Electrolysis [1]

(ii) Magnesium chloride is an ionic compound / electrolyte / conduct electricity in molten state / contains mobile ions. [1]

(d) Sacrificial protection / making alloy / firework / flash [1]

CE08_03

[5]

Case	Observation	Explanation
Iron-made object fully plated with zinc	No observable changes	Iron does not rust without contact with water and oxygen / air
Iron-made object fully plated with tin	No observable changes	Iron does not rust without contact with water and oxygen / air
Iron-made object fully plated with zinc, but part of the zinc scratched to expose the iron underneath	No observable changes	Zinc is more reactive / loses electrons more easily than iron *OR*, sacrificial protection
Iron-made object fully plated with tin, but part of the tin scratched to expose the iron underneath	Blue colour observed near the scratched area	The exposed iron rusts. Fe changes to Fe^{2+} which turns the indicator to blue / Fe is more reactive than Sn

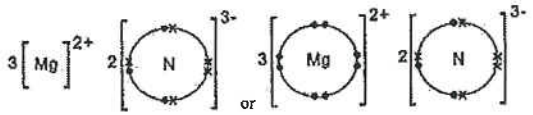
CE09_02

(a) (i) Brilliant light [1]

OR, white powder formed

(ii) (1) Mg_3N_2 [1]

(2) [1]



(b) (i) Mix carbon powder with copper(II) oxide, and heat the mixture strongly. [1]

Brown powder is formed. [1]

(ii) No. MgO is very stable. / Mg is high in the reactivity series of metal. / Mg is a strong reducing agent. / Mg loses electrons readily. [1]

CE09_03

(a) Iron powder reacts with oxygen. [1]

The reaction is exothermic. [1]

(b) Increase surface area / rate of reaction between iron and oxygen. / Speed up heat production. [1]

(c) Provide mobile ions. / Provide electrolyte. / Increase conductivity. / Increase rate of redox reaction. / Facilitate electron transfer. [1]

CE09_13

Chemical knowledge

A description of electroplating of iron:

a. The protective layer plated on iron can be a metal such as nickel / chromium / copper / silver. [1]

b. Electrolyte used is an aqueous salt solution of the metal. Example: nickel(II) sulphate (solution). [1]

c. The metal (e.g. Ni) should be made anode (positive electrode / connected to positive pole of power supply). [1]

d. The iron object should be made cathode (negative electrode / connected to negative pole of power supply). [1]

e. The metal (e.g. Ni) (anode) is oxidized / loses electrons to form ions. [1]

(Accept half equation: $Ni \longrightarrow Ni^{2+} + 2e^-$)

f. The metal ions (e.g. Ni^{2+}) are reduced / gain electrons on iron (cathode) surface to form metal (e.g. Ni) [1]

(Accept half equation: $Ni^{2+} + 2e^- \longrightarrow Ni$)

Effective communication [3]

CE10_01

(a) halogens [1]

(b) p: 18; q: 7 [1]

(c) Chlorine molecules attract each other by van der Waals' forces / weak intermolecular forces, so do bromine molecules. [1]

Bromine has a bigger molecular size than chlorine, and thus the van der Waals' forces / intermolecular forces between bromine molecules are stronger than that between chlorine molecules. [1]

(d) (i) $2Rb + Br_2 \longrightarrow 2RbBr$ [1]

(ii) 2, 8, 18, 8 [1]

CE10_04

(a) Relights a glowing splint [1]

(b) Let m be the relative atomic mass of M.

Mass ratio M : O = 2m : 16 = 3.24 : (3.48 – 3.24)

OR, Mass ratio M : M_2O = 2m : (2m+16) = 3.24 : 3.48

OR, Mole ratio $M : O = \frac{3.24}{m} : \frac{3.48 - 3.24}{16} = 2 : 1$

OR, Mole ratio $M : M_2O = \frac{3.24}{m} : \frac{3.48}{2m + 16} = 2 : 1$

m = 108 [2]

(c) No. The reactivity of M is very low. / M is lower than hydrogen in the electrochemical series. [1]

CE11_02

(a) Hydrogen [1]

$Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$ [1]

(b) Most of the 'expired' calcium had been oxidized by air to form calcium oxide. [1]

(c) The pH would increase [1]

It is because calcium hydroxide formed is alkaline. [1]

(d) Any TWO points, 1 mark for each point [2]

- Hydrogen formed is explosive / flammable.
- Calcium / calcium hydroxide formed is corrosive.
- Heat is given off from the reaction.

AL02(II)_01

Heat a sample of the blackboard chalk (with a known mass) in a crucible until there is no [½]
further reduction in mass. Assuming that the initial mass and the final mass of the sample are [½]
m_1 and m_2 respectively.

No. of moles of $CaSO_4 = \frac{m_2}{40 + 32 + 16 \times 4} = \frac{m_2}{136}$ [½]

No. of moles of $H_2O = \frac{m_1 - m_2}{1 \times 2 + 16} = \frac{m_1 - m_2}{18}$ [½]

No. of moles of water of crystallization per formula unit of $CaSO_4 = \frac{m_1 - m_2}{18} \div \frac{m_2}{136}$ [1]

AL04(I)_08d

(i) The high temperature of the piece of burning sodium may cause decomposition of CO_2. [1]
The sodium will continue to burn.

(ii) Covering the piece of burning Na with sand / use dry powder extinguisher to put out the fire. [1]

AL04(II)_01 (Modifieid)

(a) Mole ratio of $N : O : F = \frac{21.6}{14} : \frac{49.2}{16} : \frac{29.2}{19} = 1.543 : 3.075 : 1.537 = 1 : 2 : 1$ [1]

∴ empirical formula : NO_2F [1]

(b) Molecular formula of A: $(NO_2F)_n$

$60 < (14.0 + 16.0 \times 2 + 19.0)n < 70$ [1]

$0.923 < n < 1.077$

n = 1 (n must be an integer)

Molecular formula: NO_2F [1]

AL11(I)_07

(a) (i) Treat the vapor with **anhydrous $CoCl_2$ / dry cobalt(II) chloride paper.** A change of color from **blue to pink** shows the presence of water. [½] [½]

OR, Treat the vapor with **anhydrous $CuSO_4$.** A change of color from **white to blue** shows the presence of water.

(ii) **Weigh** an empty crucible and its lid (m_1). [½]

Put a sample of the salt in the crucible and weigh the crucible, its content and the lid (m_2). [½]

Heat the crucible and its content, not completely covered by the lid, to allow water vapor to escape until the sample turns white. [½]

Allow the crucible and its content to cool in a desiccator and then weigh the crucible, its content and the lid.

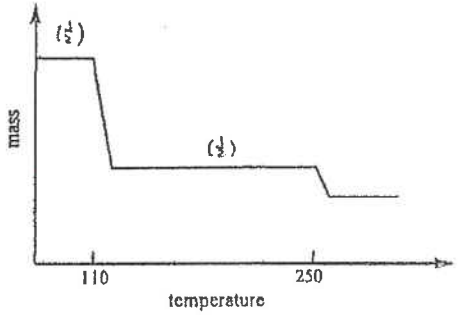
Repeat the heating and weighing processes until a constant mass (m_3) is reached. [½]

No. of molecules of water of crystallization

$= \frac{(m_2 - m_3)}{(m_3 - m_1)} \times \frac{(63.5 + 32.1 + 16 \times 4)}{(2 \times 1 + 16)}$ [1]

Should be equal to 5.

(iii) [2]



(1 mark for showing two 'steps' in the curve; 1 mark for showing that the heights of two 'steps' are in 4 : 1 ratio.)

AL12(I)_01

Mole ratio	K	Fe	C	O
	$\frac{26.8}{39.1}=0.685$	$\frac{12.8}{55.8}=0.229$	$\frac{16.5}{12.0}1.375$	$\frac{43.9}{16}2.744$
Simples ratio	3	1	6	12

[1]

Empirical formula of the salt is $K_3FeC_6O_{12}$ or $K_3Fe(C_2O_4)_3$ [1]

ASL12(II)_02

(a) No. of moles of AgBr(s) formed $= \frac{0.816}{(107.9+79.9)} = 0.004345$ [1]

No. of moles of MBr_2 used $= \frac{0.004345}{2} = 0.00217$ [1]

Formula mass of $MBr_2 = \frac{0.400}{0.00217} = 184.1$ [1]

(b) Relative atomic mass of M $= 184.1 - 2(79.9) = 24.3$ [1]

M is likely to be magnesium. [1]

AL13(II)_05

(b) Ra is more reactive than Ca towards water. ($H_2(g)$ is formed.) [1]

$M(s) + 2H_2O(l) \longrightarrow M(OH)_2(aq) + H_2(g)$

Ra has a larger size and is more ready to donate its outermost electrons. [1]

DSE11SP_03

(a) Hydrogen / H_2 [1]

It burns with a 'pop' sound. [1]

(b) Redox / reduction-oxidation reaction [1]

(c) Reactivity: $Z < Y < X$ [1]

Y is more reactive than *Z* as *Y* can displace Cu from $CuSO_4$(aq) but *Z* cannot. [1]

X is more reactive than *Y* as *X* can react with cold water but *Y* cannot / oxide of *X* cannot be reduced by carbon but oxide of *Y* can. [1]

(d) *X* is a reactive metal. It reacts with water in the copper(II) suphate solution and the colorless gas liberated is hydrogen [1]

DSE11SP_08

(a) zinc granules dissolve / a colorless gas is produced / solution gets warm [1]

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$ [1]

OR, $Zn + 2H^+ \longrightarrow Zn^{2+} + H_2$

DSE12PP_05

(a) Atomic ratio of C : H $= \frac{81.8}{12} : \frac{18.2}{1} = 6.82 : 18.2 = 3 : 8$ [1]

Alkane has the general formula C_nH_{2n+2} [1]

∴ **X** is propane / C_3H_8 [1]

DSE12_05

(a) Displacement reaction occurred when the iron rod is dipped into the copper(II) sulphate solution. / Some copper(II) ions (Cu^{2+}) are reduced and deposited onto the surface of the iron rod as copper metal. [1]

$Cu^{2+}(aq) + Fe(s) \longrightarrow Cu(s) + Fe^{2+}(aq)$ [1]

$CuSO_4(aq) + Fe(s) \longrightarrow Cu(s) + FeSO_4(aq)$

DSE12_09

(a) Yellow to Blue / yellow to Blue and pink / blue and pink colouration would be observed near the iron nail which rusts. [1]

(b) Both iron nail B and iron nail C would not rust. [1]

For iron nail B, **as Mg is higher than iron in the metal reactivity series** (with further explanation such as: the magnesium ribbon loses electrons more readily and will become Mg^{2+} / Mg corrodes more readily). [1]

For iron nail B, the magnesium ribbon protects the iron nail from rusting by **sacrificial protection.** [1]

For iron nail C, as it is sealed with grease, the iron cannot contact with water and / or air (oxygen), so rusting cannot occur.

DSE13_03

(a) Atomic ratio of C : H : O $= \frac{2.64}{44} : \frac{1.08}{18} \times 2 : \frac{0.48}{16} = 2 : 4 : 1$ [1]

Empirical formula is C_2H_4O [1]

Molecular formula is $(C_2H_4O)_n$

$n \times (12 \times 2 + 1 \times 4 + 16 \times 1 = 88.0$

$n = 2$

molecular formula of W is $C_4H_8O_2$ [1]

Alternative method:

No. of C atoms in W $= \frac{2.64}{44} \times \frac{88}{1.32} = 4$

No. of H atoms in W $= \frac{1.08}{18} \times \frac{88}{1.32} \times 2 = 8$

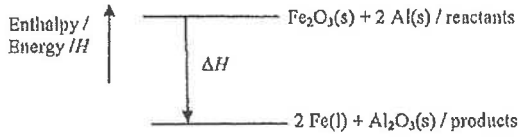
No. of O atoms in W $= \frac{88 - 12 \times 4 - 8 \times 1}{16} = 2$

molecular formula of W is $C_4H_8O_2$

DSE13_07

(a) (i) $Fe_2O_3(s) + 2Al(s) \longrightarrow 2Fe(s) + Al_2O_3(s)$ [1]

(ii)



[1]

(b) Copper is less reactive than iron. [*comparsive sense*] [1]

OR, Copper has a lower affinity for oxygen than iron.

OR, Copper is a weaker reducing agent than iron.

OR, Copper is lower than iron in the chemical reactivity series / electrochemical series.

∴ Cu(s) cannot reduce $Fe_2O_3(s)$.

(c) (i) Aluminium is more expensive than iron. / Using aluminium to extract iron is costly. [1]

(ii) Coke / carbon / charcoal / carbon monoxide / CO [1]

(Not accept coal or H_2)

DSE14_04

- By heating oxide of silver directly, silver can be obtained, while copper and magnesium cannot be obtained by similar method. [1]
- By heating with charcoal / carbon / hydrogen / carbon monoxide / town gas, oxide of copper can be reduced to copper, while magnesium cannot obtained by similar method. [1]
- Magnesium can only be obtained by electrolysis of its oxide in molten state. [1]
- As more stable is the metal oxide, the more reactive is the metal. So the order of reactivity is : magnesium > copper > silver
- Effective communication [1]

DSE15_03

(a) Iron is less reactive than aluminium [1]

OR, Compound/oxide/ore of iron is less stable

OR, Compound/oxide/ore of aluminum is more stable.

NOT accept answers like 'easy to extract", 'easier to extract"

(b) (i)

	Fe	O
Mass / g	1.67	0.64
Atom ratio	$\frac{1.67}{55.8} = 0.03$	$\frac{0.64}{16} = 0.04$

[1]

Empirical formula = Fe_3O_4 [1]

(ii) $Fe_3O_4(s) + 4CO(g) \longrightarrow 3Fe(s) + 4CO_2(g)$ [1]

(iii) Perform the experiment in a fume cupboard. [1]

(c) Zn is more reactive / a stronger reducing agent than iron. [1]

For galvanized objects with the surface layer of zinc broken, iron will be protected from corrosion as zinc will be preferentially oxidized (react with oxygen). [1]

OR, Zn is higher than Fe in the reactivity series or ECS.

OR, Zn is more electropositive than Fe.

NOT accept answers like "zinc sacrifices", "zinc corrodes".

OR, Zn releases / loses electrons

(d) The surface of the aluminium object is oxidized to $Al_2O_3(s)$ / aluminium oxide / oxide of aluminium. [1]

$Al_2O_3(s)$ is impermeable to water/oxygen/air, thus corrosion of aluminium is inhibited. [1]

DSE16_01

(a) (i) number of moles of P : number of moles of Cl

$= \frac{0.226}{31.0} : \frac{0.774}{35.5} = 1:3$

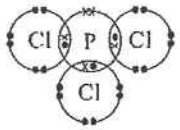
Molecular formula is $(PCl_3)_n$ [1]

$(31.0 + 35.5x3)\ n < 250$

$n = 1$

Molecular formula is PCl_3 [1]

(ii) [1]



DSE17_02

(a) Copper is not easily oxidized / corroded as iron [1]

(Accept: iron reacts with water / oxygen / air / acids but copper does not.)

(Not accept: iron rust but copper does not / Copper does not so easily rust as iron.)

Copper has a lower tendency to lose electrons than iron [1]

OR, Copper occupies at a lower position than iron in the e.c.s. / metal reactivity series / Copper is less reactive than iron.

(b) (i) To lower the melting point of soldering materials. [1]

(Not accept: The melting point of lead is low.)

(ii) Lead is / compounds of lead are toxic / poisonous. (not accept harmful) [1]

(Accept: Lead will damage / is harmful to the central nervous system (or other internal organs).)

DSE18_01

(b) (i) $6Li + N_2 \longrightarrow 2Li_3N$ [1]

(State symbols not required) (Ignore incorrect state symbols)

(ii) $\frac{y}{6.9} = 3 \times \frac{1.25}{34.7}$ [1]

$y = 0.746$ g

(Also accept 0.745, 0.75; NOT accept 0.750) (Correct unit is required) [1]

(Accept max. 4 decimal places)

(c) Lithium oxide / lithium peroxide [1]

DSE18_05

(b) Connect zinc / magnesium blocks (through connecting wires to the surface of the pipelines / scarification protection. [1]

Zinc / magnesium can release electrons more readily than iron. [1]

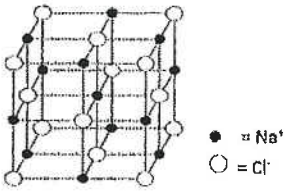
OR, Zinc and magnesium are more reactive than iron. / Zinc and magnesium has greater reducing power than iron. / Zinc and magnesium is higher than iron in the ECS.

OR, Connect the negative electrode of a D.C. source (through connecting wires) to the surface of the pipelines (and the positive electrode to a platinum electrode) / Cathodic protection

The electrons provided by the D.C. source prevent iron from releasing electrons.

(Do not accept wrapping with plastics / alloying / use stainless steel pipelines)

DSE19_02

(a) 

[1]

(b) (i) Total mass of 4 Na^+ ions and 4 Cl^- ions = (23.0 + 35.5) × 4 / L = 234 / L (g) [1]

(Accept answer without an unit, but NOT accept answer with an incorrect unit.)

(ii) $234/L = 2.17 \times 1.80 \times 10^{-22}$ [1]

$L = L = 5.99 \times 10^{23}$ (mol^{-1}) [1]

(Accept max. 3 decimal places)

(Accept answer without an unit, but NOT accept answer with an incorrect unit.)

SECTION 4 Acids and Bases

Multiple-Choice Questions

CE90_07

The reaction between lead(II) nitrate solution and sodium hydrogencarbonate solution can be represented by the equation below:

$$Pb^{2+}(aq) + 2HCO_3^-(aq) \longrightarrow PbCO_3(x) + H_2O(y) + CO_2(z)$$

	x	y	z
A.	aq	aq	aq
B.	aq	l	g
C.	s	aq	g
D.	s	l	g

CE90_12

150.0 cm^3 of 3.0 M sodium hydroxide solution is mixed with 50.0 cm^3 of 1.0M sodium hydroxide solution. The concentration of the resultant solution is

A. 2.0 M.
B. 2.5 M.
C. 3.3 M.
D. 4.0 M.

CE90_14

Which of the following statements concerning 25 cm^3 of 1M hydrochloric acid and 25 cm^3 of 1M ethanoic acid is/are correct?

(1) They give the same colour change when the same quantity of universal indicator is added.
(2) They react with marble chips at the same rate when the initial temperature are the same.
(3) They require the same number of moles of sodium hydroxide for complete neutralization.

A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

CE90_22

X is a white solid. When dilute hydrochloric acid is added to **X**, a colourless gas is liberated. An aqueous solution of **X** gives a white precipitate with silver nitrate solution. **X** is probably

A. ammonium chloride.
B. sodium ethanoate.
C. sodium carbonate.
D. calcium carbonate.

CE90_26

Dry zinc chloride solid is a non-conductor of electricity because

A. it is a non-electrolyte.
B. it exists as molecules.
C. its ions are not mobile.
D. metallic bonding is not present.

CE90_35

Which of the following hydroxide is insoluble in BOTH excess sodium hydroxide solution and excess aqueous ammonia?

A. $Cu(OH)_2$
B. $Zn(OH)_2$
C. $Fe(OH)_2$
D. $Al(OH)_3$

CE90_44

If dilute hydrochloric acid gets into a student's eye during an experiment, the first thing the student should do is to

A. dial 999 for help.
B. wash the eye with water.
C. wash the eye with dilute ammonia solution.
D. wash the eye with dilute sodium hydroxide solution.

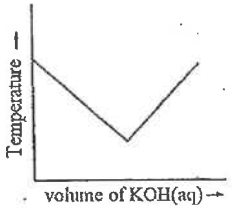
CE90_46

1st statement	2nd statement
A solution of dry hydrogen chloride in methylbenzene turns blue litmus paper red.	Gaseous hydrogen chloride contains hydrogen ions.

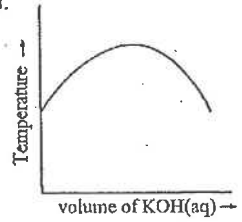
CE91_13

Which of the following graphs represents what would be obtained in a thermometric titration of 2M hydrochloric acid with potassium hydroxide solution?

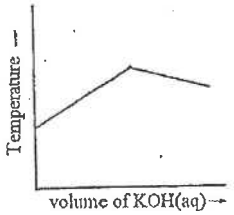
A.



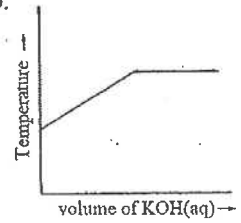
B.



C.



D.



CE91_16

What volume of water should be added to 100 cm^3 of 2M hydrochloric acid to change the acid concentration to 0.2M?

A. 100 cm^3
B. 500 cm^3
C. 900 cm^3
D. 1000 cm^3

CE91_18

22 g calcium carbonate are allowed to react with 200 cm^3 of 0.5 M hydrochloric acid until no further reaction occurs. What is the mass of calcium carbonate left behind?
(Relative atomic masses: C = 12.0, O = 16.0, Ca = 40.0)

A. 2 g
B. 5 g
C. 12 g
D. 17 g

CE91_20

What is the number of moles of Fe^{3+} ions in 0.1 dm^3 of 0.5M $Fe_2(SO_4)_3$ solution?

A. 0.1×0.5
B. $2 \times 0.1 \times 0.5$
C. $0.1 \times 0.5 \times 6.02 \times 10^{23}$
D. $2 \times 0.1 \times 0.5 \times 6.02 \times 10^{23}$

CE91_21

Iron(II) sulphate solution is mixed with chlorine water. Excess aqueous ammonia is then added to the mixture. What is the colour of the precipitate formed?

A. white
B. yellow
C. green
D. brown

CE91_23

1.55 g of a hydrated sodium carbonate, $Na_2CO_3 \cdot xH_2O$, react completely with 25 cm^3 of 1 M hydrochloric acid. What is the value of x?
(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0, Na = 23.0)

A. 1
B. 2
C. 4
D. 10

CE91_39

In an experiment to study the rate of reaction, 100 cm^3 of 2 M hydrochloric acid are added to excess zinc granules at room temperature. Which of the following modifications would increase the initial rate of reaction?

(1) The concentration of hydrochloric acid is 4 M instead of 2 M.
(2) The volume of hydrochloric acid is 200 cm^3 instead of 100 cm^3.
(3) The hydrochloric acid is replaced by 100 cm^3 of 2 M sulphuric acid.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE91_45

Which of the following statements about hydrogen chloride is/are correct?

(1) It forms dense white fumes with ammonia gas.
(2) It dissolves in methylbenzene to form H^+ and Cl^- ions.
(3) It turns dry litmus paper red.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

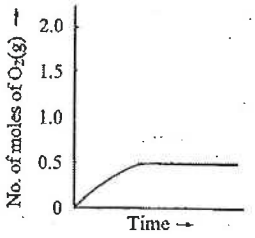
CE91_28

Hydrogen peroxide decomposes according to the following equation:

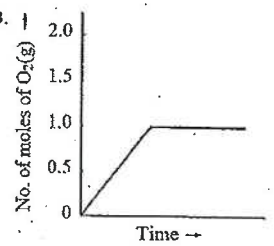
$2H_2O_2(aq) \longrightarrow 2H_2O(l) + O_2(g)$

A student made use of the above reaction to study how the rate of decomposition of 1.0 mole of hydrogen peroxide varied with time. Which of the following graphs is a correct representation of the result?

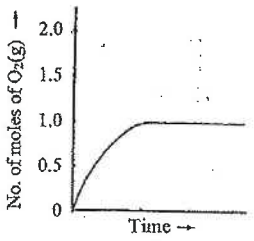
A.



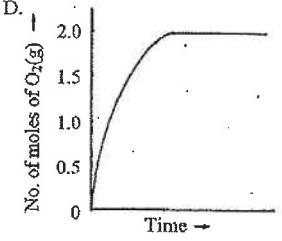
B.



C.



D.



CE91_47

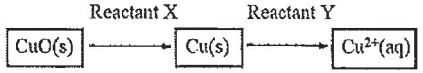
1st statement	2nd statement
Distilled water is a poor conductor of electricity.	Distilled water contains an equal number of $H^+(aq)$ ions and $OH^-(aq)$ ions.

CE91_50

1st statement	2nd statement
Magnesium oxide dissolves faster in 1M hydrochloric acid than in 1M ethanoic acid.	Hydrochloric acid is a stronger acid than ethanoic acid.

CE92_11

Consider the following diagram:



Which of the following combinations is correct?

	Reactant X	Reactant Y
A.	$H_2(g)$	dilute H_2SO_4
B.	$CO(g)$	dilute HNO_3
C.	$NH_3(g)$	dilute HCl
D.	$C(s)$	concentrated HCl

CE92_17

Directions: Q.17 and Q.18 refer to the following experiment:

A student measured the conductivity of a certain acid. When he added barium hydroxide solution dropwise to the acid, he found that the conductivity of the acid gradually dropped to almost zero.

The acid is probably

A. hydrochloric acid.
B. sulphuric acid.
C. nitric acid.
D. ethanoic acid.

CE92_18

Which of the following reasons accounts for the change in the conductivity of the acid?

A. Barium hydroxide is a weak electrolyte.
B. The acid is a weak electrolyte.
C. The neutralization reaction between barium hydroxide solution and the acid is exothermic.
D. A precipitate is formed when barium hydroxide solution is added to the acid.

CE92_19

Solution X is 45 cm^3 of 1.2 M HCl and Solution Y is 60 cm^3 of 0.9 M CH_3COOH. Which of the following statement concerning X and Y is correct?

A. X has a higher pH than Y.
B. Both X and Y need the same volume of 1 M NaOH for neutralization.
C. Both X and Y have the same electrical conductivity.
D. Y has a faster rate of reaction with marble chips than X.

CE92_26

Consider the following chemical equilibrium:

$$\underset{\text{(orange)}}{Cr_2O_7^{2-}(aq)} + H_2O(l) \rightleftharpoons \underset{\text{(yellow)}}{2CrO_4^{2-}(aq)} + 2H^+(aq)$$

Which of the following statements is correct?

A. Both dichromate ions and chromate ions are present in the reaction mixture.
B. On adding NaOH(aq) to the mixture, the solution becomes orange.
C. On adding dilute H_2SO_4 to the mixture, the position of equilibrium shifts to the right.
D. On diluting with water, the solution becomes orange.

CE92_27

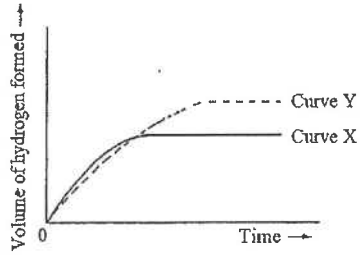
The following experiment results were obtained when 2 M HCl was allowed to react separately with 2 M NaOH and 2 M KOH:

Expt No.	Volume of acid	Volume of alkali	Rise in temperature
1	100 cm^3 of 2 M HCl	100 cm^3 of 2 M NaOH	T_1°C
2	200 cm^3 of 2 M HCl	200 cm^3 of 2 M KOH	T_2°C

Which of the following is correct?

A. $T_1 = T_2$
B. $T_1 = 2T_2$
C. $2T_1 = T_2$
D. $4T_1 = T_2$

CE92_28



In the above graph, curve X was obtained by the reaction between 100 cm^3 of 1 M HCl and excess zinc granules.

Which of the following changes would produce curve Y?

A. Increasing the temperature by 10°C.
B. Adding the same amount of zinc powder instead of zinc granules.
C. Using 200 cm^3 of 0.8 M HCl instead of 100 cm^3 of 1 M HCl.
D. Using 50 cm^3 of 1.5 M HCl instead of 100 cm^3 of 1 M HCl.

CE92_29

After 50 cm^3 of 0.60 M H_2SO_4 have completely neutralized 100 cm^3 of 0.6 M NaOH, the concentration of the resulting sodium sulphate solution is

A. 0.2 M
B. 0.3 M
C. 0.6 M
D. 1.2 M

CE92_36

Which of the following reagents form(s) a white precipitate with lead(II) nitrate solution?

(1) potassium carbonate solution
(2) dilute hydrochloric acid
(3) sodium sulphate solution

A. (3) only
B. (1) and (2) only
C. (1) and (3) only
D. (1), (2) and (3)

CE92_48

1st statement	2nd statement
In the reaction between calcium carbonate and hydrochloric acid, the reaction rate decreases with time.	The molar concentration of hydrochloric acid decreases as the reaction between calcium carbonate and hydrochloric acid proceeds.

CE92_49

1st statement	2nd statement
A solution of hydrogen chloride in methylbenzene can turn blue litmus paper red.	Hydrogen chloride dissolves in methylbenzene to form hydrogen ions.

CE93_07

$$CO_2(g) + CaCO_3(x) + H_2O(y) \longrightarrow Ca(HCO_3)_2(z)$$

In the above chemical equation, which of the following combination is correct?

	x	y	z
A.	aq	l	aq
B.	s	aq	s
C.	s	l	s
D.	s	l	aq

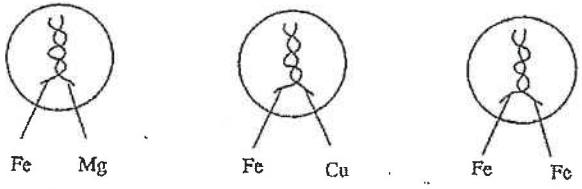
CE93_11

The following substances were burnt in oxygen and the products were mixed with water. Which of these substances would produce a resulting solution with the highest pH value?

A. calcium
B. iron
C. sulphur
D. carbon

CE93_21

Three different pairs of metal wires are placed separately in petri dishes (as shown in the diagram below) containing a mixture of gelatin, potassium hexacyanoferrate(III) solution and phenolphthalein solution.



Dish I Dish II Dish III

In Dish II, which of the following colours will develop around the iron wire and the copper wire?

	iron wire	copper wire
A.	pink	blue
B.	blue	pink
C.	pink	no colour
D.	blue	no colour

CE93_23

Which of the following statements about a solution of hydrogen chloride in water is correct?

A. The hydrogen chloride exists as molecules in the solution.
B. The hydrogen chloride is highly ionized in water.
C. The pH value of the solution is greater than 7.
D. The reaction between the solution and aqueous ammonia is exothermic.

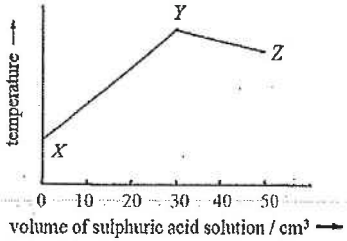
CE93_27

Which of the following solutions forms a precipitate with excess aqueous ammonia?

A. copper(II) chloride solution
B. aluminium nitrate solution
C. zinc sulphate solution
D. sodium chloride solution

CE94_31

A sulphuric acid solution is titrated against 25.0 cm^3 of 3.0 M sodium hydroxide solution. The results of the thermometric titration can be represented by the following graph.



Which of the following statement(s) is/are correct?

(1) The temperature rises from *X* to *Y* because the reaction between the sulphuric acid solution and sodium hydroxide solution is exothermic.
(2) The temperature drops from *Y* to *Z* because water is formed in the reaction between the sulphuric acid solution and sodium hydroxide solution.
(3) *Z* corresponds to the end point of the titration.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE94_33

Which of the following statements concerning 25.0 cm^3 of 0.1 M hydrochloric acid and 25.0 cm^3 of 0.1 M ethanoic acid is/are correct?

(1) They contain the same number of hydrogen ions.
(2) They require the same volume of 0.1 M sodium hydroxide solution for complete neutralization.
(3) They react with excess zinc granules at the same rate.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE94_43

Which of the following statements concerning a catalyst are correct?

(1) It can change the rate of a reaction.
(2) It can change the amount of product formed in a reaction.
(3) It remains chemically unchanged at the end of a reaction.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE95_08

In order to prepare 250.0 cm^3 of 0.1 M sodium hydroxide solution from 1.0 M sodium hydroxide solution, which of the following combinations of apparatus should be used?

A. burette, measuring cylinder, pipette
B. conical flask, measuring cylinder, volumetric flask
C. burette, conical flask, wash bottle
D. pipette, volumetric flask, wash bottle

CE95_09

A student performed a titration experiment in which he added an acid from a burette to an alkali contained in a conical flask. The following diagrams show the initial and final readings of the burette.

What was the volume of the acid added from the burette to the conical flask?

A. 24.5 cm^3
B. 24.6 cm^3
C. 24.7 cm^3
D. 32.3 cm^3

CE95_12

Which of the following pairs of solutions, when mixed, would give a neutral solution?

A. 10 cm^3 of 1 M sulphuric acid and 10 cm^3 of 1 M sodium hydroxide solution
B. 10 cm^3 of 1 M sulphuric acid and 10 cm^3 of 2 M sodium hydroxide solution
C. 10 cm^3 of 2 M sulphuric acid and 20 cm^3 of 1 M sodium hydroxide solution
D. 20 cm^3 of 2 M sulphuric acid and 10 cm^3 of 2 M sodium hydroxide solution

CE95_16

What volume of water is required to dilute 100 cm^3 of 8 M hydrochloric acid to a concentration of 2 M?

A. 200 cm^3
B. 300 cm^3
C. 400 cm^3
D. 700 cm^3

CE95_18

Metal X reacts with dilute hydrochloric acid to liberate hydrogen, but metal Y and metal Z have no reaction with dilute acid. The oxide of metal Y decomposes on heating but the oxide of metal Z does not.

Which of the following arrangements represents the order of increasing reactivity of the three metals?

A. X < Y < Z
B. Y < Z < X
C. X < Z < Y
D. Z < Y < X

CE95_24

Consider the following equation.

$$2FeSO_4 \cdot 7H_2O(x) \longrightarrow Fe_2O_3(y) + SO_3(z) + SO_2(g) + 14H_2O(l)$$

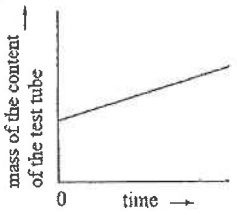
Which of the following combinations is correct?

	x	y	z
A.	aq	s	g
B.	aq	s	l
C.	s	aq	s
D.	s	s	g

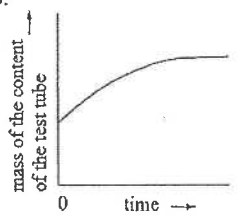
CE95_27

A certain amount of silver oxide is heated in a test tube. Which of the following graphs represents the correct plot of the mass of the contents of the test tube against time?

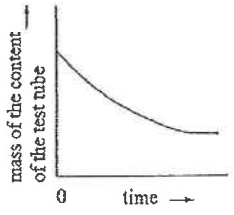
A.



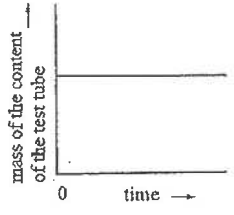
B.



C.



D.



CE95_35

Which of the following substances, when mixed with lemon juice, would give off gas bubbles?

(1) iron nails
(2) milk of magnesia
(3) polyethene wrap

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE95_39

Which of the following substances can conduct electricity?

(1) molten zinc chloride
(2) an aqueous solution of magnesium sulphate
(3) a mixture of ethanol and water

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE95_46

1st statement	2nd statement
The basicity of ethanoic acid is four.	One molecule of ethanoic acid contains four atoms of hydrogen.

CE95_49

1st statement	2nd statement
If a student accidentally spills some hydrochloric acid on his hand, he should immediately wash his hand with sodium hydroxide solution.	Sodium hydroxide solution can neutralize hydrochloric acid.

CE96_04

Consider the following chemical equation:

$$2HNO_3(aq) + CaCO_3(x) \longrightarrow Ca(NO_3)_2(y) + H_2O(z) + CO_2(g)$$

Which of the following combinations is correct?

	x	y	z
A.	aq	aq	l
B.	aq	aq	aq
C.	s	aq	l
D.	s	s	aq

CE96_06

Which of the following substances is used by farmers to increase the pH of soil?

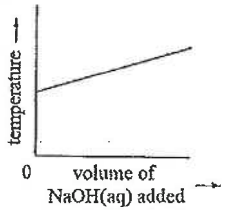
A. ammonium nitrate
B. calcium hydroxide
C. citric acid
D. potassium hydroxide

CE96_10

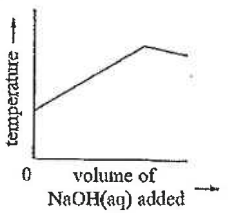
A student added 16 cm^3 of 2M sodium hydroxide solution, in 2 cm^3 portions, to 10 cm^3 of 2M nitric acid. He measured the temperature of the mixture immediately after each addition of the sodium hydroxide solution.

Which of the following graphs represents the relationship between the temperature of the mixture and the volume of sodium hydroxide solution added?

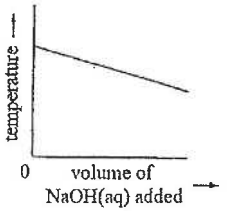
A.



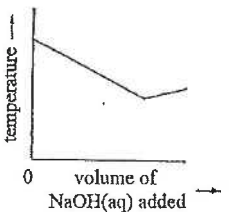
B.



C.



D.



CE97_13

Which of the following statements concerning the reaction of aqueous ammonia with hydrochloric acid is correct?

A. The reaction is exothermic.
B. A white precipitate is formed.
C. Ammonium chloride and chlorine are produced.
D. The product ammonium chloride is a covalent compound.

CE97_14

The formula of a metal carbonate is X_2CO_3. 100 cm^3 of a solution containing 0.69 g of the carbonate requires 50 cm^3 of 0.20 M hydrochloric acid for complete reaction. What is the relative atomic mass of metal X?

(Relative atomic masses: C = 12.0, O = 16.0)

A. 19.0
B. 23.0
C. 39.0
D. 78.0

CE97_31

Which of the following statements concerning citric acid is/are correct?

(1) It is a strong acid.
(2) It is present in oranges.
(3) It exists as a solid at room temperature.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE97_37

Which of the following substances would react with sodium hydroxide solution?

(1) ammonium chloride solution
(2) copper(II) sulphate solution
(3) ethanoic acid

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE97_49

1st statement	2nd statement
When filling a pipette with a solution, a pipette filler is preferred to sucking with the mouth.	It is more accurate to fill a pipette with a solution by using a pipette filler than by sucking with the mouth.

CE98_09

Which of the following substances has a pH less than 7?

A. lemon juice
B. soap solution
C. glass cleaner
D. milk of magnesia

CE98_13

In an experiment, 10 cm^3 of 1M hydrochloric acid is added slowly into 10 cm^3 of 1M sodium hydroxide solution. Which of the following statements concerning this experiment is correct?

A. The temperature of the mixture increases.
B. The pH of the mixture increases.
C. The mixture does not conduct electricity at the end of the experiment.
D. The concentration of sodium ions in the mixture remains unchanged.

CE98_16

The formula of a solid dibasic acid is H_2X. 2.88g of the acid is dissolved in some distilled water and the solution is then diluted to 250.0 cm^3 with distilled water. 25.0 cm^3 of the diluted solution requires 16.0 cm^3 of 0.40M sodium hydroxide solution for complete neutralization. What is the molar mass of H_2X?

A. 22.5 g
B. 45.0 g
C. 90.0 g
D. 180.0 g

CE98_18

Which of the following ions has the same number of protons as the hydroxide ion, OH^-?

A. O^{2-}
B. F^-
C. Na^+
D. Mg^{2+}

CE98_23

Which of the following is NOT the appropriate substance for preparing zinc sulphate by directly mixing with dilute sulphuric acid?

A. zinc
B. zinc carbonate
C. zinc hydroxide
D. zinc nitrate

CE98_25

Dilute sodium hydroxide solution is added successively to four different solutions. Which of the following combinations is correct?

	Solution	Observation
A.	ammonium chloride	white precipitate
B.	lead(II) nitrate	yellow precipitate
C.	potassium dichromate	orange precipitate
D.	iron(III) sulphate	brown precipitate

CE98_31

What is the purpose of adding quicklime (calcium oxide) to soil?

A. to neutralize the acidity of the soil.
B. to act as a fertilizer for the soil.
C. to kill micro-organisms in the soil.
D. to increase the amount of calcium ions in the soil.

CE98_43

Which of the following substances are commonly found in canned grapefruit juice?

(1) citric acid
(2) benzoic acid
(3) ethanoic acid

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE99_06

The concentration of an aqueous solution of an acid is 1.0 M. 25.0 cm^3 of this acid solution requires 37.5 cm^3 of 2.0 M sodium hydroxide solution for complete neutralization. What is the basicity of the acid?

A. 1
B. 2
C. 3
D. 4

CE99_20

Which of the following solutions would produce a white precipitate with sodium hydroxide solution?

A. lead(II) nitrate solution
B. iron(III) nitrate solution
C. copper(II) nitrate solution
D. potassium nitrate solution

CE99_25

In an experiment, 1.00 M sodium hydroxide solution was added to 25.0 cm^3 of 1.00 M sulphuric acid until the acid was completely neutralized. What is the concentration of sodium sulphate (correct to two decimal places) in the resulting solution?

A. 1.00M
B. 0.50M
C. 0.33M
D. 0.25M

CE99_45

	1st statement	2nd statement
	Sulphur is classified as a non-metal.	Sulphur does not react with dilute acids.

CE00_11

Different volumes of 2.0 M potassium hydroxide solution and 2.0 M sulphuric acid are mixed in a polystyrene cup. In which of the following combination would the temperature rise be the greatest?

	Volume of 2.0 M KOH(aq) /cm^3	Volume of 2.0 M H_2SO_4(aq) /cm^3
A.	20.0	40.0
B.	30.0	30.0
C.	40.0	20.0
D.	45.0	15.0

CE00_29

Which of the following compounds would react with ammonium chloride on heating?

A. concentrated nitric acid
B. concentrated hydrochloric acid
C. sodium hydroxide solution
D. magnesium sulphate solution

CE00_33

In an experiment, a piece of calcium metal was added to a beaker of water. Which of the following statements concerning the experiment is/are correct?

(1) The calcium metal sank to the bottom of the beaker.
(2) The calcium metal burnt with brick red flame.
(3) At the end of the experiment, an alkaline solution was found in the beaker.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE01_06

When potassium carbonate solution and calcium chloride solution are mixed, calcium carbonate is precipitated. Which of the following mixtures would produce the greatest amount of precipitate?

A. 5 cm^3 of 1 M K_2CO_3(aq) + 15 cm^3 of 1 M $CaCl_2$(aq)
B. 10 cm^3 of 1 M K_2CO_3(aq) + 10 cm^3 of 1 M $CaCl_2$(aq)
C. 15 cm^3 of 1 M K_2CO_3(aq) + 8 cm^3 of 1 M $CaCl_2$(aq)
D. 18 cm^3 of 1 M K_2CO_3(aq) + 5 cm^3 of 1 M $CaCl_2$(aq)

CE01_07

Which of the following statements concerning water is correct?

A. It reacts with calcium to give a colourless gas.
B. It is a strong electrolyte.
C. It turns anhydrous cobalt(II) chloride from pink to blue.
D. It is immiscible with methanol.

CE01_15

A mixture consists of one mole of sodium carbonate and one mole of sodium hydrogencarbonate. What is the least number of moles of hydrochloric acid required to liberate all the available carbon dioxide from the mixture?

A. 1.5
B. 2.0
C. 3.0
D. 4.0

CE01_23

Phosphoric acid is a tribasic acid with formula H_3PO_4. Which of the following formulae is INCORRECT?

A. CaH_2PO_4
B. $Mg_3(PO_4)_2$
C. $(NH_4)_2HPO_4$
D. Na_2HPO_4

CE01_34

In a titration experiment, 25.0 cm^3 of diluted vinegar is titrated against a standard solution of sodium hydroxide with phenolphthalein as indicator. Which of the following statements concerning this experiment is/are correct?

(1) The colour of phenolphthalein changes from colourless to pink at the end point.
(2) The colour of phenolphthalein changes from pink to colourless at the end point.
(3) A measuring cylinder is used to measure the volume of the diluted vinegar.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE02_02

Which of the following compounds, when dissolved in water, gives a green solution?

A. copper(II) sulphate
B. nickel(II) sulphate
C. cobalt(II) sulphate
D. iron(II) sulphate

CE02_05

Consider the aqueous solutions listed below:

(1) 1 M ethanoic acid
(2) 1 M hydrochloric acid
(3) 1 M ammonia solution

Which of the following represents the increasing order of pH of the solution?

A. (1), (2), (3)
B. (2), (1), (3)
C. (3), (1), (2)
D. (3), (2), (1)

CE02_17

Which of the following solution does NOT react with sodium hydroxide solution?

A. ammonium chloride solution
B. potassium carbonate solution
C. copper(II) nitrate solution
D. zinc sulphate solution

CE02_32

A black powder is suspected to be carbon or a mixture of carbon and copper(II) oxide. Which of the following methods can be used to identify the black powder?

(1) adding dilute sulphuric acid to the powder
(2) adding sodium hydroxide solution to the powder
(3) heating the powder strongly

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE02_42

In which of the following is ammonia used?

(1) the manufacture of nitric acid
(2) the making of fertilizers
(3) the making of antiacids

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE03_04

Which of the following statements concerning nitric acid is INCORRECT?

A. It is manufactured from ammonia.
B. It is used to make explosives.
C. It is used to make fertilizers.
D. It is a dehydrating agent.

CE03_26

20.0 cm^3 of 2.0 M aqueous ammonia required 16.0 cm^3 of sulphuric acid for complete neutralization. What is the concentration for the sulphuric acid?

(Relative atomic masses: H = 1.0, O = 16.0, S = 32.1)

A. 61.3 g dm^{-3}
B. 122.6 g dm^{-3}
C. 183.9 g dm^{-3}
D. 245.2 g dm^{-3}

CE03_30

40 cm^3 of 2 M hydrochloric acid was mixed with 40 cm^3 of 2 M sodium hydroxide solution in a polystyrene cup and the maximum rise in temperature was recorded. Which of the following pairs of solutions, upon mixing, would produce a similar rise in temperature?

A. 40 cm^3 of 2 M ethanoic acid and 40 cm^3 of 2 M potassium hydroxide solution
B. 40 cm^3 of 2 M ethanoic acid and 40 cm^3 of 2 M ammonia solution
C. 40 cm^3 of 2 M nitric acid and 40 cm^3 of 2 M potassium hydroxide solution
D. 40 cm^3 of 2 M nitric acid and 40 cm^3 of 2 M ammonia solution

CE03_43

Which of the following pairs of solution would form a precipitate when they are mixed?

(1) $NH_4Cl(aq)$ and $K_2SO_4(aq)$
(2) $NH_3(aq)$ and $Pb(NO_3)_2(aq)$
(3) $(NH_4)_2CO_3(aq)$ and $CaCl_2(aq)$

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE05SP_17

Consider the following equation:

$$O_2(g) + 4Fe(OH)_2(x) \longrightarrow 2Fe_2O_3(y) + 4H_2O(z)$$

Which of the following combinations is correct?

	x	y	z
A.	s	s	l
B.	s	aq	aq
C.	aq	s	aq
D.	aq	aq	l

CE05SP_18

A white solid dissolves in water to give a colourless solution. The solution reacts with dilute hydrochloric acid to give a gas. The solid is probably

A. calcium oxide.
B. calcium carbonate.
C. potassium hydroxide.
D. potassium carbonate.

CE05SP_36

A sample of connected sulphuric acid has density of 1.83 g cm^{-3} and contains 94% of sulphuric acid by mass. What is the concentration (correct to one decimal place) of sulphuric acid in the sample?

A. 17.5 M
B. 18.3 M
C. 18.7 M
D. 19.8 M

CE05SP_45

In an experiment, zinc granules are allowed to react with 100 cm^3 of 2 M sulphuric acid at room temperature and pressure. In which of the following situations would the rate of reaction be increased at the initial stage?

(1) using the same mass of zinc which is in powder form
(2) adding some ice to the reaction mixture
(3) using 200 cm^3 of 2 M sulphuric acid instead of 100 cm^3 of 2 M sulphuric acid

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE04_08

Which of the following pairs of ions would react together to form a white precipitate?

A. $Ca^{2+}(aq)$ and $SO_4^{2-}(aq)$
B. $Cu^{2+}(aq)$ and $NO_3^-(aq)$
C. $Ni^{2+}(aq)$ and $CO_3^{2-}(aq)$
D. $NH_4^+(aq)$ and $OH^-(aq)$

CE04_11

A white solid is found around the mouth of a reagent bottle containing limewater. The white solid is likely to be

A. calcium oxide.
B. calcium hydroxide.
C. calcium carbonate.
D. calcium hydrogencarbonate.

CE04_14

Chlorine can be prepared from concentrated hydrochloric acid and potassium permanganate according to the following equation:

$$2KMnO_4 + xHCl \longrightarrow 2KCl + 2MnCl_2 + yH_2O + zCl_2$$

What is the value of x?

A. 4
B. 5
C. 8
D. 10

CE04_20

Which of the following concerning aqueous ammonia is correct?

A. It contains both ammonia molecules and ammonium ions.
B. It is commonly used as the active ingredient in toilet cleaners.
C. It reacts with iron(III) sulphate solution to give a green precipitate.
D. It gives a colourless solution with phenolphthalein.

CE04_44

When solid acid is added to an aqueous solution of sodium hydrogencarbonate, the mixture fizzes. Which of the following ions/ compounds are responsible for the fizz?

(1) sodium ions
(2) hydrogencarbonate ions
(3) citric acid
(4) water

A. (1), (2) and (3) only
B. (1), (3) and (4) only
C. (2), (3) and (4) only
D. (1), (2), (3) and (4)

CE05_14

Which of the following compounds has the highest basicity?

A. HCl
B. HCOOH
C. H_2SO_4
D. CH_3COOH

CE05_22

500 cm^3 of calcium hydroxide contains 3.7 g of calcium hydroxide. What is the molarity of the solution?

(Relative atomic masses: H = 1.0, O = 16.0, Ca = 40.1)

A. 0.05M
B. 0.10M
C. 0.13M
D. 0.26M

CE05_29

1st statement	2nd statement
Citric acid is an electrolyte.	When citric acid is dissolved in water, citric acid molecules becomes mobile.

CE05_34

Which of the following statements concerning 20 cm^3 of 1 M CH_3COOH and 10 cm^3 of 1 M H_2SO_4 is correct?

A. They have the same pH values.
B. They have the same electrical conductivity.
C. They react with magnesium at the same rate.
D. They require the same number of moles of sodium hydroxide for complete neutralization.

CE05_38

Which of the following pairs of substances would NOT react together?

A. copper, dilute ethanoic acid
B. copper(II) oxide, dilute ethanoic acid
C. copper(II) hydroxide, dilute sulphuric acid
D. copper(II) carbonate, dilute sulphuric acid

CE05_39

Directions: Q.39 to 41 refer to the following information.

In an experiment to determine the concentration of sulphuric acid in a brand of toilet cleaner, 25.0 cm^3 of the cleaner was first diluted to 250.0 cm^3 with distilled water. Upon titration with 0.950 M sodium hydroxide solution using phenolphthalein as indicator, 25.0 cm^3 of the diluted cleaner required 27.1 cm^3 of the sodium hydroxide solution to reach the end point.

Which of the following types of apparatus should be used to measure 25.0 cm^3 of the toilet cleaner?

A. pipette
B. burette
C. measuring cylinder
D. volumetric flask

CE05_40

What is the colour change at the end point of the titration?

A. from colourless to pink
B. from pink to colourless
C. from yellow to red
D. from red to yellow

CE05_41

What is the concentration of sulphuric acid in the undiluted toilet cleaner?

A. 1.29 M
B. 2.58 M
C. 5.15 M
D. 10.3 M

CE05_50

1st statement	2nd statement
2 M hydrochloric acid reacts faster with 1 g of zinc granules than with 1 g of zinc powder.	The surface area of 1 g of zinc powder is larger than that of 1 g of zinc granules.

CE06_07

Compound X is soluble in water. Addition of sodium hydroxide solution to a solution of X gives a white precipitate. The precipitate does not dissolve upon the addition of excess alkali. X may be

A. $MgCl_2$
B. $ZnCl_2$
C. $FeSO_4$
D. $(NH_4)_2SO_4$

CE06_10

Solution X is prepared by mixing 100.0 cm^3 of 2.0 M $Na_2SO_4(aq)$ with 50.0 cm^3 of 1.0 M $NaNO_3(aq)$. What is the concentration of $Na^+(aq)$ ions in X?

A. 1.5 M
B. 1.7 M
C. 3.0 M
D. 3.3 M

CE06_28

1st statement	2nd statement
Solid citric acid reacts with magnesium to give hydrogen.	Citric acid contains ionisable hydrogen atoms.

CE06_31

Oxalic acid is a dibasic acid. 10.0 cm^3 of an aqueous solution of oxalic acid requires 30.0 cm^3 of 0.10 M KOH(aq) for complete neutralization. What is the concentration of the oxalic acid solution?

A. 0.15 M
B. 0.20 M
C. 0.30 M
D. 0.60 M

CE06_39

Which of the following solutions when mixed with 50.0 cm^3 of 1.0 M hydrochloric acid would NOT result in a change in pH?

A. 50.0 cm^3 of 1.0 M sodium chloride solution
B. 50.0 cm^3 of 1.0 M ethanoic acid
C. 50.0 cm^3 of 1.0 M nitric acid
D. 50.0 cm^3 of 1.0 M sulphuric acid

CE06_47

In a titration experiment, which of the following apparatus should be rinsed with the solution it is about to contain?

(1) burette
(2) pipette
(3) conical flask

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE06_48

1st statement	2nd statement
Carbon dioxide can effectively be prepared by the action of dilute sulphuric acid on calcium carbonate.	Carbonate reacts with dilute acids to give carbon dioxide.

CE07_15

What is the volume of 0.5 M hydrochloric acid required to react with 1.49 g of lithium oxide for complete neutralization?

(Relative atomic masses: Li = 6.9, O = 16.0)

A. 50 cm^3
B. 100 cm^3
C. 200 cm^3
D. 260 cm^3

CE07_17

20 cm^3 of calcium chloride solution contains 1.0×10^{-2} moles of $Cl^-(aq)$ ions. What is the molarity of the solution?

A. 1.0×10^{-4} M
B. 2.5×10^{-4} M
C. 2.5×10^{-1} M
D. 5.0×10^{-1} M

CE07_35

Different metals are dropped into water or dilute hydrochloric acid. Assuming that the experimental conditions are the same, which of the following comparisons concerning the initial rates of hydrogen formation is correct?

	Initial rate of hydrogen formation		Initial rate of hydrogen formation
A.	Ca and H_2O	>	Ba and HCl
B.	Fe and HCl	>	K and H_2O
C.	K and H_2O	>	Ca and H_2O
D.	Cs and H_2O	>	Ca and H_2O

CE07_47

A student pours two different acids respectively into two test tubes, each containing a piece of magnesium ribbon of the same mass, until the ribbons are completely covered by the acids. If she wishes to compare the relative strength of the acids by observing the initial rate of evolution of gas, which of the following items should be the same?

(1) volume of acids
(2) concentration of the acids
(3) basicity of the acids

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE08_01

Which of the following statements concerning acid rain is INCORRECT?

A. Acid rain refers to rain with pH less than 5.6.
B. Acid rain can corrode iron window frames and marble buildings.
C. One major air pollution that causes the formation of acid rain is carbon dioxide.
D. Acid rain will be formed when the gases discharged by power stations using fossil fuels enter the atmosphere.

CE08_07

30.0 cm^3 of 0.10 M KOH is completely neutralized by 20.0 cm^3 of dilute H_2SO_4 to form K_2SO_4 solution. What is the molarity of the salt solution obtained?

A. 0.03 M
B. 0.05 M
C. 0.06 M
D. 0.10 M

CE08_17

The basicity of an acid is

A. a value to express the concentration of the acid.
B. the number of hydrogen atoms in one acid molecule.
C. the number of moles of any base which can completely react with one mole of the acid.
D. the number of hydrogen ions which can be produced by complete ionization of one acid molecule.

CE08_20

A small piece of potassium is dropped into a trough of water containing methyl orange. Which of the following observations is/are correct?

(1) The potassium moves about on the water surface with a hissing sound.
(2) The potassium dissolves in water and the solution turns red.
(3) The potassium burns with a golden yellow flame.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE08_30

1st statement	2nd statement
If concentrated hydrochloric acid is dripped onto one's hand, one should wash the hand immediately with concentrated ammonia solution.	Concentrated ammonia solution is a weak alkali.

CE08_33

When calcium granules are added to water, colourless gas bubbles are formed. The mixture is then filtered to obtain a clear solution. Which of the following is correct if excess dilute hydrochloric acid is added to the clear solution?

A. Gas bubbles are formed.
B. There is no visible change.
C. A white precipitate is formed.
D. The clear solution turns brick red.

CE08_37

The following table shows some information on mixing hydrochloric acid with sodium hydroxide solution:

Mixture			Temperature rise / °C
25 cm^3 of 1 M HCl	+	25 cm^3 of 1 M NaOH	w
50 cm^3 of 1 M HCl	+	50 cm^3 of 1 M NaOH	x
25 cm^3 of 2 M HCl	+	25 cm^3 of 2 M NaOH	y
50 cm^3 of 2 M HCl	+	50 cm^3 of 2 M NaOH	z

Which of the following concerning the values of temperature rise is correct?

A. $w < x < y < z$
B. $w < x = y < z$
C. $w = y < x = z$
D. $w = x < y = z$

CE08_43

Which of the following pieces of apparatus should be used when an acid is titrated with an alkali?

(1) burette
(2) pipette
(3) conical flask

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE08_45

In an experiment, a solution containing 3 moles of KOH reacts with another solution containing 1 mole of an acid for complete neutralization. Which of the following deduction is/are correct?

(1) 1 mole of the acid provides 3 moles of $H^+(aq)$ ions.
(2) The acid is three times as concentrated as the KOH(aq).
(3) The acid is a strong acid.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE09_10

X is an acid. 25.0 cm^3 of 0.20 M solution X requires 30.0 cm^3 of 0.50 M sodium hydroxide solution for complete neutralization. What is the basicity of X?

A. 1
B. 2
C. 3
D. 4

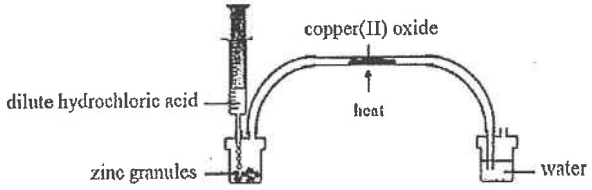
CE09_14

Which of the following is NOT an industrial product made from sulphuric acid?

A. fertilizer
B. paint additive
C. soapless detergent
D. sulphur dioxide preservative

CE09_17

This question refers to the following micro-scale experiment.



Which of the following types of reaction is/are involved in the experiment?

(1) redox reaction
(2) neutralization
(3) thermal decomposition

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE09_23

Which of the following substances can be used to distinguish between magnesium nitrate solution and silver nitrate solution?

(1) zinc strip
(2) ammonium nitrate solution
(3) potassium chloride solution

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE09_29

1st statement	2nd statement
Copper(II) carbonate dissolves in water to give a blue solution.	All solid compounds with copper(II) as the only cations are blue in colour.

CE09_32

Which of the following chemicals can best be used to remove the oil dirt inside the drainage pipe in kitchen?

A. nitric acid
B. sodium chloride
C. hydrochloric acid
D. sodium hydroxide

CE09_35

Directions: Questions 35 and 36 refer to the following information.

The table below shows how solutions X and Y are respectively made from two monobasic acids A and B.

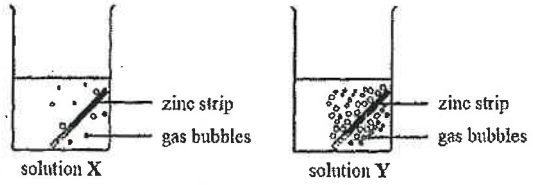
solution X	solution Y
40 cm^3 of 0.2 M acid A + 10 cm^3 of distilled water	20 cm^3 of 0.4 M acid B + 30 cm^3 of distilled water

What is the concentration of acid A in solution X?

A. 0.2 M
B. 0.16 M
C. 0.01 M
D. 0.008 M

CE09_36

Two identical zinc strips are added to solutions **X** and **Y**. The diagrams below show how gas bubbles are given out when the zinc strips are just added to the solutions.



Which of the following deductions is correct?

A. Acid **A** is weaker than acid **B**.
B. Acid **B** is weaker than acid **A**.
C. The concentration of acid **A** in solution **X** is higher than that of acid **B** in solution **Y**.
D. The concentration of acid **B** in solution **Y** is higher than that of acid **A** in solution **X**.

CE09_37

Comparing the same volume of 0.5 M NaOH(aq) and 0.5 M NH_3(aq), which of the following is NOT correct?

	0.5M NaOH(aq)	0.5M NH_3(aq)
A.	higher pH	lower pH
B.	higher electrical conductivity	lower electrical conductivity
C.	forms precipitate with $FeSO_4$ solution	does not form precipitate with $FeSO_4$ solution
D.	larger temperature rise when completely neutralized by 1 M HCl	smaller temperature rise when completely neutralized by 1 M HCl

CE09_48

1st statement	2nd statement
All salt solutions are neutral.	All salts are formed from neutralization.

CE10_19

Besides pipette, which of the following apparatus must be used in order to prepare 250.0 cm^3 of 0.100 M Na_2CO_3(aq)?

A. burette
B. conical flask
C. volumetric flask
D. measuring cylinder

CE10_20

A mixture of $(NH_4)_2SO_4$(aq) and $MgSO_4$(aq) is heated with excess NaOH(aq). Which of the following observations is correct?

A. No pungent gas is evolved and no precipitate is formed.
B. No pungent gas is evolved but a white precipitate is formed.
C. A pungent gas is evolved but no precipitate is formed.
D. A pungent gas is evolved and a white precipitate is formed.

CE10_23

The oxide of metal **Z** reacts with dilute hydrochloric acid to form a colourless solution. Which of the following metals may **Z** be?

(1) zinc
(2) copper
(3) silver

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE10_28

1st statement	2nd statement
Solid citric acid can turn dry blue litmus paper red.	Solid citric acid contains hydrogen ions.

CE10_35

Solid acid **T** has a relative molecular mass of 192.0. A sample of 0.80 g of **T** is dissolved in water to form a solution which requires 25.0 cm^3 of 0.50 M sodium hydroxide solution for complete neutralization. What is the basicity of **T**?

A. 1
B. 2
C. 3
D. 4

CE10_39

20.0 cm^3 of 1.0 M NaCl(aq) is mixed with 10.0 cm^3 of 2.0 M Na_2CO_3(aq). What is the concentration of Na^+(aq) ions in the resulting solution?

A. 1.3M
B. 1.5M
C. 2.0M
D. 3.0M

CE10_40

Which of the following steps should be involved in an experiment to prepare copper(II) sulphate crystals?

A. adding excess $CuCl_2$(s) to H_2SO_4(aq)
B. adding $CuCl_2$(s) to excess H_2SO_4(aq)
C. adding excess CuO(s) to H_2SO_4(aq)
D. Adding CuO(s) to excess H_2SO_4(aq)

CE10_42

Which of the following hazard warning labels should be displayed on a bottle of concentrated hydrochloric acid?

(1) 

(2) 

(3) 

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE10_43

Solution Y is added dropwise to a solution of NaOH containing several drops of phenolphthalein. The mixture changes from pink to colourless. Which of the following substances may Y be?

(1) HCl(aq)
(2) KCl(aq)
(3) Cl_2(aq)

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE10_44

In an experiment, 10 g of zinc granules is added to 100 cm^3 of 1 M HCl(aq) in a beaker. Which of the following changes to the experiment can increase the initial rate of the reaction?

(1) Use 200 cm^3 of 1 M HCl(aq) to replace 100 cm^3 of 1 M HCl(aq).
(2) Use 50 cm^3 of 2 M HCl(aq) to replace 100 cm^3 of 1 M HCl(aq).
(3) 10 g of zinc granules of greater size are used instead.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE10_45

Which of the following reaction is/are neutralization?

(1) $Cu + 4HNO_3 \longrightarrow Cu(NO_3)_2 + 2H_2O + 2NO_2$
(2) $2CH_3COOH + MgO \longrightarrow (CH_3COO)_2Mg + H_2O$
(3) $CH_3COOH + CH_3CH_2OH \rightleftharpoons CH_3COOCH_2CH_3 + H_2O$

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE11_12

Which of the following statements concerning KOH(aq) is correct?

A. The reaction between KOH(aq) and dilute hydrochloric acid is exothermic.
B. There are more hydrogen ions than hydroxide ions in KOH(aq).
C. Adding water to KOH(aq) can increase the pH.
D. KOH(aq) cannot conduct electricity.

CE11_19

What is/are the potential hazard(s) of mixing an acidic toilet cleaner with chlorine bleach?

(1) A toxic gas is liberated.
(2) A large amount of heat is given out.
(3) A flammable substance is produced.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE11_20

Which of the following gases can be dried by using concentrated sulphuric acid?

(1) ammonia
(2) sulphur dioxide
(3) hydrogen chloride

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE11_24

Gas Y dissolves in water to form an acidic solution. Which of the following gases would Y be?

(1) oxygen
(2) chlorine
(3) sulphur dioxide

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE11_28

1st statement	2nd statement
Unpolluted rainwater can erode limestone.	Carbon dioxide in air dissolves in unpolluted rainwater to form carbonic acid.

CE11_29

1st statement	2nd statement
Dilute ethanoic acid can conduct electricity.	Ethanoic acid molecules ionize in water to produce mobile ions.

CE11_43

In an experiment, 10 cm^3 of 1.0 M sulphuric acid is mixed with 30 cm^3 of 0.5 M sodium hydroxide solution. Which of the following statements concerning this experiment is/are correct?

(1) 0.015 mole of water is formed.
(2) The pH of the resulting mixture is greater than 7.
(3) After water is completely evaporated from the resulting mixture, pure sodium sulphate solid can be obtained.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

ASL05(I)_01

Which of the following substances can be used to dry $SO_2(g)$?

A. $Al_2O_3(s)$
B. $PbO_2(s)$
C. $P_4O_{10}(s)$
D. $CaO(s)$

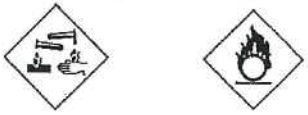
ASL12(I)_03

Which of the following salts will produce an aqueous with pH greater than 7 at 298K?

A. $NaNO_3$
B. NaCN
C. NH_4NO_3
D. KCl

DSE11SP_08

The following hazard warning labels are displayed on the reagent bottle of an acid.



What information about this acid can be obtained from the labels?

A. It is very concentrated and flammable.
B. It is very concentrated and oxidizing.
C. It is flammable and corrosive,
D. It is corrosive and oxidizing.

DSE11SP_14

500 cm^3 of calcium hydroxide solution contains 3.7 g of calcium hydroxide. What is the molarity of the solution?

(Relative atomic masses : H = 1.0, O = 16.0, Ca = 40.1)

A. 0.05 M
B. 0.10 M
C. 0.13 M
D. 0.26 M

DSE11SP_16

In an experiment to determine the concentration of sulphuric acid in a brand of toilet cleaner, 25.0 cm^3 of the cleaner was first diluted to 250.0 cm^3 with distilled water. Upon titration with 0.950 M sodium hydroxide solution using phenolphthalein as indicator, 25.0 cm^3 of the diluted cleaner required 27.1 cm^3 of the sodium hydroxide solution to reach the end point?

Which of the following types of apparatus should be used to measure 25.0 cm^3 of the toilet cleaner?

A. Pipette
B. Burette
C. Measuring cylinder
D. Volumetric flask

DSE11SP_17

In an experiment to determine the concentration of sulphuric acid in a brand of toilet cleaner, 25.0 cm^3 of the cleaner was first diluted to 250.0 cm^3 with distilled water. Upon titration with 0.950 M sodium hydroxide solution using phenolphthalein as indicator, 25.0 cm^3 of the diluted cleaner required 27.1 cm^3 of the sodium hydroxide solution to reach the end point?

What is the color change at the end point of the titration?

A. From colorless to pink
B. From pink to colorless
C. From yellow to red
D. From red to yellow

DSE11SP_18

In an experiment to determine the concentration of sulphuric acid in a brand of toilet cleaner, 25.0 cm^3 of the cleaner was first diluted to 250.0 cm^3 with distilled water. Upon titration with 0.950 M sodium hydroxide solution using phenolphthalein as indicator, 25.0 cm^3 of the diluted cleaner required 27.1 cm^3 of the sodium hydroxide solution to reach the end point?

What is the concentration of sulphuric acid in the undiluted toilet cleaner?

A. 1.29 M
B. 2.58 M
C. 5.15 M
D. 10.3 M

DSE11SP_20

A black powder is suspected to be carbon or a mixture of carbon and copper(II) oxide. Which of the following methods can be used to identify the black powder?

(1) Adding dilute sulphuric acid to the powder.
(2) Adding sodium hydroxide solution to the powder.
(3) Heating the powder strongly.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE12PP_08

At 298 K, the pH of 0.10 mol dm^{-3} HCl(aq) is 1. Which of the following statements is correct?

A. At 298 K, the pH of 0.20 mol dm^{-3} HCl(aq) is 2.
B. At 298 K, the pH of 0.20 mol dm^{-3} HCl(aq) is 0.5.
C. At 298 K, the pH of 0.01 mol dm^{-3} HCl(aq) is 2.
D. At 298 K, the pH of 0.01 mol dm^{-3} HCl(aq) is 0.1.

DSE12PP_09

When 25 cm^3 of 1.00 mol dm^{-3} NaOH(aq) is mixed with 25 cm^3 of 1.00 mol dm^{-3} HCl(aq), the temperature of the mixture rises by 6°C. Which of the following reactants, when mixed under the same conditions, would give a similar temperature rise?

A. 25 cm^3 of 2.00 mol dm^{-3} NaOH(aq) and 25 cm^3 of 2.00 mol dm^{-3} HCl(aq)
B. 50 cm^3 of 1.00 mol dm^{-3} NaOH(aq) and 50 cm^3 of 1.00 mol dm^{-3} HCl(aq)
C. 50 cm^3 of 0.50 mol dm^{-3} NaOH(aq) and 50 cm^3 of 0.50 mol dm^{-3} HCl(aq)
D. 100 cm^3 of 0.25 mol dm^{-3} NaOH(aq) and 100 cm^3 of 0.25 mol dm^{-3} HCl(aq)

DSE12PP_13

10 cm^3 of 0.25 mol dm^{-3} calcium nitrate solution is mixed with 40 cm^3 of 0.10 mol dm^{-3} nitric acid. What is the concentration of nitrate ions in the resulting solution?

A. 0.18 mol dm^{-3}
B. 0.13 mol dm^{-3}
C. 0.080 mol dm^{-3}
D. 0.050 mol dm^{-3}

DSE12PP_19

Which of the following reagents would undergo neutralization with limewater?

(1) HCl(aq)
(2) Na_2SO_4(aq)
(3) SO_2(g)

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE12PP_20

A salt has the formula $(NH_4)_2SO_4 \cdot FeSO_4 \cdot 6H_2O$. Which of the following is/are the expected observation(s) when an aqueous solution of this salt is treated with aqueous sodium hydroxide solution?

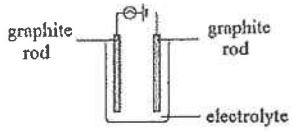
(1) formation of a dirty green precipitate
(2) formation of a brown precipitate
(3) evolution of a gas with a pungent odor

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE12PP_24

Which of the following methods can be used to distinguish between 0.1 mol dm^{-3} HCl(aq) and 0.1 mol dm^{-3} CH_3CO_2H(aq)?

(1) Add magnesium ribbon of the same length to each solution and compare the rate of evolution of gas bubbles.
(2) Add 10 cm^3 of 0.1 mol dm^{-3} NaOH(aq) to 10 cm^3 of each solution and compare the temperature change.
(3) Use each solution as electrolyte in the set-up shown below and compare the brightness of the bulb.



A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE12_02

A small amount of a powder can dissolve in water to form a clear solution. When this solution is mixed with K_2CO_3(aq), a white precipitate is obtained. What can the powder be?

A. Sodium sulphate
B. Calcium sulphate
C. Sodium hydroxide
D. Calcium hydroxide

DSE12_04

Which of the following statements concerning CH_3COOH and HCl is correct?

A. CH_3COOH is a stronger acid than HCl.
B. The pH of 0.1 M CH_3COOH(aq) is lower than that of 0.1 M HCl(aq).
C. Both CH_3COOH(aq) and HCl(aq) react with NH3(aq), each giving a salt.
D. Both CH_3COOH(aq) and HCl(aq) react with Ag(s), each giving a colorless gas.

DSE12_10

A sample of 1.02 g of potassium hydrogenphthalate ($C_8H_5O_4K$) is dissolved completely in distilled water, and then diluted to 250.0 cm^3. What is the concentration of the solution obtained?
(Relative atomic masses : H = 1.0, C = 12.0, O = 16.0, K = 39.1)

A. 0.004 M
B. 0.010 M
C. 0.020 M
D. 4.080 M

DSE12_14

Which of the following pairs of reactants would react in water to give out the largest amount of heat?

A. 1 mol of HCl and 2 mol of KOH
B. 1 mol of H_2SO_4 and 2 mol of KOH
C. 1 mol of $(COOH)_2$ and 2 mol of KOH
D. 1 mol of CH_3COOH and 1 mol of KOH

DSE12_19

In which of the following processes would a colorless gas evolve?

(1) Magnesium is added to dilute sulphuric acid.
(2) Ammonium chloride is heated with calcium hydroxide.
(3) Water is added to a solid mixture of citric acid and sodium hydrogencarbonate.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE12_20

Which of the following methods can be used to distinguish between $ZnCl_2$(aq) and $CaBr_2$(aq)?

(1) Adding NH_3(aq)
(2) Performing flame test
(3) Evaporating to dryness

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE13_03

Solid **Y** is soluble in cold water. When an aqueous solution of **Y** is added separately to sodium hydroxide solution and to acidified silver nitrate solution, a white precipitate is formed in both cases. Which of the following compounds might **Y** be?

A. Ammonium carbonate
B. Zinc carbonate
C. Lead(II) chloride
D. Magnesium chloride

DSE13_08

Which of the following reaction routes can best be used to prepare barium sulphate from barium carbonate?

A. $BaCO_3(s) \xrightarrow{H_2SO_4(aq)} BaSO_4(s)$

B. $BaCO_3(s) \xrightarrow{\text{conc. } H_2SO_4} BaSO_4(s)$

C. $BaCO_3(s) \xrightarrow{HCl(aq)} BaCl_2(aq) \xrightarrow{H_2SO_4(aq)} BaSO_4(s)$

D. $BaCO_3(s) \xrightarrow{\text{conc. } HCl} BaCl_2(aq) \xrightarrow{Na_2SO_4(aq)} BaSO_4(s)$

DSE13_09

Which of the following statements about potassium hydroxide solution is INCORRECT?

A. When potassium hydroxide solution is added to iron(III) sulphate solution, a dirty green precipitate is formed.
B. When potassium hydroxide solution is heated with ammonium chloride solution, ammonia gas is liberated.
C. Dilute potassium hydroxide solution contains $K^+(aq)$ ions, $H^+(aq)$ and $OH^-(aq)$ ions.
D. Concentrated potassium hydroxide solution is corrosive.

DSE13_10

Consider the four solution **W**, **X**, **Y** and **Z** listed below:

W: 0.01 mol dm^{-3} $HNO_3(aq)$
X: 0.01 mol dm^{-3} $H_2SO_4(aq)$
Y: 0.01 mol dm^{-3} $KOH(aq)$
Z: 0.10 mol dm^{-3} $KOH(aq)$

Which of the following represents the four solutions arranged in increasing order of pH?

A. W, X, Y, Z
B. W, X, Z, Y
C. X, W, Y, Z
D. X, W, Z, Y

DSE13_11

Which of the following pairs of aqueous solutions, when mixed, would give a precipitate?

A. Lead(II) nitrate and ammonia
B. Copper(II) sulphate and sodium nitrate
C. Calcium chloride and sodium nitrate
D. Iron(II) sulphate and acidified potassium dichromate

DSE14_06

50.0 cm^3 of 0.6 M $FeSO_4(aq)$ is mixed with 150.0 cm^3 of 0.2 M $Fe_2(SO_4)_3(aq)$. What is the concentration of $SO_4^{2-}(aq)$ ions in the resulting mixture?

A. 0.3 M
B. 0.4 M
C. 0.6 M
D. 0.8 M

DSE14_07

Which of the following pairs of aqueous solutions, upon mixing, would have the lowest electrical conductivity?

A. 20.0 cm^3 of 0.1 M HNO_3 and 20.0 cm^3 of 0.1 M KOH
B. 20.0 cm^3 of 0.1 M H_2SO_4 and 20.0 cm^3 of 0.1 M $Ba(OH)_2$
C. 20.0 cm^3 of 0.1 M CH_3COOH and 20.0 cm^3 of 0.1 M NH_3
D. 20.0 cm^3 of 0.1 M HCl and 20.0 cm^3 of 0.1 M $C_6H_{12}O_6$ (glucose)

DSE14_13

Which of the following gases, after dissolved in 1 dm^3 of water, would give a solution with the highest pH?

A. 0.002 mol of NO_2
B. 0.002 mol of SO_2
C. 0.002 mol of NH_3
D. 0.002 mol of HCl

DSE14_15

Which of the following hazard warning labels should be displayed on both the reagent bottle storing concentrated sulphuric acid and the reagent bottle storing concentrated hydrochloric acid?

(1) 
(2) 
(3) 

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE14_21

Which of the following processes would show a blue color?

(1) adding litmus to NaOH(aq)

(2) mixing $CuSO_4(s)$ and $NH_3(aq)$

(3) $K_3Fe(CN)_6(aq)$ and $FeCl_2(aq)$

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE15_01

Which of the following statements is correct?

A. All aqueous solutions contain $H^+(aq)$ ions.
B. The pH of all acid solutions is greater than zero.
C. All acidic compounds contain hydrogen as their constituent elements.
D. A 'corrosive' hazard warning label must be displayed on all reagent bottles containing acid solution.

DSE15_04

Which of the following salts CANNOT be prepared from the reaction of a metal with a dilute acid?

A. Zinc sulphate
B. Iron(II) chloride
C. Calcium chloride
D. Copper(II) sulphate

DSE15_08

In an experiment, 25.0 cm^3 of HCl(aq) is measured with apparatus X and is placed in apparatus Y. The HCl(aq) in Y is then titrated with a standard NaOH(aq). Which of the following combinations is correct?

	X	Y
A.	Measuring cylinder	Beaker
B.	Measuring cylinder	Conical flask
C.	Pipette	Beaker
D.	Pipette	Conical flask

DSE15_09

In an experiment to prepare calcium sulphate, excess dilute sulphuric acid is added to 10.0 cm^3 of 1.0 mol dm^{-3} calcium nitrate solution. Which of the following is the theoretical mass of the calcium sulphate obtained? (Relative atomic masses: O = 16.0, S = 32.1, Ca = 40.1)

A. 0.68 g
B. 1.36 g
C. 2.72 g
D. 4.08 g

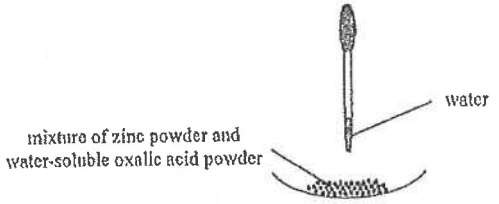
DSE16_06

The pH of a sample of sulphuric acid is 2.6. 100 cm^3 of this sample is mixed with 100 cm^3 of water. What is the pH of the resulting mixture?

A. 5.8
B. 2.9
C. 2.6
D. 1.3

DSE16_07

Consider the following experimental set-up



A colorless gas is given out when water is dropped to the mixture. Which of the following statements is correct?

A. Oxalic acid ionizes in water to give hydrogen ions.
B. Zinc ionizes in water to give zinc ions.
C. Water reacts with oxalic acid to give the colorless gas.
D. Water reacts with zinc to give the colorless gas.

DSE16_08

Which of the following pairs of substances, when mixed together, can be used to prepare copper(II) sulphate crystals?

A. CuO(s) and $H_2SO_4(aq)$
B. CuO(s) and $MgSO_4(aq)$
C. Cu(s) and $H_2SO_4(aq)$
D. Cu(s) and $MgSO_4(aq)$

DSE16_18

Which of the following statements concerning vinegar is/are correct?

(1) The process of forming hydrogen ions in vinegar is reversible.

(2) Neutralization occurs when sugar is added to vinegar.

(3) The pH of vinegar used in kitchen is around 1.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE16_19

The hazard warning label below is displayed on a bottle containing chemical Z:
Which of the following chemicals may Z be?

(1) Sodium
(2) Trichloromethane
(3) Concentrated aqueous ammonia

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE16_22

Which of the following processes are exothermic?

(1) Placing calcium oxide in water
(2) Placing a zinc strip in a copper(II) sulphate solution
(3) Passing hydrogen chloride gas into a sodium hydroxide solution

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE17_02

Which of the following statements concerning hydrochloric acid is INCORRECT?

A. It is a mineral acid.
B. It completely ionizes in water.
C. It contains aqueous hydrogen ions.
D. It does not contain aqueous hydroxide ions.

DSE17_06

Which of the following is NOT the appropriate substance for preparing magnesium sulphate by directly mixing it with dilute sulphuric acid?

A. Magnesium metal
B. Magnesium oxide
C. Magnesium nitrate
D. Magnesium carbonate

DSE17_10

Calcium phosphate is insoluble in water. What is the theoretical number of moles of calcium phosphate obtained when 100.0 cm^3 of 0.30 mol dm^{-3} $CaCl_2(aq)$ is mixed with 300.0 cm^3 of 0.10 mol dm^{-3} $Na_3PO_4(aq)$?

A. 0.010
B. 0.015
C. 0.020
D. 0.030

DSE17_11

Which of the following statements concerning zinc is correct?

A. It forms a soluble oxide when placed in $NH_3(aq)$.
B. It acts as a reducing agent when placed in HCl(aq).
C. It undergoes oxidation when placed in $MgCl_2(aq)$.
D. It forms an acidic solution when placed in hot $H_2O(l)$.

DSE17_17

Which of the following statements concerning NaOH(aq) and $NH_3(aq)$ is/are correct?

(1) Both of them can react with $MgCl_2(aq)$.
(2) Both of them can form a deep blue solution with $Cu(OH)_2(s)$.
(3) NaOH(aq) can react with CH_3COOH, but $NH_3(aq)$ cannot.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE17_21

Which of the following can distinguish a sample of $AgNO_3(aq)$ from a sample of $NaNO_3(aq)$?

(1) Adding $Cu(NO_3)_2(aq)$ to the samples.
(2) Adding HCl(aq) to the samples
(3) Adding KOH(aq) to the samples.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE18_06

Dilute sodium hydroxide solution is added to a 0.1 M solution until in excess. Which of the following combinations is correct?

	Solution	Observation
A.	Zinc sulphate	White precipitate formed
B.	Calcium nitrate	White precipitate formed
C.	Lead(II) nitrate	Yellow precipitate formed
D.	Iron(III) sulphate	Dirty green precipitate formed

DSE18_10

Which of the following reagents does NOT react with copper?

A. 2 M H_2SO_4
B. 2 M HNO_3
C. 16 M H_2SO_4
D. 16 M HNO_3

DSE18_11

Consider the solutions W, X, Y and Z below:

W	100 cm^3 of 0.20 M $HNO_3(aq)$
X	50 cm^3 of 0.20 M $HCl(aq)$
Y	100 cm^3 of 0.20 M $CH_3CO_2H(aq)$
Z	50 cm^3 of 0.10 M $NaOH(aq)$

Which of the following statements is correct?

A. The pH of Y equals –log 0.2.
B. Mixing W and Z gives a neutral solution.
C. The pH of the mixture of W and X is lower than that of W.
D. The pH of the mixture of W and X is lower than that of the mixture of X and Y.

DSE18_24

Consider the following statements and choose the best answer:

1st statement	2nd statement
To completely neutralize 1 mole of HCl(aq), the number of moles of $NH_3(aq)$ needed is more than the number of moles of KOH(aq) needed.	$NH_3(aq)$ is a weaker alkali than KOH(aq).

DSE19_04

25.00 cm^3 of 0.051 M $C_4H_4O_4(aq)$ can completely neutralise 22.18 cm^3 of 0.115 M KOH(aq). What is the basicity of the acid $C_4H_4O_4$?

A. 1
B. 2
C. 3
D. 4

DSE19_05

25.00 cm^3 of 0.50 M lead(II) nitrate solution is mixed with 50.00 cm^3 of 1.00 M sodium chloride solution. Insoluble lead(II) chloride is formed during mixing. What is the concentration of $Cl^-(aq)$ in the mixture?

A. 0.33 M
B. 0.50 M
C. 0.75 M
D. 1.50 M

DSE19_16

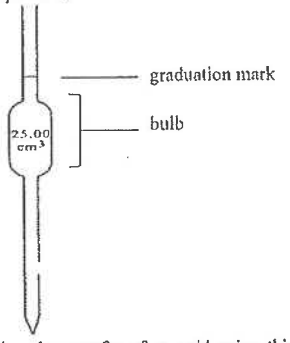
Which of the following chemicals can be used to distinguish concentrated hydrochloric acid from concentrated nitric acid?

(1) Sodium carbonate solid
(2) Silver nitrate solution
(3) Copper metal

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE19_21

The diagram below shows a common glass apparatus :



Which of the following statements concerning the transfer of an acid using this apparatus are INCORRECT?

(1) The bulb should be firmly held in the hand when being filled with acid.
(2) Exactly 20.00 cm^3 of acid can be transferred using this apparatus.
(3) The apparatus should first be rinsed by distilled water, then immediately followed by the transfer of acid.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3) only

DSE19_20

Aqueous calcium hydroxide can be used to

(1) neutralise acidic substances in soil.
(2) distinguish carbon dioxide from carbon monoxide.
(3) remove sulphur dioxide from a polluted air sample.

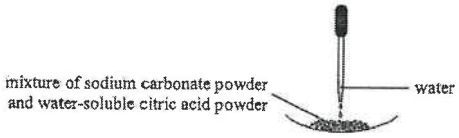
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3) only

DSE2020:

4. Which of the following combinations would give a brown gas when putting X in Y ?

	X	Y
A.	magnesium	concentrated nitric acid
B.	magnesium	concentrated sulphuric acid
C.	magnesium oxide	concentrated sulphuric acid
D.	magnesium oxide	concentrated nitric acid

11. A reaction occurs when water is dropped into the mixture in the set-up below. A colourless gas is given out.



What is the role of water in this reaction ?

A. Water reacts with sodium carbonate to give the colourless gas.
B. Water reacts with citric acid to give the colourless gas.
C. Water is a medium for the formation of carbonate ions from sodium carbonate.
D. Water is a medium for the formation of hydrogen ions from citric acid.

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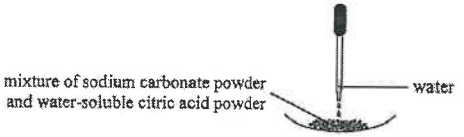

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A. Water reacts with sodium carbonate to give the colourless gas.
B. Water reacts with citric acid to give the colourless gas.
C. Water is a medium for the formation of carbonate ions from sodium carbonate.
D. Water is a medium for the formation of hydrogen ions from citric acid.

17. Which of the following ways is / are acceptable in the storage of the chemical concerned ?

(1) Store concentrated $H_2SO_4(l)$ in a copper container.
(2) Store concentrated $AgNO_3(aq)$ in a brown glass container.
(3) Store concentrated $Pb(NO_3)_2(aq)$ in an iron container.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

18. Which of the following steps can be involved in preparing copper(II) chloride crystals ?

(1) Add $CuCO_3(s)$ to HCl(aq).
(2) Add $Cu(NO_3)_2(s)$ to NaCl(aq).
(3) Add Cu(s) to HCl(aq).

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE2021:

6. Refer to the information in the table below :

Solution	Contents	pH
X	50 cm^3 of 0.001M HCl(aq)	3.0
Y	25 cm^3 of 0.001M $H_2SO_4(aq)$	2.7
Z	50 cm^3 of 0.1M $CH_3COOH(aq)$	2.9

Which of the following statements is correct ?

A. **X** has a higher pH than **Z** because HCl is a stronger acid than CH_3COOH.
B. **Y** has a lower pH than **X** because the volume of $H_2SO_4(aq)$ is smaller than that of HCl(aq).
C. **Y** has a lower pH than **X** because H_2SO_4 is a strong dibasic acid but HCl is a strong monobasic acid.
D. **Y** has a lower pH than **Z** because the concentration of $H_2SO_4(aq)$ is lower than that of $CH_3COOH(aq)$.

5. 15.0 cm^3 of 0.20 M $Ba(NO_3)_2(aq)$ is added to 25.0 cm^3 of 0.10 M $Na_2SO_4(aq)$. After the reaction is completed, which of the following ions has the highest concentration in the mixture ?

A. $SO_4^{2-}(aq)$
B. $NO_3^-(aq)$
C. $Ba^{2+}(aq)$
D. $Na^+(aq)$

13. **W**, **X**, **Y** and **Z**, each represents one of the following solutions :

HCl(aq) NaOH(aq) $MgCl_2(aq)$ $Na_2CO_3(aq)$

Given that :

- Mixing **W** and **X** gives a white precipitate.
- Mixing **W** and **Y** gives a white precipitate.
- Mixing **W** and **Z** gives a clear colourless solution.

What is **Z** ?

A. HCl(aq)
B. NaOH(aq)
C. $MgCl_2(aq)$
D. $Na_2CO_3(aq)$

16. A sample of sulphuric acid was completely neutralised by 25.0 cm^3 of 0.200 M potassium hydroxide solution. The salt solution obtained was then made up to 100.0 cm^3 with deionised water. What is the concentration of the resulting salt solution ?

A. 0.0125 M
B. 0.0250 M
C. 0.0375 M
D. 0.0500 M

24. Consider the following statements and choose the best answer :

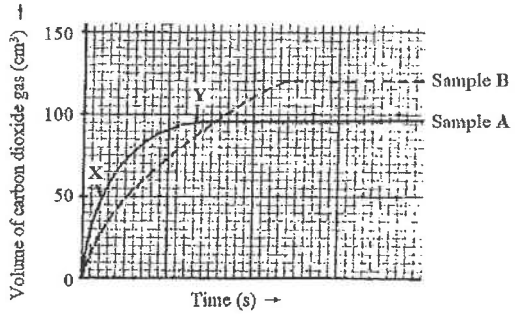
1st statement	2nd statement
Iron(II) hydroxide is a base.	Iron(II) hydroxide is insoluble in water.

A. Both statements are true and the 2nd statement is a correct explanation of the 1st statement.
B. Both statements are true but the 2nd statement is NOT a correct explanation of the 1st statement.
C. The 1st statement is false but the 2nd statement is true.
D. Both statements are false.

Structural Questions

CE90_02b

Two different samples of calcium carbonate (A and B), each weighing 0.8 g and containing inert impurities, were allowed to react with excess hydrochloric acid under same laboratory conditions. The volumes of carbon dioxide gas evolved with time are shown in the graph below:



(i) Draw a diagram to show how the above experiment can be performed in the laboratory.
(ii) Explain why the slopes of the curve for sample A is steeper at X than at Y.
(iii) From the two curves, deduce TWO differences between sample A and sample B.

(7 marks)

CE90_03b

The formula of a weak alkanoic acid can be represented by

$C_nH_{2n+1}CO_2H$ (where n is an integer)

A sample of the alkanoic acid weighing 0.355 g was dissolved in about 20 cm^3 of water in a conical flask. The solution was then titrated against a 0.18 M sodium hydroxide solution. A total of 22.40 cm^3 of the alkali was required for complete neutralization.

(i) Explain the meaning if the term 'weak acid'
(ii) Describe how the end-point in this titration can be determined.
(iii) Calculate
  (1) the number of moles of sodium hydroxide used for the titration.
  (2) the relative molecular mass of the alkanoic acid.

(8 marks)

CE91_02a

A student wished to find out which of the two commercial brands of vinegar, A and B, was the better buy, i.e. of lower price per gram of ethanoic acid (CH_3COOH).

The following table listed some of the information about these two brands:

Brand	Price	Volume of vinegar	Concentration of ethanoic acid
A	\$3.00	250 cm^3	50 g dm^{-3}
B	\$6.00	500 cm^3	UNKNOWN

The student carried out a titration experiment to determine the concentration of ethanoic acid in Brand B as follows:

25 cm^3 of the vinegar was first diluted to 250 cm^3 with distilled water. 25.0 cm^3 portions of the diluted solution were then titrated against 0.10 M sodium hydroxide solution, using a suitable indicator, until the end-point was reached.

The following results were obtained:

Titration / Burette reading	1	2	3	4
Final reading (cm^3)	25.50	25.70	26.20	25.90
Initial reading (cm^3)	0.00	1.00	1.30	1.10

(i) Describe, giving the names of the apparatus used, how 25.0 cm^3 of the vinegar should be diluted to 250.0 cm^3.

(ii) Suggest a suitable indicator for this titration and state its color change at the end-point.

(iii) Based on the titration results, calculate a reasonable average for the volume of the sodium hydroxide solution used.

(iv) Write the equation for this reaction. (Ionic equation will not be accepted.)

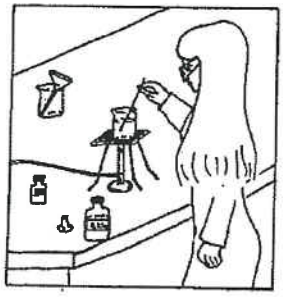
(v) Calculate the molarity of ethanoic acid in Brand B.

(vi) Show by calculation which brand of vinegar is the better buy.
(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0)

(13 marks)

CE92_01a

A student tried to prepare a sample of a solid salt by reacting copper(II) oxide with sulphuric acid in the laboratory as shown in the diagram on the right.



The student wrote the following procedure of the experiment in her notebook:

I. Excess copper(II) oxide was added to 50.0 cm^3 of 2.0
II. M sulphuric acid in a beaker.
III. The mixture was heated for 2 minutes, and was stirred
IV. continuously during this time.
The remaining copper(II) oxide was filtered off.
The filtrate was allowed to cool for one day.

(i) Referring to the above diagram, write down **TWO** aspects that are considered **UNSAFE** in the laboratory.

(ii) (1) Name the salt the student tried to prepare.
(2) Calculate the theoretical mass of the salt that can be obtained.

(iii) Explain why the student heated the reaction mixture in step II.

(iv) The student followed exactly the procedure written her notebook, but did not obtain any SOLID salt after one day. Suggest an explanation.
(Relative atomic masses: H = 1.0, O = 16.0, S = 32.0, Cu = 63.5)

(8 marks)

CE93_01b

Liquid wastes discharged from some factories are acidic and need to be neutralized before discharging into the sea. A certain factory used slaked lime (calcium hydroxide) to neutralize its liquid waste, which consisted of 0.5 M hydrochloric acid, discharging at a rate of 20 dm^3 per minute.

(i) Why are the liquid wastes neutralized before discharging into the sea?

(ii) Write an equation for the reaction between hydrochloric acid and slaked lime.

(iii) Calculate the mass of slaked lime required per minute to neutralize the acid present in the liquid waste.

(iv) Although slaked lime is cheaper, factories nowadays use sodium carbonate instead of slaked lime to neutralize their acidic wastes. Suggest a reason.
(Relative atomic masses: H = 1.0; O = 16.0; Ca = 40.0)

(6 marks)

CE93_04b

To determine the percentage by mass of calcium carbonate in egg shells, a student added 10.0 cm^3 of 2 M hydrochloric acid to 0.3 g of egg shells in a container. After 30 minutes, all the egg shells dissolved and 67 cm^3 of carbon dioxide were collected at room temperature and pressure.

(i) Write an equation for the reaction between calcium carbonate and hydrochloric acid.

(ii) The rate of reaction between the egg shells and 2 M hydrochloric acid was slow. Suggest TWO methods to increase the rate of this reaction without using other chemicals. Explain your answer in each case.

(5 marks)

CE94_01

The table below lists some information about three metals X, Y and Z.

Metal	X	Y	Z
Atomic number	12	20	–
Action of cold water	No apparent change	A colourless gas slowly evolves	No apparent change
Action of 0.1 M hydrochloric acid	A colourless gas evolves	–	No apparent change

(a) To which group in the Periodic Table does Y belong?

(b) (i) Write an equation for the reaction between **X** and 0.1 M hydrochloric acid.
(An ionic equation will NOT be accepted for this question.)

(ii) Draw electronic structures for the TWO products formed in (i) above, showing electrons in the outermost shell ONLY.

(c) What would be observed when **Y** is added to 0.1M hydrochloric acid?

(d) Based on the results of the reaction give in the above table, arrange the three metals in descending order of reactivity. Explain your answer.

(8 marks)

CE94_05a

A domestic drain cleaner named "RAINBOW" contains concentrated sulphuric acid as the active ingredient. A student carried out the following experiment to determine the concentration of sulphuric acid in "RAINBOW".

1.0 cm^3 of "RAINBOW" was diluted to 500 cm^3 with distilled water. 25.0 cm^3 of the diluted solution were measured and transferred to a conical flask. The solution in the flask required 18.2 cm^3 of 0.10 M sodium hydroxide solution for complete neutralization.

(i) Name the apparatus used to measure 25.0 cm^3 of the diluted solution.

(ii) Calculate the molarity of sulphuric acid in "RAINBOW".

(iii) Suggest ONE disadvantage of using "RAINBOW" for cleaning drains.

(iv) State ONE safety precaution needed when using "RAINBOW". Explain your answer.

(6 marks)

CE95_07

Effervescent Calcium

Each bottle contains 10 tablets.

Each tablet contains :

Calcium carbonate	625 mg
Vitamin C	1000 mg
Citric acid	1350 mg

Dosage : 1 tablet daily

Administration : Dissolve one tablet in a glass of water.

Warning : (1) Keep out of reach of children.
(2) Keep .....

(i) Effervescence occurs when a tablet of 'Effervescent Calcium' is added to water. Based on the information given on the label, explain why effervescence occurs. Write the ionic equation for the reaction that occurs.

(iii) On the label, some words are missing in the second warning statement. Complete the second warning statement, beginning with the word 'keep'. Explain your answer.

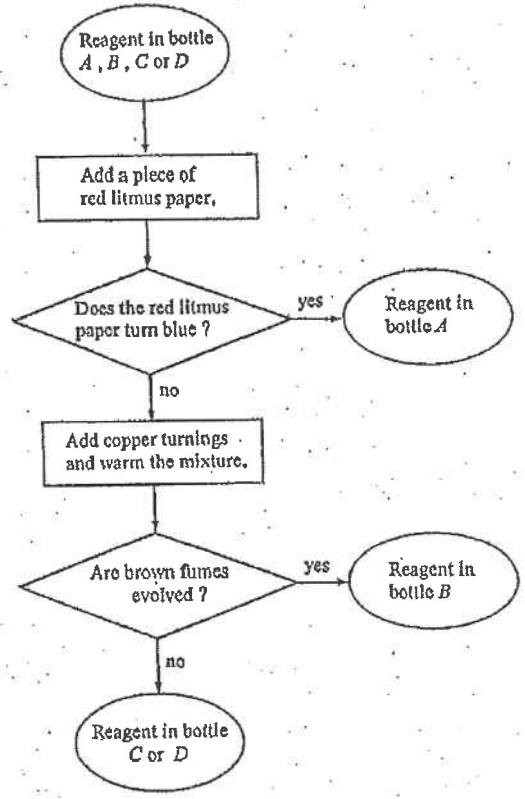
(5 marks)

CE96_06b

A, *B*, *C* and *D* are four unlabeled bottles, each containing one of the following reagents:

2M ammonia solution, 2M ethanoic acid,
2M hydrochloric acid, 2M nitric acid

The following scheme is used to identify the four reagents:



(i) What is the reagent in bottle *A*? Explain why this reagent turned red litmus paper blue.

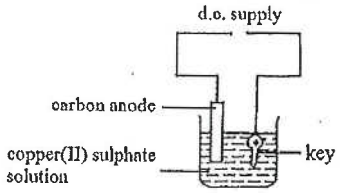
(iii) (1) Suggest a test to distinguish between the reagents in bottles *C* and *D*.
(Smelling the reagents is NOT an acceptable answer.)

(2) State the observable change in this test and explain your answer.

(5 marks)

CE96_09b

A student carried out a copper-plating experiment in the laboratory using the set-up shown below:



In a copper-plating factory, the waste water is treated with sodium hydroxide solution to remove the copper(II) ions present before discharge.

(1) Suggest TWO reasons why it is necessary to remove the copper(II) ions from the waste water before discharge.

(2) 20.0 dm^3 of a sample of waste water requires 3.5 dm^3 of 8.0M sodium hydroxide solution for complete removal of the copper(II) ions present.
Calculate the concentration, in mol dm^{-3}, of copper(II) ions in the sample.

(4 marks)

CE97_03

(a) Suggest ONE method to determine the pH of an aqueous solution.

(b) Arrange the following substances in the order of increasing pH and explain your answer.
1M ethanoic acid, 1M hydrochloric acid, 1M sulphuric acid

(4 marks)

CE97_07a

Malachite is a mineral containing copper(II) carbonate and copper(II) hydroxide. It is insoluble in water but reacts with dilute sulphuric acid. The procedures for preparing copper(II) sulphate crystals from malachite is as follows:

Step 1	Pour 50 cm^3 of 2M sulphuric acid in a beaker and then warm the acid.
Step 2	Add small portions of powdered malachite to the warm acid while constantly stirring, until effervescence stops and some powdered malachite remains in the beaker.
Step 3	Remove the remaining powdered malachite from the solution.
Step 4	Evaporate the solution slowly to obtain copper(II) sulphate crystals.

(i) Write a chemical equation for the reaction which causes the effervescence.

(ii) Why is it necessary to add powdered malachite until some of it remains in the beaker?

(iii) Draw a labelled diagram to show how the remaining powdered malachite can be removed from the solution.

(iv) Calculate the theoretical mass of copper(II) sulphate crystals, $CuSO_4 \cdot 5H_2O$, that can be obtained.
(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0, S = 32.1, Cu = 63.5)

(8 marks)

CE98_06a

(i) A student prepared sodium nitrate solution by reacting 1 M sodium hydroxide solution with dilute nitric acid. The student carried out a titration to determine the amount of dilute nitric acid required to react with a known volume of 1 M sodium hydroxide solution.

(1) Write the chemical equation for the reaction.
(An ionic equation will NOT be accepted for this question.)

(2) Draw a labelled diagram for the set-up of the titration.

(3) Phenolphthalein can be used to determine the end point of the titration. State the colour change at the end point.

(4) Suggest how the student can prepare a sodium nitrate solution using the titration results.

(ii) Sodium nitrate is a nitrogenous fertilizer.

(1) Calculate the percentage by mass of nitrogen in sodium nitrate.

(2) Explain why nitrogen is essential for the growth of plants.
(Relative atomic masses: N = 14.0, O = 16.0, Na = 23.0)

(9 marks)

CE99_02

For each of the following experiments, state ONE observable change and write a chemical equation for the reaction involved.

(a) Dilute nitric acid is added to magnesium carbonate powder in a beaker.

(2 marks)

CE00_02

The table below lists some information about four elements, W, X, Y and Z:

Element	Atomic number	Relative atomic number
W	16	32.1
X	18	39.9
Y	19	39.1
Z	20	40.1

(a) What is the meaning of the term 'relative atomic mass'?

(2 marks)

(b) State, with explanation, which of the above elements

(i) should be stored under paraffin oil.

(ii) is used to fill a light bulb.

(iii) forms an oxide which dissolves in water to give a solution with pH less than 7.

(6 marks)

CE01_02

For each of the following experiments, state an expected observation and write a chemical equation for the reaction involved.

(a) Adding dilute hydrochloric acid to zinc granules.

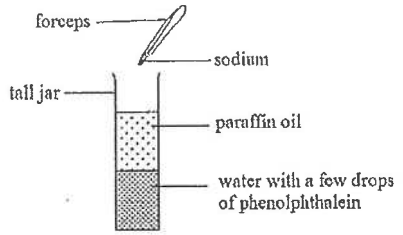
(b) Adding sodium hydroxide solution to iron(II) sulphate solution.

(4 marks)

CE01_04

A small piece of sodium is added to a tall jar containing two layers of liquids, paraffin oil and water with a few drops of phenolphthalein, as shown in the diagram below. Describe and explain all expected observations.

(Density of sodium = 0.97 g cm^{-3}, density of paraffin oil used = 0.82 g cm^{-3})



(6 marks)

CE01_06b

In an experiment, 0.933 g of a sample of washing soda ($Na_2CO_3 \cdot xH_2O$) was dissolved in some distilled water. The solution was titrated against 0.258 M hydrochloric acid with methyl orange as indicator. 25.4 cm^3 of the acid was required for the completion of the following reaction:

$$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2$$

(i) From the titration result, calculate the number of moles of sodium carbonate in the sample of washing soda.

(ii) Deduce the value of x in the formula of the washing soda.

(iii) State the colour change at the end-point of the titration.

(iv) Briefly describe the procedure that should be followed to prepare a burette containing the hydrochloric acid for the titration.

(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0, Na = 23.0)

(9 marks)

CE02_01c

Both ammonium dihydrogenphosphate and ammonium sulphate are nitrogenous fertilizers.

(i) Calculate the percentage by mass of nitrogen in ammonium sulphate.

(ii) The use of ammonium sulphate as a fertilizer adds acidity to the soil. If the soil is too acidic, it is not suitable for plant growth. Suggest ONE substance that is commonly used by farmers to reduce soil acidity. Explain your answer.

(4 marks)

CE02_06a

Magnesium can be extracted from sea water which contains magnesium ions. The extraction of magnesium from sea water involves three stages:

Stage 1: Add slaked lime to sea water to precipitate magnesium ions as magnesium hydroxide.

Stage 2: Heat the magnesium hydroxide obtained in a stream of hydrogen chloride gas to give magnesium chloride.

Stage 3: Extract magnesium by electrolysis of the molten magnesium chloride.

(i) What substance is mainly present in slaked lime?

(ii) Write a chemical equation, with state symbols, for the reaction in Stage 2.

(iii) Explain why molten magnesium chloride can conduct electricity.

(4 marks)

CE02_07a

Calcite is a mineral which contains mainly calcium carbonate. An experiment, consisting of the following five stages, was conducted to determine the percentage by mass of calcium carbonate in a sample of calcite.

Stage 1: Weigh the sample. Add dilute nitric acid to it until the acid is in excess.

Stage 2: Filter the mixture obtained in Stage 1 to remove any undissolved solid.

Stage 3: Add excess sodium sulphate solution to the filtrate to precipitate out calcium sulphate.

Stage 4: Collect the calcium sulphate precipitate and wash it with distilled water.

Stage 5: Allow the calcium sulphate to dry and weigh it.

(i) Write a chemical equation for the reaction of calcium carbonate with dilute nitric acid. Suggest how one can know that excess acid has been added in *Stage 1*.

(ii) Draw a labelled diagram of the set-up used in the filtration process in *Stage 2*.

(iii) Write the ionic equation for the reaction in *Stage 3*.

(iv) Explain why it is necessary to wash the precipitate with distilled water in *Stage 4*.

(v) The results obtained in the experiment are listed below:

Mass of the calcite sample = 7.98 g

Mass of the calcium sulphate obtained = 10.52 g

(1) Calculate the percentage by mass of calcium carbonate in the sample of calcite.

(2) State ONE assumption in the calculation.

(Relative atomic masses: C = 12.0, O = 16.0, S = 32.0, Ca = 40.0)

(10 marks)

CE02_07c

Ammonia was once used to detect the leakage of chlorine in chemical plants. If there was a leakage, white fumes would be observed. The word equation below represents the reaction of chlorine with ammonia:

chlorine + ammonia ⟶ ammonium chloride + nitrogen

(i) Transcribe the word equation into a chemical equation.

(ii) Suggest what the white fumes might have been.

(3 marks)

CE02_09a

Ammonia is a weak alkali. It is used as an active ingredient in domestic glass cleaners.

(i) (1) Write a chemical equation to represent the ionization of ammonia in water.

(2) Explain why an alkaline solution can help remove oily dirt on glass.

(ii) Suggest, with explanation, a precaution necessary when using such glass cleaners.

(4 marks)

CE02_09b

In an experiment to determine the concentration of ammonia in a sample of glass cleaner, 25.0 cm^3 of the sample was diluted to 250.0 cm^3 in a volumetric flask. 25.0 cm^3 of the diluted sample was transferred to a conical flask and was then titrated against 0.23 M hydrochloric acid. 28.7 cm^3 of the acid was required to reach the end-point.

(i) State the liquid that should be used to rinse the following pieces of apparatus used in this experiment.

(1) Volumetric flask.

(2) Conical flask.

(ii) Name the apparatus that should be used to transfer 25.0 cm^3 of the diluted sample to the conical flask.

(iii) Calculate the concentration, in mol dm^{-3}, of ammonia in the sample of glass cleaner.
(You may assume that ammonia is the only substance in the sample that reacts with hydrochloric acid.)

(6 marks)

CE03_08b

An experiment was carried out to determine the concentration of a nickel(II) sulphate solution. The experiment consisted on the following three stages:

Stage 1: 25.0 cm^3 of 0.503 M sodium hydroxide solution was added to 25.0 cm^3 of the nickel(II) sulphate solution to precipitate out nickel(II) hydroxide.

Stage 2: The mixture obtained in Stage 1 was filtered and the residue was washed thoroughly with distilled water.

Stage 3: The excess alkali in the filtrate was titrated against 0.251 M hydrochloric acid with methyl orange as indicator. 18.5 cm^3 of the acid was required to reach the end-point.

(i) Write the ionic equation for the reaction in Stage 1.

(ii) State the colour change at the end-point of the titration in Stage 3.

(iii) (1) Based on the titration result in Stage 3, calculate the number of moles of hydroxide ions present in the filtrate.

(2) Calculate the number of moles of sodium hydroxide that was added in Stage 1.

(iv) Why was it necessary to wash the residue thoroughly in Stage 2?

(9 marks)

CE04_02b

For each of the following pairs of substances, suggest a chemical test to distinguish one substance from the other and state the expected observations.

(b) ammonium chloride and potassium chloride.

(2 marks)

CE04_07a

An experiment, consisting of the three stages listed below, was carried out to determine the basicity of a solid acid.

Stage 1: 1.15 g of a sample of the acid was weighed.

Stage 2: The sample of acid was dissolved in some distilled water and then made up to 250.0 cm^3 with distilled water.

Stage 3: 25.0 cm^3 of the solution obtained in Stage 2 was titrated against 0.100 M sodium hydroxide solution using phenolphthalein as indicator. 25.7 cm^3 of the sodium hydroxide solution was required to reach the end point.

(i) Briefly describe how the 250.0 cm^3 solution was made up in Stage 2.

(ii) State the colour change at the end point of the titration in Stage 3.

(iii) (1) Calculate the number of moles of sodium hydroxide used in the titration.

(2) Given that the molar mass of the solid acid is 90.0 g. Calculate its basicity.

(8 marks)

CE05_03

A student proposed the following methods to accomplish three tasks, (a), (b) and (c). The proposed methods were all considered inappropriate.

(a) *Task:* To neutralize acidic soil in a flower bed.
Proposed method: Add solid sodium hydroxide to soil.

(i) State ONE reason why the method is inappropriate.

(ii) Suggest an appropriate method to accomplish the task

(2 marks)

(b) *Task:* To prepare hydrogen gas from an acid.
Proposed method: Add copper to dilute hydrochloric acid.

(i) State ONE reason why the method is inappropriate.

(ii) Suggest an appropriate method to accomplish the task

(2 marks)

(c) *Task:* To dilute concentrated sulphuric acid with water.
Proposed method: Add water to concentrated sulphuric acid and stir the mixture.

(i) State ONE reason why the method is inappropriate.

(ii) Suggest an appropriate method to accomplish the task

(2 marks)

CE05_10

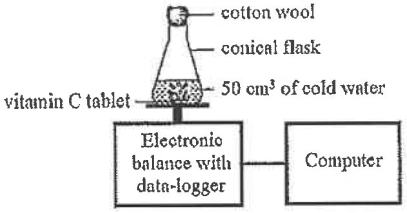
The information below was found on the label of a brand of effervescent vitamin C tablets:

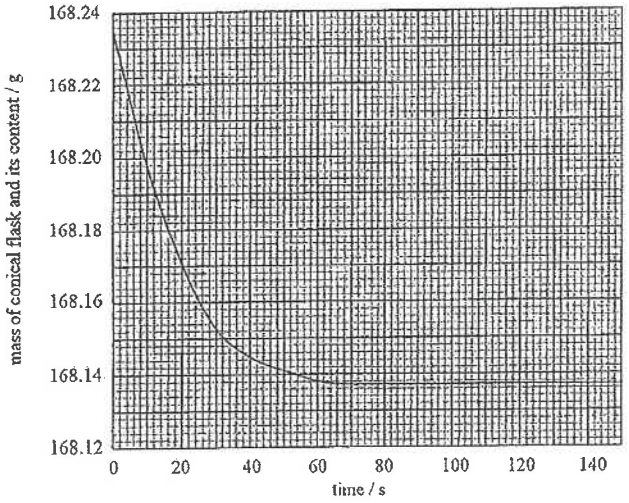
Each tablet contains 1000 mg of vitamin C. Other ingredients: sodium hydrogencarbonate, citric acid, sugar and colourant

(a) With the help of a chemical equation, explain why effervescence occurs when a tablet of the effervescent vitamin C is added to water.

(2 marks)

(b) An experiment was carried out to study the action of water on a tablet of the effervescent vitamin C using the set-up as shown below. The graph shows the results obtained in the experiment.





(i) Find, from the graph, the mass of gas liberated from the reaction of the tablet with water. (You may assume that the gas liberated is NOT soluble in water.)

(ii) At the end of the experiment, the sodium hydrogencarbonate in the tablet had been completely used up. Calculate the mass of sodium hydrogencarbonate present in the tablet.

(iii) Suggest ONE advantage of using a data-logger in this experiment.

(iv) The experiment was repeated using warm water instead of cold water. Sketch, on the same graph, the results that would be obtained in the repeated experiment.

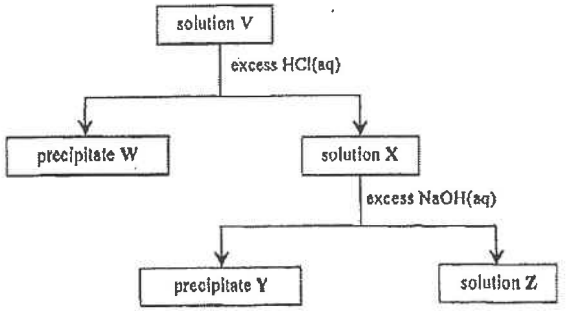
(6 marks)

CE06_04

An aqueous solution V is known to contain the following four cations:

$NH_4^+(aq)$, $K^+(aq)$, $Fe^{3+}(aq)$ and $Ag^+(aq)$

The flow diagram below outlines a series of tests that can be used to detect the presence of two of the above cations in V:



(a) Write an ionic equation, with state symbols, for the formation of W from V.

(1 mark)

(b) Suggest an experimental method that can be used to separate X from W.

(1 mark)

(c) Name Y.

(1 mark)

(d) Z still contains two of the above-mentioned cations. Is it possible to show experimentally the presence of each of these cations in Z? Explain your answer.

(2 marks)

(e) Based on the above information, suggest a colour for V.

(1 mark)

CE06_09

'Soda ash' is crude sodium carbonate (Na_2CO_3) commonly used in treating fresh water in water treatment plants. The following experiment was carried out to determine the percentage by mass of sodium carbonate in a sample of soda ash:

2.00 g of the sample was dissolved in distilled water, and the solution was diluted and made up to 250.0 cm^3. Four portions of the diluted solution of volume 25.0 cm^3 each were titrated against 0.18M hydrochloric acid using methyl orange as indicator. The table below lists the titration results obtained:

Titration / Burette reading	1	2	3	4
Final reading /cm^3	21.00	21.10	25.20	25.20
Initial reading /cm^3	0.00	1.00	5.30	5.20

(a) A 25.0 cm^3 portion of the above diluted solution was transferred to a clean conical flask. Briefly describe how the titration of this portion of the diluted solution should be carried out.

(3 marks)

(b) Based on the titration results, calculate

(i) a reasonable average for the volume of the hydrochloric acid used, and

(ii) the percentage by mass of sodium carbonate in the sample.
(You may assume that the sample does NOT contain any impurity that reacts with hydrochloric acid.)

(5 marks)

(c) Suggest another method for detecting the titration end point without the use of any acid-base indicator.

(1 mark)

(d) Why is soda ash used for treating fresh water? Briefly describe the chemistry involved.

(2 marks)

CE07_05

A solid sample contains zinc and copper only. The composition of the solid sample was analyzed experimentally as outlined below:

2.00 g of the solid sample was added to excess dilute hydrochloric acid in a beaker. Upon completion of reaction, the mixture inside the beaker was filtered. The residue obtained was first washed with distilled water, and then dried. The mass of the dried residue was 1.75 g.

(a) Write a chemical equation for the reaction involved.

(1 mark)

(b) How can one know that the reaction has been completed?

(1 mark)

(c) Explain why it is necessary to wash the residue obtained.

(1 mark)

(d) Explain why it is NOT appropriate to dry the residue with a Bunsen flame after washing.

(1 mark)

(e) Assuming negligible experimental errors, calculate the percentage of zinc by mass in the solid sample.

(2 marks)

CE07_10

In an experiment to determine the concentration of phosphoric acid (H_3PO_4), 10.0 cm^3 of the acid was first diluted to 250.0 cm^3 with distilled water. 25.0 cm^3 of the diluted solution was then transferred to a conical flask and titrated with a 0.025 M sodium hydroxide solution using phenolphthalein as indicator. 17.60 cm^3 of sodium hydroxide solution was needed to reach the end point.

(a) Describe briefly how 10.0cm^3 of phosphoric acid can be diluted to 250.0 cm^3 with distilled water in the laboratory.

(2 marks)

(b) Phosphoric acid reacts with sodium hydroxide in the titration according to the following equation:

$$H_3PO_4 + 2NaOH \longrightarrow Na_2HPO_4 + H_2O$$

Calculate the molarity of the original phosphoric acid before dilution.

(3 marks)

(c) 'At the beginning of titration, the solution in the conical flask turned pink upon the addition of sodium hydroxide solution but became colourless immediately upon swirly. However, near the end point, the solution took longer time to become colourless upon swirling.'

Explain why the time needed for the solution to become colourless is different at the two stages mentioned above.

(2 marks)

(d) In the titration, the 0.025 M sodium hydroxide solution was used as a standard solution.

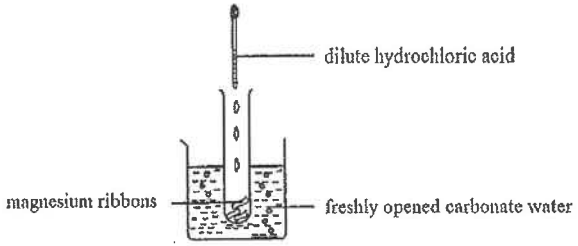
(i) What does the term 'standard solution' mean?

(ii) Comment whether it is appropriate to prepare a standard solution of sodium hydroxide by the following procedure:
'Weigh a sample of solid sodium hydroxide, dissolve it some distilled water and make up to a known volume of solution.'

(2 marks)

CE08_04

A test tube with magnesium ribbons is immersed in a beaker of freshly opened carbonated water. Dilute hydrochloric acid is then added to the magnesium ribbon as shown in the following diagram.



(a) State the expected observation inside the test tube, and give a relevant chemical equation.

(2 marks)

(b) When dilute hydrochloric acid is added to the magnesium ribbons, more gas bubbles are seen in the carbonated water outside the test tube. Explain.

(2marks)

CE08_11

Copper(II) sulphate crystals ($CuSO_4 \cdot 5H_2O$) can be prepared in a laboratory by the following steps.

Step 1: Add excess copper(II) oxide to dilute sulphuric acid and warm the mixture.
Step 2: Remove the remaining copper(II) oxide from the solution obtained.
Step 3: Evaporate the solution until it becomes saturated.
Step 4: Allow the saturated solution to cool down to obtain copper(II) sulphate crystals.
Step 5: Separate the crystals from the saturated solution.
Step 6: Dry the crystals obtained.

(a) (i) For Step 1,
(1) write a chemical equation for the reaction involved, and
(2) explain why copper(II) oxide should be added in excess.

(ii) For Step 2, suggest how to remove the remaining copper(II) oxide.

(iii) For Step 4, explain why crystals would be obtained when the saturated solution is allowed to cool down.

(iv) For Step 6,
(1) explain why the crystals obtained should not be dried by heating, and
(2) suggest an appropriate method to dry the crystals.

(6 marks)

(b) A student finally obtained 16.2g dry copper(II) sulphate crystals through the above steps by reacting $150cm^3$ of 1.0M sulphuric acid with excess copper(II) oxide.

(i) Calculate the number of moles of copper(II) sulphate in the solution obtained in Step 1.

(ii) Calculate the number of moles of copper(II) sulphate crystals finally obtained.

(iii) Assuming the student dried the crystals in Step 6 by an appropriate method, comment on whether there should be any difference between the answers obtained in (i) and (ii) above.

(3 marks)

CE08_13

For question 13, candidates are required to give answers in paragraph form. For this question, 6 marks will be awarded for chemical knowledge and 3 marks for effective communication.

With reference to the properties of 1M H_2SO_4 and 1M HNO_3, suggest THREE methods based on different chemical principles to distinguish these two acids.
(You can use any common chemicals available in a school laboratory. Both the processes and the observations involved are required in your answers.)

(9 marks)

CE09_01

Limestone is an important earth resource.

(a) What is the major chemical constituent in limestone?

(1 mark)

(b) State the expected observation when dilute hydrochloric acid is added to limestone, and write the ionic equation for the reaction involved.

(2 marks)

(c) Limestone can be decomposed under strong heating.
(i) Write a chemical equation for the reaction involved.
(ii) Explain why limestone can be used as fire-proofing additive.

(2 marks)

CE09_07

Describe briefly how you would accomplish the following tasks in a school laboratory.

(a) Obtain calcium sulphate from a solid mixture of calcium sulphate and calcium nitrate.

(2 marks)

(b) Distinguish potassium bromide solution from potassium chloride solution.

(2 marks)

CE09_11

A drug tablet contains aluminium hydroxide, $Al(OH)_3$, as the only active ingredient. A student performed the following experiment to determine the amount of aluminium hydroxide contained in the drug tablet.

Step	Experimental process	Remarks
I	A drug tablet was dissolved in 50.0 cm^3 of 1.0 M hydrochloric acid to form a solution.	As aluminium hydroxide is insoluble in water, the drug tablet was dissolved in hydrochloric acid instead. The amount of hydrochloric acid used was more than needed to react with aluminium hydroxide in the drug tablet.
II	The solution was then diluted to 250.0 cm^3 with distilled water.	The solution, containing excess hydrochloric acid, was diluted for the titration in Step III.
III	25.0 cm^3 of the diluted solution was titrated with 0.20M sodium hydroxide solution using a suitable indicator. 20.80 cm^3 of sodium hydroxide solution was needed to reach the end point.	The amount of excess hydrochloric acid in the diluted solution could be calculated from the data obtained in the titration.

(a) Write a chemical equation for the reaction involved in Step I.

(1 mark)

(b) Describe how the dilution process in Step II should be performed by using suitable apparatus.

(3 marks)

(c) Suggest a suitable indicator for the titration in Step III, and state the expected colour change at the end point.

(2 marks)

(d) (i) Calculate the number of moles of excess hydrochloric acid in the 25.0 cm^3 of the diluted solution from the data obtained in the titration.

(ii) Hence, calculate the number of moles of aluminium hydroxide in the drug tablet.

(3 marks)

CE10_02

Two experiments are performed using ammonium dichromate, $(NH_4)_2Cr_2O_7$.

(a) Solid ammonium dichromate is dissolved in water to form a solution.

(i) State the expected colour of the solution and suggest which ion leads to this colour.

(ii) Suggest a chemical test to show that the solution contains ammonium ions. State the expected observation.

(3 marks)

(b) Solid ammonium dichromate is heated in a test tube. It decomposes into solid chromium(III) oxide, nitrogen gas and water vapour.

(i) Write a chemical equation for the decomposition of ammonium dichromate.

(ii) Suggest a chemical test to show that water vapour is formed in the decomposition. State the expected observation.

(3 marks)

CE10_06

In an experiment, carbon dioxide is passed into limewater until excess.

(a) State the expected observations and write the chemical equations for the reactions involved.

(3 marks)

(b) Explain whether the similar observations in (a) would be made if sodium hydroxide solution is used instead of limewater.

(1 mark)

(c) Explain whether the similar observations in (a) would be made if air is used instead of carbon dioxide.

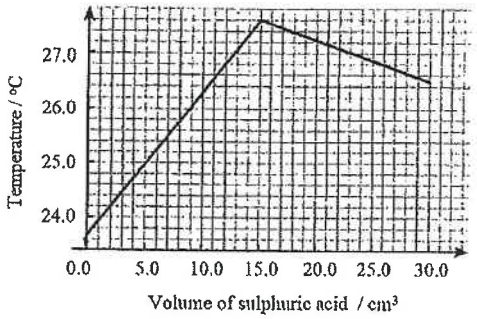
(1 mark)

(d) Carbon dioxide can be obtained from the reaction of solid sodium carbonate with dilute hydrochloric acid. Write an ionic equation for the reaction.

(1 mark)

CE10_10

In an experiment, 25.00 cm^3 of sodium hydroxide solution is transferred to an expanded polystyrene cup. 0.50 M sulphuric acid is then added to the solution from a burette, and the temperature of the mixture is measured with a data-logger. The graph below shows the experimental results:



(a) Name the apparatus that should be used to transfer 25.00 cm^3 of sodium hydroxide solution to the expanded polystyrene cup.

(1 mark)

(b) Outline the procedure for cleaning the burette before experiment.

(2 marks)

(c) Write an ionic equation for the reaction involved.

(1 mark)

(d) With reference to the above graph, explain the temperature change of the mixture throughout the experiment.

(3 marks)

(e) Calculate the molarity of the sodium hydroxide solution used.

(2 marks)

CE10_13

For question 13, candidates are required to give answers in paragraph form. For this question, 6 marks will be awarded for chemical knowledge and 3 marks for effective communication.

Using some suitable examples, discuss the factors that affect pH of acids.

(9 marks)

CE11_01b

Salt **X** is known to be one of the following substance:

lead(II) nitrate, sodium sulphate, zinc sulphate, sodium nitrate

X gives a golden yellow flame in flame test. When a solution of **X** is mixed with calcium chloride solution, a white precipitate is formed. Deduce what **X** is.

(3 marks)

CE11_09

An experiment was performed to determine the concentration of an ammonia solution. Firstly, 25.0 cm^3 of 2.0 M hydrochloric acid was diluted with distilled water to 250.0 cm^3. After that, 25.0 cm^3 of the diluted hydrochloric acid was titrated with the ammonia solution using methyl orange as the indicator. 22.90 cm^3 of the ammonia solution was required to reach the end point.

(a) Name one piece of the glass apparatus that must be used in the dilution process.

(1 mark)

(b) Calculate the concentration of the diluted hydrochloric acid.

(1 mark)

(c) Draw a labelled diagram to show the set-up used in the titration.

(3 marks)

(d) State the expected colour change at the end point.

(1 mark)

(e) Write a chemical equation for the reaction involved.

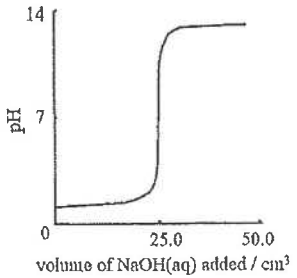
(1 mark)

(f) Calculate the concentration of the ammonia solution.

(2 marks)

AL99(I)_04

The graph below shows the variation of pH when 25.0 cm^3 of 0.10 M HCl (aq) is titrated against 0.10 M NaOH(aq).



(a) On the above graph, sketch a curve to represent the variation of pH when 0.10 M CH_3COOH(aq) is titrated against 0.10 M NaOH(aq).

(0.5 mark)

(b) From the table below, choose an appropriate indicator for the titration in (a). Explain your choice.

Indicator	pH range of colour change
bromocresol green	2.8 – 5.4
bromothymol blue	6.0 – 7.6
thymolphthalein	8.3 – 10.6

(1.5 mark)

AL99(I)_04

Constant boiling hydrochloric acid contains 20.2 % by mass of HCl. Calculate the mass of constant boiling hydrochloric acid required to prepare 1.00 dm^3 of HCl (aq) of pH 2.0 at 298 K.

(3 marks)

AL00(I)_02

Calculate the pH at 298 K of a solution prepared by mixing equal volumes of 0.105 M NaOH(aq) and 0.095 M HCl(aq).

(2 marks)

AL00(II)_02

A sample of nitric(V) acid contains 68.0% of HNO_3 by mass and has a density of 1.42 g cm^{-3}. Calculate the concentration, in mol dm^{-3}, of HNO_3 in the sample.

(2 marks)

ASL00(II)_11

Suggest a chemical test to distinguish one solution from the other in each of the following pairs. Equations should be given where appropriate.

$Mg(NO_3)_2(aq)$ and $Al(NO_3)_3(aq)$

(4 marks)

ASL00(II)_12

Some toothpastes contain baking soda ($NaHCO_3$) as an active ingredient. Explain why baking soda can help prevent tooth decay.

(3 marks)

AL01(I)_07

Office paper contains calcium carbonate (up to 50%) as an additive to enhance its brightness, whiteness and opacity. Devise an experiment to estimate the percentage by mass of calcium carbonate in a sample of office paper.

(4 marks)

AL01(I)_07

Suggest how you would prepare a sample of dry hydrogen chloride gas in a school laboratory. Draw a labeled diagram of the set-up of apparatus used in the preparation.

(4 marks)

AL01(II)_04 (modified)

Comment on the statement: 'The acids HCl, HBr and HI are of comparable strength.'

(1 mark)

AL03(I)_01 (modified)

Phosphoric acid, $H_3PO_4(aq)$, a weak acid, ionizes in three stages to give $H_2PO_4^-(aq)$, $HPO_4^{2-}(aq)$ and $PO_4^{3-}(aq)$.

(a) Write an chemical equations to show the stepwise formation of $H_2PO_4^-(aq)$, $HPO_4^{2-}(aq)$ and $PO_4^{3-}(aq)$.

(2 marks)

(b) Explain why the ability of phosphoric acid to dissociate $H^+(aq)$ in each step progressively decreases.

(1 mark)

(c) Sketch the expected pH titration curve when $H_3PO_4(aq)$ is titrated with $NaOH(aq)$.

(3 marks)

AL04(I)_07

A student proposed a method to determine the concentration of citric acid in a sample of lemon juice by titration with standard sodium hydroxide solution. The method proposed consists of the following experimental procedures:

1. Prepare a standard sodium hydroxide solution by dissolving a known mass of sodium hydroxide pellets in deionized water and then make it up to 250.0 cm^3.
2. Transfer a known volume of the sample of lemon juice to a clean conical flask.
3. Fill a burette, which has been well rinsed with deionized water beforehand, with the standard sodium hydroxide solution.
4. Titrate the lemon juice in the flask with the sodium hydroxide solution using methyl orange as the indicator.
5. Using this titration result, calculate the concentrate of citric acid in the sample.

Point out four inappropriate practices in the method. Explain why they are inappropriate and suggest corrections for them.

(6 marks)

ASL04(II)_11

A student was asked to suggest possible ways to distinguish concentrated HCl, concentrated H_2SO_4, and concentrated H_3PO_4 from one another.

The student suggested that concentrated HCl can be distinguished from the other acids by observing what would happen when stoppers of reagent bottles containing the acids are removed.

(a) State and explain the expected observation when the stopper of a reagent bottle containing concentrated HCl is removed.

(2 marks)

(b) Suggest a chemical test to confirm the identity of concentrated HCl.

(2 marks)

AL05(I)_08

The photograph below shows a person conducting a test in a laboratory to detect the presence of ammonium ions in a solid sample. He is holding a test tube containing a hot mixture of the sample and sodium hydroxide solution, and is trying to smell.

State three inappropriate laboratory practices of the person and suggest the proper actions that should be taken.

(3 marks)

AL05(II)_01

X is a trivalent metal. When treated with hydrochloric acid, X(s) gives hydrogen, while its oxide $X_2O_3(s)$ undergoes neutralization.

(a) Write the chemical equation for the reaction of X(s) with HCl(aq) and that of $X_2O_3(s)$ with HCl(aq).

(2 marks)

(b) 16.5 g of a mixture of X(s) and $X_2O_3(s)$ is allowed to react with 6.0 M HCl(aq). 95.4 cm^3 of the acid is required for both the metal and its oxide to undergo complete reaction.
Deduce respectively the greatest possible value and the smallest possible value of the relative atomic mass of X.

(4 marks)

(c) With reference to the Periodic Table, deduce what X may be.

(1 marks)

AL05(II)_04

Aluminium hydroxide is an active ingredient of antacid. Two paths for the production of aluminium hydroxide using Al(s), $H_2SO_4(aq)$ and NaOH(aq) as reactants are outlined below:

Paths I: $Al(s) \longrightarrow Al_2(SO_4)_3(aq) \longrightarrow Al(OH)_3(s)$

Paths II: $Al(s) \longrightarrow Na[Al(OH)_4](aq) \longrightarrow Al(OH)_3(s)$

(a) Use chemical equations to describe the reactions in Path I and in Path II.

(4 marks)

(b) Work out the number of moles of H_2SO_4 and NaOH required for producing 2 mol of $Al(OH)_3$ via Path I and via Path II.

(1 mark)

(c) Suggest, with explanation, whether Path I or Path II is recommended for the production of aluminium hydroxide.

(2 marks)

AL06(I)_02

Hard water contains $Mg^{2+}(aq)$ and $Ca^{2+}(aq)$ ions.

(a) Name a mineral that provides $Ca^{2+}(aq)$ ions in hard water.

(1 mark)

(b) An experiment as described below was carried out to determine the total hardness in a sample of hard water.

"50.0 cm^3 of the sample was allowed to pass through an ion-exchange column, in which the metal ions present in the sample were totally exchanged by hydrogen ions. The eluent collected required 15.0 cm^3 of 0.020 mol dm^{-3} KOH(aq) for complete neutralization."

Assuming that the metal ions present in the sample are $Mg^{2+}(aq)$ and $Ca^{2+}(aq)$ only, calculate the total hardness, in mol dm^{-3}, of the sample.

(2 marks)

ASL06(I)_03

Explain whether you agree with each of the following statements.

A is a stronger acid than B, so the pH of an aqueous solution of A must be lower than that of B.

(2 marks)

ASL07(I)_03

A brand of sugar-free chewing gum contains urea, $CO(NH_2)_2$, as an additive.

(a) Urea reacts with $H^+(aq)$ to give ammonium ions and carbon dioxide. Write the chemical equation for this reaction.

(1 mark)

(b) Each piece of the chewing gum contains 1.5 mg of urea. Calculate the number of moles of $H^+(aq)$ that can be neutralized by chewing 2 pieces of the gum.

(2 marks)

(c) Tooth enamel consists mainly of hydroxyapatite, $Ca_5(PO_4)_3OH$, which undergoes continuous mineralization and demineralization according to the following equation:

$$Ca_5(PO_4)_3OH(s) \underset{\text{mineralization}}{\overset{\text{demineralization}}{\rightleftharpoons}} 5Ca^{2+}(aq) + 3PO_4^{3-}(aq) + OH^-(aq)$$

With reference to the above information, suggest why the manufacturer of this brand of sugar-free chewing gum claimed that chewing such gums after meals can help prevent tooth decay.

(2 marks)

ASL07(I)_07

(a) What is meant by 'primary standard' in the titrimetric analysis?

(1 mark)

(b) Give one reason why each of the following chemicals is not used as a primary standard.

(i) Liquid bromine

(1 mark)

(ii) Potassium hydroxide pellets

(1 mark)

ASL07(I)_09

Outline the experimental procedure and data treatment that you would use to determine the solubility of KCl(s) in water at 298 K.

(5 marks)

AL07(II)_01

Outline how 1.0×10^{-2} mol dm^{-3} $AgNO_3(aq)$ can be prepared from 1.0×10^{-1} mol dm^{-3} $AgNO_3(aq)$.

(2 marks)

ASL08(I)_08

Outline how you would prepare a sample of dry $CuSO_4 \cdot 5H_2O$ crystals from copper turning in a laboratory.

(3 marks)

AL09(I)_07c

Explain why water should NOT be added to concentrated H_2SO_4 in order to dilute the acid.

(1 mark)

ASL09(II)_03

In an experiment to determine the relative atomic mass of magnesium, 0.420 g of magnesium ribbon was added to 25.0 cm^3 of 0.955 mol dm^{-3} $H_2SO_4(aq)$. When effervescence ceased, the resulting mixture was diluted to 250.0 cm^3 with deionized water. 25.0 cm^3 portions of the diluted solution were withdrawn and titrated against 0.0941 dm^{-3} NaOH(aq) using methyl orange as indicator. The mean titre was 16.48 cm^3.

(a) State the color change at the end point of the titration.

(1 mark)

(b) Based on the titration results, calculate the relative atomic mass of magnesium.

(4 marks)

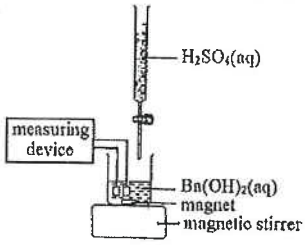
(c) Assuming that the experimental error is negligible, suggest ONE reason why the relative atomic mass of magnesium calculated in (b) is different from that found in the Periodic Table.

(1 mark)

ASL10(I)_09 [Similar to DSE17_01]

The diagram on the right shows the set-up of a titrimetric experiment involving the following reaction:

$$Ba(OH)_2(aq) + H_2SO_4(aq) \longrightarrow BaSO_4(aq) + 2H_2O(l)$$



(a) What physical parameter of the reaction mixture is measured by this set-up?

(1 mark)

(b) $H_2SO_4(aq)$ is added gradually to $Ba(OH)_2(aq)$ until in excess.
Sketch a graph to show the variation of measured physical parameter with the volume of $H_2SO_4(aq)$ added. Explain your answer.

(2 marks)

AL10(I)_07

The hardness of a water sample is due to $Ca^{2+}(aq)$ ions. Outline a method for determining the hardness in mol dm^{-3} in the sample by using volumetric titrimetric method.

Hint: $Ca^{2+}(aq)$ in water sample can be replaced by $H^+(aq)$ using proton-exchange resin column

$$Ca^{2+}(\text{in sample}) + 2H^+(\text{from resin}) \longrightarrow Ca^{2+}(\text{on resin}) + 2H^+(\text{in sample})$$

(3 marks)

AL11(I)_07

(b) For each of the following pairs of species, suggest a chemical test to distinguish between them and write the chemical equation(s) of the reaction(s) involved.

(i) $Ba^{2+}(aq)$ and $Pb^{2+}(aq)$

(2 marks)

(ii) $Cl^-(aq)$ and $Br^-(aq)$

(2 marks)

AL11(II)_06

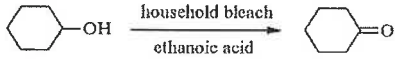
State the expected observation(s) in each of the following experiments, and write the chemical equation(s) of the reaction(s) involved.

(c) NaOH(aq) is added dropwise to $Al(NO_3)_3(aq)$ until in excess.

(3 marks)

ASL13(I)_09a (modified)

In an experiment to prepare cyclohexanone from cyclohexanol, a household bleach, containing 5.25% of sodium chlorate(I) by mass, was used as the oxidizing agent.



Density:	0.948 g cm^{-3}	0.947 g cm^{-3}
Solubility in water:	3.6 g / 100 cm^3	Very slightly soluble
Melting point:	25 °C	−16 °C
Boiling point:	160 °C	156 °C

5.0 cm^3 of cyclohexanol and 3 cm^3 of ethanoic acid were placed in a 250 cm^3 conical flask. A 25 cm^3 portion of the household bleach was added to the conical flask with vigorous stirring. Then additional 25 cm^3 portions of bleach were successively added into the reaction mixture until all cyclohexanol had reacted.

(i) Assuming that the density of the household bleach is 1.0 g cm^{-3}, calculate the molarity of NaClO in the bleach used. (Formula mass of NaClO = 74.5)

(1 mark)

(ii) Given that the mole ratio between cyclohexanol and NaClO is 1 : 1, calculate the minimum number of 25 cm^3 portions of household bleach required for the complete reaction of cyclohexanol. (Relative molecular mass of cyclohexanol = 100.0)

(2 marks)

DSE11SP_01

State whether each of the following statements is true or false. Explain your answer in each case.

(b) When concentrated sulphuric acid is diluted, water should be added slowly to the acid.

(2 marks)

(c) A is a stronger acid than B, so that pH of an aqueous solution of A must be lower than that of B.

(2 marks)

DSE11SP_08

For each of the following experiments, state an expected observation and write a chemical equation for the reaction involved.

(a) adding dilute hydrochloric acid to zinc granules

(2 marks)

(b) adding sodium hydroxide solution to iron(II) sulphate solution

(2 marks)

DSE11SP_09

There are four unlabelled reagent bottles each containing one of the white solids listed below:

ammonium chloride, ammonium nitrate, sodium hypochlorite and sodium sulphate

Suggest how you would carry out tests to distinguish the four solids from one another.

(6 marks + 1 mark)

DSE12PP_01

An experiment on the preparation of hydrated zinc sulphate involves the following steps:

Step 1: Warm 30 cm^3 of dilute sulphuric acid in a beaker. Add zinc oxide to the acid until in excess.

Step 2: Filter the reaction mixture and collect the filtrate.

Step 3 : Heat the filtrate until it becomes saturated. Then allow it to cool to room temperature to crystallize out hydrated zinc sulphate.

Step 4: Filter off the crystals formed, and then wash them with a little amount of cold distilled water.

Step 5: Dry the crystals.

(a) For Step 1,

(i) write the chemical equation for the reaction that occurs,

(1 mark)

(ii) suggest how one can know that zinc oxide is in excess, and

(1 mark)

(iii) explain why zinc oxide rather than sulphuric acid is used in excess.

(1 mark)

(b) Suggest ONE way to show that a saturated solution has been obtained in Step 3.

(1 mark)

(c) Explain why a little amount of cold distilled water is used to wash the crystals in Step 4.

(2 marks)

(d) Suggest ONE way of drying the crystals in Step 5.

(1 mark)

(e) Suggest ONE chemical that can be used to replace zinc oxide in this experiment.

(1 mark)

DSE12PP_04

A student was given a sample of a water-soluble metal carbonate, $M_2CO_3(s)$. In order to deduce what M was, the student prepared a 100.0 cm^3 aqueous solution of the carbonate using 1.14 g of the sample. The student then withdrew several 10.0 cm^3 portions of the solution, and titrated each portion with 0.085 mol dm^{-3} HCl(aq) using methyl orange as indicator. The mean titre was 25.30 cm^3.

(a) Describe how the 100.0 cm^3 aqueous solution was prepared.

(3 marks)

(b) Based on the experimental results, determine the formula mass of M_2CO_3 and deduce what M is.

(3 marks)

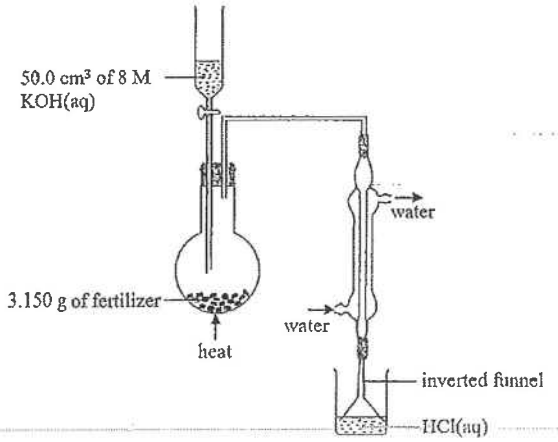
DSE12_06

Outline the steps in preparing solid lead(II) sulphate from solid lead(II) nitrate. You have to state the additional chemical reagents that are required, but need NOT mention the apparatus involved.

(4 marks)

DSE12_07

A fertilizer only contains ammonium nitrate (NH_4NO_3) and potassium chloride (KCl). An experiment was performed to determine the percentage by mass of NH_4NO_3 in this fertilizer. The set-up is shown below:



The KOH(aq) was added slowly to the fertilizer and the mixture formed was heated gently. The ammonia liberated from the reaction between NH_4NO_3 and KOH was first cooled in a condenser, and then passed through an inverted funnel to a solution containing 0.0485 mol of HCl. The solution was finally made up to 100.00 cm^3 and labelled as 'S'.

(a) Write an ionic equation for the reaction between NH_4NO_3 and KOH.

(1 mark)

(b) Suggest the potential hazard of one of the chemicals used.

(1 mark)

(c) Given that ammonia is very soluble in water, state the advantage of using an inverted funnel.

(1 mark)

(d) 25.00 cm^3 of 'S' was transferred to a conical flask, and then titrated with 0.100 M NaOH(aq) using methyl orange as an indicator. 41.00 cm^3 of the NaOH(aq) was required to reach the end point.

(i) Name the apparatus that should be used to transfer 25.00 cm^3 of 'S'.

(1 mark)

(ii) State the color change at the end point of the titration.

(1 mark)

(iii) Calculate the percentage by mass of NH_4NO_3 in this fertilizer.

(3 marks)

(e) Suggest a test to show the presence of a potassium-containing compound in the fertilizer.

(1 mark)

DSE13_04

The structure of a dibasic acid with chemical formula $H_2C_2O_4$ is shown below:

(b) A student expected a 0.0500 mol dm^{-3} standard $H_2C_2O_4$(aq) to have a pH of 1.0, however, the pH of the solution, when measured with a calibrated pH meter, was found to be greater than 1. Explain this observation with the aid of a chemical equation.

(2 marks)

(c) Solid sodium hydroxide is available in school laboratories. However, a standard NaOH(aq) CANNOT be directly prepared by weighing NaOH(s) and then dissolving it in water. Explain why.

(1 mark)

(d) In a titration experiment, 25.00 cm^3 of a 0.0500 mol dm^{-3} standard $H_2C_2O_4$(aq) and a few drops of phenolphthalein indicator were placed in a conical flask. NaOH(aq) of unknown concentration was then added from a burette into the flask. 17.20 cm^3 of the NaOH(aq) was required to reach the titration end point.

(i) State the color change at the titration end point.

(1 mark)

(ii) From the titration results, calculate the concentration of the NaOH(aq), in mol dm^{-3}.

(2 marks)

(e) The following were considered as INAPPROPRIATE practices when carrying out the experiment in (d). For each of them, explain why it would lead to inaccurate titration results:

(i) Rinsing the conical flask with the standard $H_2C_2O_4$(aq) before transferring 25.00 cm^3 of the acid solution to it.

(1 mark)

(ii) Carrying out the titration with the filter funnel remained on top of the burette after using it to fill the burette with the NaOH(aq).

(1 mark)

DSE14_05

Concentrated acids are common reagents found in laboratories.

(a) State a safety measure in handing concentrated acids in laboratories.

(1 mark)

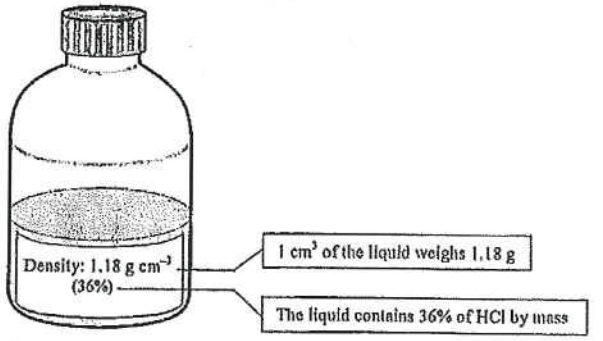
(b) Comment on the following statement:

'*All concentrated acids are strong acids.*'

(1 mark)

DSE14_07

A bottle of concentrated hydrochloric acid HCl(aq) is shown below:



(a) According to the information on the label, calculate the concentration of the concentrated hydrochloric acid in mol dm^{-3}.

(2 marks)

(b) To find out the concentration of the concentrated acid, a laboratory technician first drew from the bottle a sample of 10.00 cm^3 of the concentrated acid and diluted it to 100.0 cm^3 in a volumetric flask. The diluted acid sample was then used to titrate a standard sodium carbonate solution placed in a conical flask using methyl orange as an indicator. 10.00 cm^3 of 1.06 mol dm^{-3} sodium carbonate solution required 20.30 cm^3 of the diluted acid sample to reach the end point.

(i) Briefly describe the procedure in preparing a standard sodium carbonate solution.

(2 marks)

(ii) Using the titration result, calculate the concentration, in mol dm^{-3}, of the concentrated hydrochloric acid in the bottle.

(3 marks)

(c) Suggest a possible reason why the concentration of the concentrated hydrochloric acid in the bottle obtained from (b)(ii) would be smaller than that obtained from (a) above.

(1 mark)

DSE14_09

Consider each of the experiments below and answer the questions that follow.

(a) Dilute sodium hydroxide solution is added to copper(II) sulphate solution.

(i) State the expected observation.

(1 mark)

(ii) Write the chemical equation for the reaction that occurs.

(1 mark)

DSE15_02

For each of the following experiments, state the expected observation, and write the chemical equation(s) for the reaction(s) involved.

(a) Passing carbon dioxide gas into limewater until in excess.

(3 marks)

DSE15_04

Lead-acid accumulator is a secondary cell containing sulphuric acid. It is commonly used in starting up motor vehicle engines.

(c) State one environmental impact that would be imposed from the disposal of lead-acid accumulators.

(1 mark)

(d) A student diluted a sample of concentrated sulphuric acid for making a lead-acid accumulator.

(i) Describe how concentrated sulphuric acid can be diluted in a laboratory. State a safety precaution needed during the dilution process.

(3 marks)

(ii) 5.00 cm^3 of solution in the lead-acid accumulator made contains 2.48 g of sulphuric acid. Calculate the molarity of the sulphuric acid in the solution.
(Molar mass of sulphuric acid = 98.1 g)

(2 marks)

DSE15_05

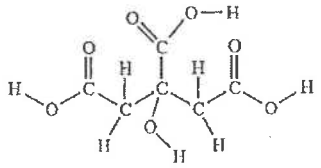
Explain, with the aid of a chemical equation, why $NH_3(aq)$ is regarded as a weak alkali. Suggest how you would show that $NH_3(g)$ is a weaker alkali than NaOH(aq) through an experiment.

(5 mark + 1 mark)

DSE16_06

Citric acid is a tribasic acid found in lemon. It is a white solid and soluble in water.

(a) In the structure of citric acid shown below, circle ALL ionizable hydrogen atom(s) making it a tribasic acid.



(1 mark)

(b) A solid sample contained citric acid and other soluble inert substances. 1.65 g of the sample was dissolved in deionized water and diluted to 250.0 cm^3 in apparatus **X**. After that, 25.00 cm^3 of the diluted solution was withdrawn and titrated with 0.123 M NaOH(aq) using phenolphthalein as an indicator. 18.45 cm^3 of the NaOH(aq) was required to reach the end point.
(Molar mass of citric acid = 192.0 g)

(i) What is apparatus **X**?

(1 mark)

(ii) Calculate the percentage by mass of citric acid in the solid sample.

(3 marks)

(c) A few drops of lemon juice are added to sodium hydrogencarboante powder.

(i) State the expected observation.

(1 mark)

(ii) Write the ionic equation for the reaction involved.

(1 mark)

DSE16_09

Three unlabeled reagent bottles each contains one of the white solids listed below:

$ZnSO_4$ $MgSO_4$ $MgSO_4 \cdot 7H_2O$

Outline how you would carry out tests to distinguish these three solids.

(5 mark + 1 mark)

DSE16_11

Under certain conditions, a pink compound **X** react with NaOH(aq) to give a colorless product. Three trials of an experiment were conducted to study the kinetics of the reaction. Firstly, three NaOH(aq) solutions were prepared by mixing different volume of 2.0 M NaOH(aq) and $H_2O(l)$ at 25 °C. after that, one drop of **X** was added top each of the them and the time needed for the pink color to disappear was recorded. The relevant data is shown below:

	Volume of 2.0 M NaOH(aq) used / cm^3	Volume of $H_2O(l)$ used / cm^3	Time needed for the pink color to disappear / s
Trial 1	5.0	0	61
Trial 2	4.0	1.0	76
Trial 3	3.0	2.0	101

(a) Why is it necessary to make the total volume of the reaction mixtures the same for the trials?

(1 mark)

(b) Given that at 25 °C, $[H^+(aq)][OH^-(aq)] = 1.0\times10^{-14}$ mol^2 dm^{-6}, calculate the pH of the NaOH(aq) solution prepared in Trial 2.

(2 marks)

DSE17_01 [Similar to ASL10(I)_09]

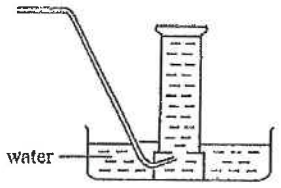
Barium (Ba) is an element in Group II of the Periodic Table. Its chemical properties are similar to those of calcium.

(b) A gas with a pungent smell is formed when $Ba(OH)_2(s)$ is heated with $NH_4Cl(s)$. State the reason why the gas CANNOT be collected by each of the following methods.

(i) Reason:

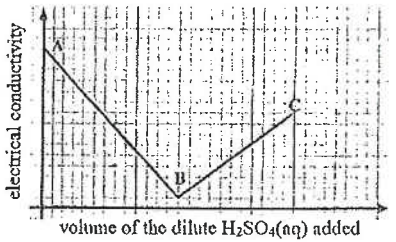
(1 mark)

(ii) Reason:



(1 mark)

(c) An experiment was carried out to study the change in electrical conductivity of the mixture formed when a dilute $H_2SO_4(aq)$ was added gradually to a fixed volume of a dilute $Ba(OH)_2(aq)$. The graph below shows the results of the experiment.



(i) State the expected observation when dilute $H_2SO_4(aq)$ is added to dilute $Ba(OH)_2(aq)$.

(1 mark)

(ii) Explain the change of electrical conductivity in the following stages:

(1) From **A** to **B**

(1 mark)

(2) From **B** to **C**

(1 mark)

DSE17_02

Water pipes used to carry drinking water are commonly made of copper instead of iron. Although lead-containing solder can be used to join these water pipes, such use is prohibited.

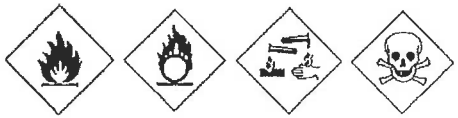
(c) A city stipulates that the concentration of lead ions in drinking water should not exceed 1.0×10^{-8} g cm^{-3}. Express this concentration in mol dm^{-3}.
(Relative atomic mass : Pb = 207.2)

(2 marks)

DSE17_06

Concentrated sulphuric acid is a reagent commonly found in laboratories.

(a) Circle TWO hazard warning labels that should be displayed on a bottle of concentrated sulphuric acid:



(1 mark)

(b) In order to determine the concentration of a sample of concentrated sulphuric acid, 5.00 cm^3 of the sample was diluted to 1000.0 cm^3 with deionized water. Portions of 25.00 cm^3 of the diluted sample were titrated with 0.189 mol dm^{-3} NaOH(aq) using methyl orange as an indicator. An average of 22.20 cm^3 of NaOH(aq) was used to reach the end point.

(i) Explain why concentrated sulphuric acid should NOT be titrated directly with NaOH(aq).

(1 mark)

(ii) State the color change at the end point of the titration.

(1 mark)

(iii) Calculate the concentration of the sample of concentrated sulphuric acid, in mol dm^{-3}.

(3 marks)

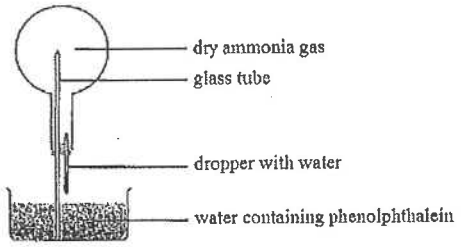
DSE18_02

This question involves the preparation of ammonia gas and the investigation of the properties of ammonia gas in a laboratory.

(a) Solid calcium hydroxide reacts with solid ammonium chloride to form ammonia gas. Draw a labelled diagram to show the set-up involved and how ammonia gas is collected.

(2 marks)

(b) An experiment was performed to investigate the properties of ammonia gas with the set-up shown below:



The round-bottomed flask was initially full of dry ammonia gas. Several drops of water were injected into the flask from the dropper. The water containing phenolphthalein was then automatically sucked into the flask through the glass tube.

(i) Briefly explain why the water containing phenolphthalein was sucked into the flask.

(2 marks)

(ii) State, with explanation, an observation related to phenolphthalein in the flask.

(2 marks)

DSE18_07

An experiment was performed to determine the number of water of crystallization, n, in a sample of hydrated sodium tetraborate ($Na_2B_4O_7 \cdot n\ H_2O$). 0.452 g of the sample was dissolved completely in about 50 cm^3 of deionized water in an apparatus **X**. The solution obtained was alkaline and was immediately titrated in **X** with 0.125 M HCl(aq) using methyl orange as an indicator. It is required 18.98 cm^3 of the acid to reach the end point.

(a) Name **X**.

(1 mark)

(b) State the color change at the end point of the titration.

(1 mark)

(c) It is known that in the reaction during the titration, the mole ratio of $B_4O_7^{2-}$(aq) to H^+(aq) is 1 : 2. Calculate the number of water of crystallization, n.
(Relative atomic masses: H = 1.0, B = 10.8, O = 16.0, Na = 23.0)

(3 marks)

(d) It is known that hydrated sodium tetraborate can be used to prepare standard solutions.

(i) What is meant by the term 'standard solutions'?

(1 mark)

(ii) Suggest one use of standard solutions.

(1 mark)

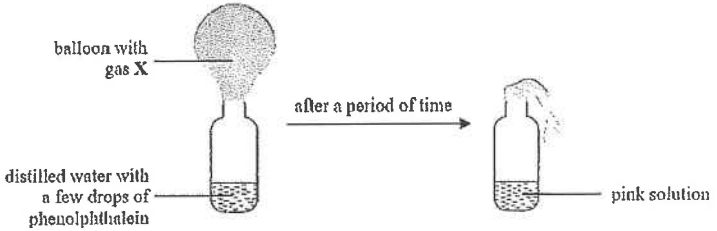
DSE18_08

(a) HCl is a strong acid. What is meant by the term 'strong acid'?

(1 mark)

DSE19_03

An experiment was carried out as shown below:



With the help of a chemical equation, suggest and explain what gas **X** may be.

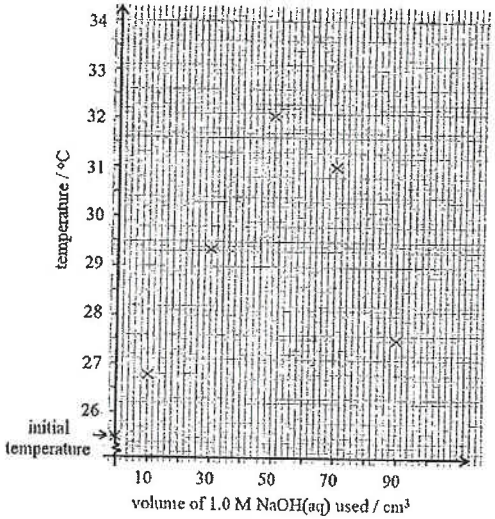
(3 marks)

DSE19_08

Several trials of an experiment were performed for determining the enthalpy change of neutralisation for a reaction. For each trial, a total volume of 100.0 cm^3 of a solution was obtained from mixing specified volumes of a HCl(aq) and 1.0 M NaOH(aq) as shown below in an expanded polystyrene cup. The HCl(aq) and NaOH(aq) were kept at the same initial temperature before mixing.

Trial	1	2	3	4	5
Volume of the HCl(aq) used / cm^3	90	70	50	30	10
Volume of 1.0 M NaOH(aq) used / cm^3	10	30	50	70	90

For each trial, the mixture was stirred and its maximum temperature reached was recorded. A graph of the maximum temperature reached for each trial is shown below :



(a) It is estimated from the graph that 58.0 cm^3 of NaOH(aq) (and 42.0 cm^3 of HCl(aq)) is required for obtaining the possible maximum temperature reached in this experiment. Show how this estimation can be done in the above graph.

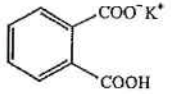
(1 mark)

(b) Calculate the number of moles of NaOH(aq) reacted with HCl(aq) in (a). Hence, find the concentration of the HCl(aq).

(2 marks)

DSE19_04

Solid potassium hydrogenphthalate can be used to prepare standard solutions. Its structure is shown below:



(a) You are provided with 1.12 g of solid potassium hydrogenphthalate.

(i) Describe briefly how a 250.0 cm^3 of standard solution containing 1.12 g of potassium hydrogenphthalate can be prepared in a laboratory.

(2 marks)

(ii) Calculate the molarity of the standard solution obtained in (i).
(Formula mass : potassium hydrogenphthalate = 204.1)

(2 marks)

(b) At room conditions, the pH of a 0.060 M of potassium hydrogenphthalate solution is 3.30. Based on this information and appropriate calculation, comment whether the –COOH group in potassium hydrogenphthalate is completely ionised.

(2 marks)

DSE19_10

You are provided with common laboratory apparatus and the following chemicals:

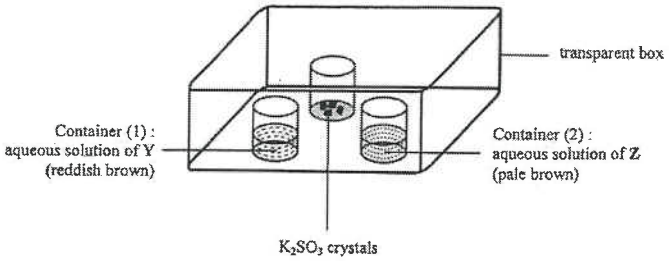
iron powder zinc powder aqueous ammonia distilled water

Describe how zinc sulphate crystals can be obtained from a solid sample of zinc sulphate containing copper(II) sulphate as impurity. (Not all chemicals must be used.)

(4+1 marks)

DSE20_01ci

(c) An experiment for Y and Z is performed as shown in the set-up below. Dilute hydrochloric acid is added to the K_2SO_3 crystals, then the whole set-up is covered with a lid.



(ii) State the expected observation in Container (1) and write an ionic equation for the reaction involved.

DSE20_04

4. Eggshells mainly contain calcium carbonate and a small amount of organic substances. The percentage by mass of calcium carbonate in a sample of eggshell was determined by the following steps :

Step (1) : The sample was ground into powder.
Step (2) : 0.204 g of the powder was put into a conical flask. After that, 25.00 cm^3 of 0.200 M HCl(aq) and 5 cm^3 of ethanol were added.
Step (3) : The mixture was heated for 15 minutes.
Step (4) : After cooling down, the mixture was titrated with 0.102 M NaOH(aq) using an indicator X.

(a) Explain why the sample was ground into powder in Step (1).

(1 mark)

(b) Suggest why ethanol was added in Step (2).

(1 mark)

(c) Suggest why the mixture was heated for 15 minutes in Step (3).

(1 mark)

(d) The mixture turned from colourless to pale pink at the end point of titration in Step (4). Name indicator X.

(1 mark)

(e) 16.85 cm^3 of NaOH(aq) was needed to reach the end point of titration in Step (4). Calculate the percentage by mass of calcium carbonate in the sample.
(Relative atomic masses : C = 12.0, O = 16.0, Ca = 40.1)

DSE20_05a

5. The molecular formula of an organic compound W is $C_4H_8O_4$. It is soluble in water.

(a) When a piece of magnesium ribbon is placed into an aqueous solution of W, hydrogen gas evolves. According to this observation, suggest a functional group that W may contain.

DSE20_07ab

7. An experiment is performed to study the following reaction :

$$Ba(OH)_2 \cdot 8H_2O(s) + 2NH_4Cl(s) \rightarrow BaCl_2(s) + 10H_2O(l) + 2NH_3(g)$$

(a) When the two solid reactants are mixed and stirred in a conical flask, ammonia gas with a characteristic pungent smell is formed. Explain how ammonia gas can be tested.

(b) $Ba(OH)_2 \cdot 8H_2O(s)$ is an alkali. What is meant by the term 'alkali' ?

DSE21_07(a),(b),(c),(d)

7. The steps for determining the concentration of a sample of hydrochloric acid are listed below :

Step (1) : A 0.1038 M standard sodium carbonate solution was prepared by dissolving 2.750 g of anhydrous sodium carbonate solid in deionised water and made up to 250.0 cm^3.
Step (2) : 25.0 cm^3 of the standard solution obtained in Step (1) was transferred to a clean conical flask and then a few drops of methyl orange were added.
Step (3) : The sample of hydrochloric acid was put into a burette. The standard solution in the conical flask was titrated with the hydrochloric acid.

Step (2) and Step (3) were repeated for several times. The table below shows the results of the titrations :

Trial	1	2	3	4
Final burette reading / cm^3	30.85	28.75	28.30	31.35	27.25
Initial burette reading / cm^3	2.00	1.50	1.00	3.00	0.00

(a) Describe the procedure in preparing the standard sodium carbonate solution in Step (1).

(b) State the colour change at the end point of the titration.

(c) Calculate a reasonable average for the volume of the hydrochloric acid used in the titrations.

(d) Calculate the concentration of hydrochloric acid (in g dm^{-3}) in the sample.
(Relative atomic masses : H = 1.0, Cl = 35.5)

4. Which of the following is an INCORRECT procedure in titration ?

A. Rinse the pipette with the solution to be delivered before titration.
B. Rinse the conical flask with the solution to be held before titration.
C. Take the burette readings with eyes on the same level as the meniscus.
D. Make sure that there are no air bubbles in the burette filled with the titrant.

20. A small piece of sodium is added to water containing a few drops of universal indicator. Which of the following statements is / are correct ?

(1) Sodium moves quickly on the water surface.
(2) The resulting solution shows a red colour.
(3) This reaction is exothermic.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

22. Both **A** and **B** are monobasic acids. The pH of 0.10 M **A**(aq) is 1.0 and the pH of 0.10 M **B**(aq) is 3.0. Which of the following statements are correct ?

(1) **A** is a stronger acid than **B**.
(2) Some **B** molecules are present in **B**(aq).
(3) Complete neutralisation of 25.0 cm^3 of 0.10 M **A**(aq) and complete neutralisation of 25.0 cm^3 of 0.10 M **B**(aq) require the same number of moles of NaOH(aq).

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

3. Antacid is a drug for neutralising stomach acid. A sample of an antacid contains $NaHCO_3(s)$ and other soluble inert substances. 1.52 g of the antacid sample was completely dissolved in deionised water to give a weakly alkaline solution. The solution was then titrated with 0.644 M HCl(aq) using a suitable indicator. 25.20 cm^3 of the HCl(aq) was required to reach the end point.

(a) Write the chemical equation for the reaction between $NaHCO_3(s)$ and HCl(aq).

(1 mark)

(b) Calculate the percentage by mass of $NaHCO_3(s)$ in the antacid sample. (Relative atomic masses : H = 1.0, C = 12.0, O = 16.0, Na = 23.0)

3 (c) The pH of the solution at the end point of the titration was found to be between 3 and 4.

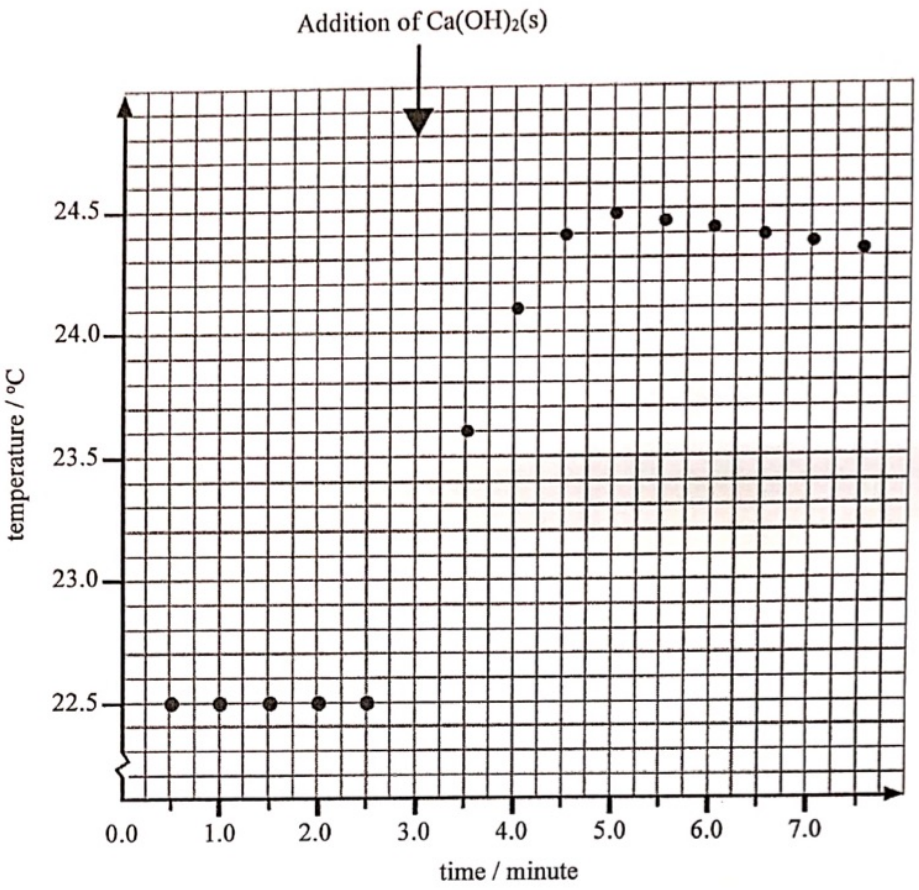
(i) Suggest a suitable indicator for this titration and state the colour change at the end point.

(ii) Suggest an instrument to measure the pH of the solution accurately.

(3 marks)

(d) State one advantage of taking antacids containing $Mg(OH)_2(s)$ over those containing $NaHCO_3(s)$.

7. An experiment was performed to determine the enthalpy change of neutralisation between $Ca(OH)_2(s)$ and HCl(aq). 100.0 cm^3 of 1.0 M HCl(aq) was placed in an expanded polystyrene cup. The temperature of the contents in the cup was measured at half-minute intervals. Right at the third minute, 0.502 g of $Ca(OH)_2(s)$ was added to the cup with thorough stirring. The recordings of temperature are shown in the graph below :



(a) Write a chemical equation for the reaction between $Ca(OH)_2(s)$ and HCl(aq).

Section A Industrial Chemistry

Answer **ALL** parts of the question.

1. (a) Answer the following short questions :

(i) Under certain conditions, ethanoic acid can be manufactured by the following reaction :

$$CH_3OH(l) + CO(g) \xrightarrow{Rh,\ HI} CH_3COOH(l)$$

(1) Suggest one reason why this reaction is considered to be green.

(2) Suggest one reason why this reaction is NOT considered to be green.

(2 marks)

(ii) A factory manufactures catalytic converters with a catalyst coating on a porous structure.

(1) Suggest one advantage of using a porous structure in the catalytic converters.

(2) Explain why the effectiveness of the catalyst may decrease after prolonged use.

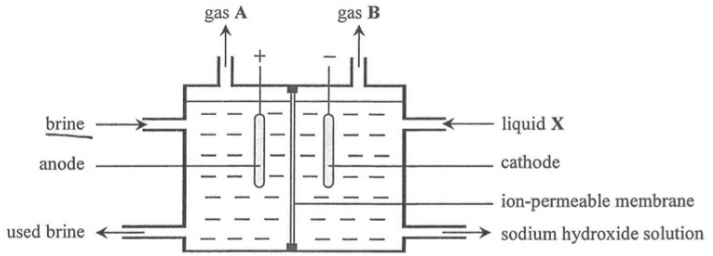
(2 marks)

(iii) Which one of the following items is NOT manufactured from petrochemicals ?

nylon rope, glass bottle, soapless detergent

(1 mark)

(b) The diagram below shows a membrane electrolytic cell used in the chloroalkali industry. Brine and liquid **X** are continuously added into the membrane electrolytic cell to produce gas **A**, gas **B** and sodium hydroxide solution.



(i) What is **X** ?

(1 mark)

(ii) Gas **A** is formed at the anode of the membrane electrolytic cell.

(1) What is **A** ?

(2) Explain why **A** is formed.

(2 marks)

(iii) Gas **B** and sodium hydroxide solution are formed at the cathode of the membrane electrolytic cell.

(1) Write a half equation for the formation of **B**.

(2) Explain why sodium hydroxide solution is formed and why it does not contain sodium chloride.

(3 marks)

(iv) Suggest a chemical that can be manufactured from the reaction between **A** and sodium hydroxide solution.

(1 mark)

Marking Scheme

MCQ

CE90_07	D	CE90_12	B	CE90_14	B	CE90_22	C
CE90_26	C	CE90_35	C	CE90_44	B	CE90_46	D
CE91_13	C	CE91_16	C	CE91_18	D	CE91_20	B
CE91_21	D	CE91_23	A	CE91_39	B	CE91_45	A
CE91_28	A	CE91_47	B	CE91_50	A	CE92_11	B
CE92_17	B	CE92_18	D	CE92_19	B	CE92_26	A
CE92_27	A	CE92_28	C	CE92_29	A	CE92_36	D
CE92_48	A	CE92_49	D	CE93_07	D	CE93_11	A
CE93_21	B	CE93_23	D	CE93_27	B	CE93_37	C
CE93_38	A	CE93_39	B	CE93_40	C	CE93_49	D
CE94_05	C	CE94_09	C	CE94_11	D	CE94_16	D
CE94_26	C	CE94_27	D	CE94_28	B	CE94_30	B
CE94_31	A	CE94_33	B	CE94_43	B	CE95_08	D
CE95_09	B	CE95_12	B	CE95_16	B	CE95_18	B
CE95_24	D	CE95_27	C	CE95_35	A	CE95_39	A
CE95_46	C	CE95_49	C	CE96_04	C	CE96_06	B
CE96_10	C	CE96_12	B	CE96_49	D	CE97_06	B
CE97_12	A	CE97_13	A	CE97_14	C	CE97_31	D
CE97_37	D	CE97_49	C	CE98_09	A	CE98_13	A
CE98_16	C	CE98_18	B	CE98_23	D	CE98_25	D
CE98_31	A	CE98_43	A	CE99_06	C	CE99_20	A
CE99_25	C	CE99_45	B	CE00_11	C	CE00_29	C
CE00_33	C	CE01_06	B	CE01_07	A	CE01_15	C
CE01_23	A	CE01_34	A	CE02_02	B	CE02_05	B
CE02_17	B	CE02_32	C	CE02_42	A	CE03_04	D (69%)
CE03_26	B (47%)	CE03_30	C (63%)	CE03_43	C (54%)	CE05SP_17	A
CE05SP_18	D	CE05SP_36	A	CE05SP_45	A	CE04_08	A (56%)
CE04_11	C (60%)	CE04_14	B (66%)	CE04_20	A (37%)	CE04_44	C (58%)
CE05_14	C (69%)	CE05_22	B (65%)	CE05_29	B (26%)	CE05_34	D (57%)
CE05_38	A (72%)	CE05_39	A (65%)	CE05_40	A (64%)	CE05_41	C (51%)
CE05_50	C (82%)	CE06_07	A (59%)	CE06_10	C (42%)	CE06_28	C (56%)
CE06_31	A (43%)	CE06_39	C (33%)	CE06_47	A (45%)	CE06_48	C (25%)
CE07_15	C (54%)	CE07_17	C (46%)	CE07_35	D (62%)	CE07_47	C (20%)
CE08_01	C (73%)	CE08_07	A (52%)	CE08_17	D (71%)	CE08_20	A (74%)
CE08_30	C (66%)	CE08_33	B (54%)	CE08_37	D (36%)	CE08_43	D (62%)
CE08_45	A (35%)	CE09_10	C (77%)	CE09_14	D (37%)	CE09_17	A (35%)
CE09_23	B (64%)	CE09_29	D (60%)	CE09_32	D (75%)	CE09_35	B (69%)
CE09_36	A (52%)	CE09_37	C (60%)	CE09_48	D (67%)	CE10_19	C (70%)
CE10_20	D (62%)	CE10_23	A (72%)	CE10_28	D	CE10_35	C (72%)
CE10_39	C (49%)	CE10_40	C (50%)	CE10_42	A (74%)	CE10_43	C (48%)
CE10_44	B (55%)	CE10_45	B (68%)	CE11_12	A (86%)	CE11_19	A (71%)

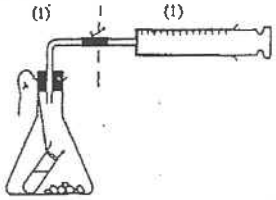
CE11_20	D (48%)	CE11_24	D (86%)	CE11_28	A (34%)	CE11_29	A
CE11_43	A (31%)	ASL05(I)_01	C	ASL12(I)_03	B	DSE11SP_08	D
DSE11SP_14	B	DSE11SP_16	A	DSE11SP_17	A	DSE11SP_18	C
DSE11SP_20	C	DSE12PP_08	C	DSE12PP_09	B	DSE12PP_13	A
DSE12PP_19	C	DSE12PP_20	C	DSE12PP_24	D	DSE12_02	D (54%)
DSE12_04	C (71%)	DSE12_10	C (88%)	DSE12_14	B (83%)	DSE12_19	D (59%)
DSE12_20	A (71%)	DSE13_03	D (64%)	DSE13_08	C (41%)	DSE13_09	A (64%)
DSE13_10	C (75%)	DSE13_11	A (62%)	DSE14_06	C (64%)	DSE14_07	B (32%)
DSE14_13	C (76%)	DSE14_15	B (70%)	DSE14_21	D (32%)	DSE15_01	A (46%)
DSE15_04	D (74%)	DSE15_08	D (88%)	DSE15_09	B (87%)	DSE16_06	B (59%)
DSE16_07	A (58%)	DSE16_08	A (66%)	DSE16_18	A (85%)	DSE16_19	C (27%)
DSE16_22	D (49%)	DSE17_02	D (64%)	DSE17_06	C (55%)	DSE17_10	A (57%)
DSE17_11	B (64%)	DSE17_17	A (59%)	DSE17_21	C (68%)	DSE18_06	B (65%)
DSE18_10	A (63%)	DSE18_11	D (50%)	DSE18_24	C (48%)	DSE19_04	B
DSE19_05	A	DSE19_16	D	DSE19_21	A	DSE19_20	D

DSE2020:

4_A 11_D 16_C 17_B 18_A

Structural Questions

CE90_02b

(i) 

[2]

(ii) At X, the rate is faster. Concentration of acid for the reaction is higher and the mass of calcium carbonate is larger. [1]

(iii) More carbon dioxide gas is collected from B (120 cm^3) than from A (96 cm^3). [1]
Thus, sample B has a higher purity (or less impurities) than sample A. [1]
The initial rate of sample A is greater than that of sample B (steeper slope for A than B). [1]
Thus, more surface area/smaller particle size in A than in B. [1]

CE90_03b

(i) A weak acid is partially (slightly) ionized [1]
to produce hydrogen ions. [1]
OR, $C_nH_{2n+1}COOH \rightleftharpoons C_nH_{2n+1}COO^- + H^+$

(ii) A few drops of phenolphthalein [1]
changes from colourless to pink. [1]

(iii) (1) moles of NaOH used $= 0.18 \times \frac{22.4}{1000} = 0.004032$ [1]

(2) $C_nH_{2n+1}COOH + NaOH \longrightarrow C_nH_{2n+1}COONa + H_2O$
mole ratio $C_nH_{2n+1}COOH$: NaOH = 1 : 1
So, number of mole of $C_nH_{2n+1}COOH$ used = 0.004032 mole [1]

molar mass of $C_nH_{2n+1}COOH = \frac{0.355}{0.004032} = 88.05$ [1]

So, relative molecular mass of $C_nH_{2n+1}COOH$ = 88.05 (no unit) [1]

CE91_02a

(i) First, use a pipette to draw 25.0 cm^3 of vinegar to a 250.0 cm^3 volumetric flask. [2]
Then fill up to the mark with distilled water. [1]

(ii) Use phenolphthalein as indicator. [1]
At end point, the colour changes from colourless to red. [1]

(iii)

Titration /Burette reading	1	2	3	4
Final reading (cm^3)	25.50	25.70	26.20	25.90
Initial reading (cm^3)	0.00	1.00	1.30	1.10
Volume of NaOH used	25.50 – 0.00 = 25.50	25.70 – 1.00 = 24.70	26.20 – 1.30 = 24.90	25.90 – 1.10 = 24.80

1st trial would not be counted since the value is largely different from others.

Reasonable average volume of NaOH used = (24.70 + 24.90 + 24.80) / 3
= 24.80 cm^3 [1]

(iv) $NaOH + CH_3COOH \longrightarrow CH_3COONa + H_2O$ [1]

(v) mole of $NaOH = 0.10 \times \frac{24.80}{1000} = 0.00248$ [1]

$NaOH + CH_3COOH \longrightarrow CH_3COONa + H_2O$
Mole ratio NaOH : CH_3COOH = 1 : 1
For diluted vinegar, so, number of mole of CH_3COOH = 0.00248 mole

$[CH_3COOH(aq)]$ (diluted) $= \frac{0.00248}{\frac{25}{1000}} = 0.0992$ mol dm^{-3} [1]

$[CH_3COOH(aq)]$ (undiluted) in B $= 0.0992 \times \frac{250}{25} = 0.992$ mol dm^{-3} [1]

(vi) Given: better buy = lower price per gram of CH_3COOH

mass of CH_3COOH in 250 cm^3 of vinegar A $= 50 \times \frac{250}{1000} = 12.5$ g

mole of CH_3COOH in B $= 0.992 \times \frac{500}{1000} = 0.496$

mass of CH_3COOH in B $= 0.496 \times (12 + 1 \times 3 + 12 + 16 \times 2 + 1) = 29.76$ g

For Brand A, \$ per g of $CH_3COOH = \frac{3.00}{12.25} = 0.24$ [1]

For Brand B, \$ per g of $CH_3COOH = \frac{6.00}{29.76} = 0.20$ [1]

Brand B is better buy. [1]

CE92_01a

(i) Any two:
The hair of the girl is not tied up. [1]
The H_2SO_4 bottle is too close to the edge of the bench. [1]
The H_2SO_4 bottle is not stoppered.

(ii) (1) Copper(II) sulphate [1]

(2) $CuO + H_2SO_4 \longrightarrow CuSO_4 + H_2O$
(excess)
1 mole of H_2SO_4 gives 1 mole of $CuSO_4$ [1]

mole of H_2SO_4 = mole of $CuSO_4 = 2.0 \times \frac{50.0}{1000} = 0.10$ [1]

mass of $CuSO_4 = 0.1 \times (63.5 + 32.1 + 16 \times 4) = 15.59$ g [1]

(iii) Heating can increase the rate of reaction. [1]
OR, Heating can make the reaction faster.

(iv) It is because the $CuSO_4(aq)$ solution obtained is unsaturated. [1]

CE93_01b

(i) Acids in liquid waste will cause serious water pollution which is harmful to aquatic species. [1]

(ii) $Ca(OH)_2 + 2HCl \longrightarrow CaCl_2 + 2H_2O$ [1]

OR, $Ca(OH)_2 + 2H^+ \longrightarrow Ca^{2+} + 2H_2O$

(iii) moles of HCl discharged per minute $= 0.5 \times 20 = 10$ mole

$Ca(OH)_2 + 2HCl \longrightarrow CaCl_2 + 2H_2O$ [1]

mole of $Ca(OH)_2$ required to react all $HCl = \frac{10}{2} = 5$ mole [1]

mass of $Ca(OH)_2$ required per minute $= 5 \times (40.1 + 16 \times 2 + 1 \times 2) = 370$ g [1]

(iv) It is because Na_2CO_3 reacts much faster with acids than that of slaked lime. [1]

OR, Na_2CO_3 has a much higher solubility in water than that of slaked lime.

CE93_04b

(i) $CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$ [1]

(iii) Method 1:

Crush the egg shell into small piece [1]

to increase the reacting surface area. [1]

Method 2:

Also, heating [1]

can increase the energy of the particles of reactants. [1]

CE94_01

(a) Group II [1]

(b) (i) $X + 2HCl \longrightarrow XCl_2 + H_2$ [1]

OR, $Mg + 2HCl \longrightarrow MgCl_2 + H_2$

(ii)  [2]

(c) A colourless gas rapidly evolves. [1]

(d) Y, X, Z [1]

Y is the most reactive because only Y can react with cold water but X and Z cannot. [1]

X is more reactive than Z because X can react with HCl but Z cannot. [1]

CE94_05a

(i) pipette [1]

(ii) [1]

mole of $NaOH = 0.10 \times \frac{18.2}{1000} = 0.00182$

$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$

mole of H_2SO_4 in 25 $cm^3 = \frac{0.00182}{2} = 9.1 \times 10^{-4}$

mole of H_2SO_4 in 500 $cm^3 = 9.1 \times 10^{-4} \times \frac{500}{25} = 0.0182$

$[H_2SO_4]$ in Rainbow $= \frac{0.0182}{\frac{1}{1000}} = 18.2$ M [1]

(iii) It will dissolve metal drains. [1]

(iv) The worker should wear safety glasses [1]

because conc. H_2SO_4 is highly corrosive. [1]

CE95_07

(i) Citric acid / vitamin C (ascorbic acid) when dissolves in water gives $H^+(aq)$ [1]

which reacts with calcium carbonate to give gas (CO_2) bubbles. [1]

$CaCO_3 + 2H^+ \longrightarrow Ca^{2+} + H_2O + CO_2$ [1]

(iii) Out of moisture (water) / in a dry place. [1]

Reason: The amount of active ingredients will decrease/ [1]

the tablet will lose function/

the active ingredients of the tablet will react in the presence of water.

OR, Out of heat/ in a cool place.

Reason: at high temperature, vitamin C deteriorate /

$CaCO_3$ undergoes decomposition /

the amount of active ingredients will decrease /

the tablet will lose function.

OR, Away from sunlight

Reason: vitamin C may decompose /

$CaCO_3$ can be decomposed by sunlight.

CE96_06b

(i) A is 2 M ammonia / 2M NH_3 [1]

Ammonia solution is alkaline. When ammonia ionizes in water to give OH^- which turns red litmus paper blue. $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$ [1]

(iii) (1) Add a piece of pH paper / a few drops of universal indicator to the reagent. [1]

(2) HCl will give a lower pH / a deeper red colour [1]

Because HCl ionize to a greater extent than CH_3COOH. HCl is a stronger acid and HCl has a higher concentration of H^+ [1]

OR (1) Add a piece of Mg ribbon / Zn granules/ $CaCO_3(s)$ to the reagent

(2) HCl will give gas bubbles at a faster rate

Because HCl ionize to a greater extent than CH_3COOH. HCl is a stronger acid and HCl has a higher concentration of H^+

OR (1) Add $AgNO_3(aq)$ / $Pb(CH_3COO)_2(aq)$ to the reagent

(2) HCl will give a white precipitate while CH_3COOH will not

Because AgCl/$PbCl_2$ is insoluble in water

OR (1) Allow the vapour of the reagent to react with $NH_3(g)$
(2) HCl will give dense white fume while CH_3COOH will not
Because $NH_4Cl(s)$ is formed when $HCl(g)$ reacts with $NH_3(g)$

OR (1) Measure the electrical conductivity of the solutions.
(2) HCl has a higher conductivity
Because HCl ionize to a greater extent than CH_3COOH. HCl is a stronger acid / HCl has a higher concentration of H^+

OR (1) Measure the pH of the solutions with a pH meter.
(2) HCl has a lower pH
Because HCl ionize to a greater extent than CH_3COOH. HCl is a stronger acid and HCl has a higher concentration of H^+

OR (1) Warm the reagent with ethanol in the presence of a few drops of conc. H_2SO_4
(2) CH_3COOH gives a pleasant smell while HCl is not
Because an ester is formed when CH_3COOH reacts with CH_3CH_2OH

CE96_09b(iv)

(1) To recover copper metal / To produce the loss of copper metal [1]
Cu^{2+} ions can cause water pollution / death of (harmful to) marine lives [1]

(2) 1 mole of Cu^{2+} ions react with 2 mole of NaOH [1]
OR, $Cu^{2+} + 2OH^- \longrightarrow Cu(OH)_2$
mole of $NaOH = 8.0 \times 3.5 = 28$
mole of $Cu^{2+} = \frac{28}{2} = 14$
$[Cu^{2+}] = \frac{14}{20} = 0.7$ M [1]

CE97_03

(a) Using pH paper / universal indicator / pH meter [1]

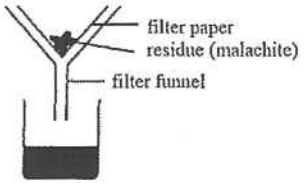
(b) pH : 1M sulphuric acid < 1M hydrochloric acid < 1M ethanoic acid [1]
Ethanoic acid is a weak acid, it undergoes incomplete ionization. It has the highest pH. [1]
Both hydrochloric acid and sulphuric acid are strong acids. It undergoes complete ionization. It has lower pH than ethanoic acid. [1]
Sulphuric acid is dibasic while hydrochloric acid is monobasic. 1M H_2SO_4 contains a higher concentration of $H^+(aq)$ ions than 1M HCl. [1]
So, pH of H_2SO_4 is lower than HCl at same concentration.

CE97_07a

(i) $CuCO_3 + H_2SO_4 \longrightarrow CuSO_4 + H_2O + CO_2$ [1]

(ii) To ensure that all the sulphuric acid has been used up / malachite is in excess [1]

(iii) [3]

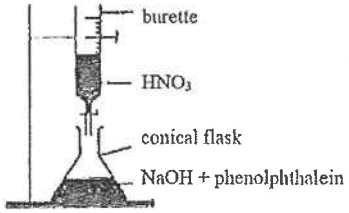


(iv) [1]
mole of H_2SO_4 used $= 2 \times \frac{50}{1000} = 0.1$
Since $CuCO_3$ is in excess,
mole of $CuSO_4 \cdot 5H_2O$ = mole of H_2SO_4 used = 0.1 [1]
Theoretical mass of $CuSO_4 \cdot 5H_2O = 0.1 \times 249.6 = 24.96$ g
Formula mass of $CuSO_4 \cdot 5H_2O = 63.5 + 32.1 + 16\times4 + 5(1.0\times2 + 16.0) = 249.6$ [1]
(Also accept 25.0 g and 25 g; deduct 1 mark for wrong/ no unit)

CE98_06a

(i) (1) $NaOH + HNO_3 \longrightarrow NaNO_3 + H_2O$ [1]

(2) [3]



(1 mark for a diagram showing the set-up for the titration experiment;
2 marks for labelling the apparatus and reagents)

(3) from red to colourless [1]

(4) Add dilute nitric acid to 1 M sodium hydroxide solution in the same volume ratio as that in the titration result, without adding the indicator. [1]
OR, repeat the titration procedure without adding the indicator.

(ii) (1) Formula mass of $NaNO_3 = 23 + 14 + 16\times3 = 85$ [1]
% by mass of $N = \frac{14}{85} \times 100\% = 16.5\%$ (*or* 16.47%) [1]

(2) Nitrogen is used in plants to produce amino acids / proteins / chlorophyll. [1]

CE99_02

(a) Effervescence / colourless gas bubbles / magnesium carbonate dissolves / heat evolves [1]

$MgCO_3 + 2HNO_3 \longrightarrow Mg(NO_3)_2 + H_2O + CO_2$ [1]

OR, $MgCO_3 + 2H^+ \longrightarrow Mg^{2+} + H_2O + CO_2$

CE00_02

(a) The relative atomic mass is **the average mass of an atom of the element on the ^{12}C (=12.000) scale.** [2]

(b) (i) Y / potassium (K) [1]

Y is a reactive metal and reacts readily with oxygen / water in air. [1]

(ii) X / argon (Ar) [1]

X is chemically inert / is a noble gas / will not react with the hot tungsten filament. [1]

(iii) W / sulphur (S) [1]

Sulphur can form SO_2 or SO_3, which, when dissolved in water, give H_2SO_3 or H_2SO_4 which are acidic solution. [1]

CE01_02

(a) Zinc granules dissolve / a colourless gas is evolved / solution gets warm. [1]

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$ [1]

OR, $Zn + 2H^+ \longrightarrow Zn^{2+} + H_2$

(b) The green colour of the solution becomes paler (colourless) and green precipitate is formed. [1]

$FeSO_4 + 2NaOH \longrightarrow Fe(OH)_2 + Na_2SO_4$ [1]

OR, $Fe^{2+} + 2OH^- \longrightarrow Fe(OH)_2$

CE01_04

Chemical knowledge

Any SIX of the following:

The piece of sodium metal sinks until it reaches the surface of water [1]

because sodium is denser than paraffin oil but less dense than water. [1]

Sodium reacts with water to give a colourless gas (hydrogen) / The size of sodium decreases. [1]

The colourless gas carries the sodium metal to the surface of paraffin oil. [1]

When hydrogen gas is discharged, the piece of sodium metal sinks again. [1]

The colour of the aqueous layer turns pink [1]

Or, due to the formation of OH^- ions to give an alkaline solution.

Effective communication [3]

CE01_06b

(i) [1]

$$\text{mole of HCl used} = 0.258 \times \frac{25.4}{1000} = 0.00655$$

$Na_2CO_3 + HCl \longrightarrow 2NaCl + H_2O + CO_2$

Mole ratio Na_2CO_3 : HCl = 1 : 2

$$\text{moles of } Na_2CO_3 = \frac{0.00655}{2} = 0.003275 \text{ mole}$$ [1]

(ii) Formula mass of $Na_2CO_3 \cdot xH_2O = 23\times2 + 12 + 16\times3 + 18x = 106 + 18x$ [1]

$$\text{number of moles of } Na_2CO_3 \cdot xH_2O = \frac{\text{mass}}{\text{molar mass}}$$

$$0.003275 = \frac{0.933}{106 + 18x}$$ [1]

$$x = 10$$ [1]

(iii) From yellow to orange [1]

(iv) Step:

1. rinse the burette with distilled water / deionized water [1]
2. then with hydrochloric acid [1]
3. fill the burette with the hydrochloric acid, making sure that there is no air bubble in the burette and the meniscus is not above the zero mark. [1]

CE02_01c

(i) Formula mass of $(NH_4)_2SO_4 = (14 + 4) \times 2 + 32 + 16 \times 4 = 132$ [1]

$$\%\text{ by mass of N} = \frac{14 \times 2}{132} = 21.2$$ [1]

(Accept 21, 21.2 and 21.21)

(ii) Calcium hydroxide / calcium oxide / calcium carbonate / ammonia solution [1]

(Accept formula and common name.)

Calcium hydroxide / calcium oxide / calcium carbonate / ammonia solution reacts with H^+ in soil to neutralize acid in soil. [1]

CE02_06a

(i) Calcium hydroxide / $Ca(OH)_2$ [1]

(ii) $Mg(OH)_2(s) + 2HCl(g) \longrightarrow MgCl_2(s) + 2H_2O(l)$ [2]

(iii) Molten magnesium chloride contains mobile ions. [1]

CE02_07a

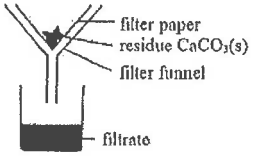
(i) $CaCO_3 + 2HNO_3 \longrightarrow Ca(NO_3)_2 + H_2O + CO_2$ [1]

OR, $CaCO_3 + 2H^+ \longrightarrow Ca^{2+} + H_2O + CO_2$

Evolution of CO_2 stops after reaction. [1]

OR, Test the pH of the solution using pH paper; the pH should be less than 7.

(ii) Diagram: [2]



(1 mark for the diagram; 1 mark for labelling the funnel and filter paper)

(iii) $Ca^{2+} + SO_4^{2-} \longrightarrow CaSO_4$ [1]

(iv) To remove any soluble impurities (or appropriate example) [1]

(v) (1) $$\text{mole of of } CaSO_4 = \frac{10.52}{40 + 32 + 16 \times 4} = 0.0774 \text{ mole}$$ [1]

Since all Ca^{2+} from $CaSO_4$ are from $CaCO_3$,

so number of mole of $CaCO_3 = 0.0774$ mole

mass of $CaCO_3$ in the sample of calcite $= 0.0774 \times (40 + 12 + 16 \times 3) = 7.74$ g [1]

$$\% \text{ by mass of } CaCO_3 = \frac{7.74}{7.98} \times 100 = 97.0$$ [1]

(Accept answers from 96.5 to 97.0)

(2) The sample does not contain ions which form insoluble sulphate, e.g. Ba^{2+}, Pb^{2+} [1]

OR, There is no loss of Ca^{2+} ions during the experiment

OR, $CaCO_3$ is the only calcium-containing compound present in the sample

CE02_07c

(i) $3Cl_2 + 8NH_3 \longrightarrow 6NH_4Cl + N_2$ [2]

(ii) ammonium chloride / NH_4Cl [1]

CE02_09a

(i) (1) $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$ [1]

(2) Oils react with alkalis to give water soluble substances. [1]

(ii) Wear safety glasses [1]

because ammonia solutions attack eyes. [1]

OR, The glass cleaner should be used in a well-ventilated environment because ammonia has a pungent smell / is toxic.

OR, Wear gloves because alkaline solutions can attack skin.

CE02_09

(i) (1) distilled water / deionized water [1]

(2) distilled water / deionized water [1]

(ii) pipette [1]

(iii) $NH_3 + HCl \longrightarrow NH_4^+ + Cl^-$

$$\text{mole of } NH_3 = \text{moles of HCl used} = 0.23 \times \frac{28.7}{1000} = 6.60 \times 10^{-3} \text{ mole}$$ [1]

$$\text{mole of } NH_3 \text{ in 250 cm}^3 \text{ diluted sample} = 6.60 \times 10^{-3} \times \frac{250}{25} = 0.066$$ [1]

$$[NH_3] \text{ in 25 cm}^3 \text{ glass cleaner} = \frac{0.066}{\frac{25}{1000}} = 2.64 \text{ mol dm}^{-3}$$ [1]

CE03_08b

(i) $Ni^{2+} + 2OH^- \longrightarrow Ni(OH)_2$ [1]

(ii) yellow to orange [1]

(iii) (1) $HCl + NaOH \longrightarrow NaCl + H_2O$ [1]

$$\text{mole of } OH^- = \text{mole of HCl used} = 0.251 \times \frac{18.5}{1000} = 4.64 \times 10^{-3}$$ [2]

(2) $$\text{mole of NaOH used} = 0.503 \times \frac{25}{1000} = 0.0126$$ [1]

(3) mole of NaOH that has reacted with Ni^{2+}

$= 0.0126 - 4.64 \times 10^{-3} = 7.96 \times 10^{-3}$ [1]

$Ni^{2+}(aq) + 2OH^-(aq) \longrightarrow Ni(OH)_2(s)$

$$\text{mole of } Ni^{2+} = \frac{7.96 \times 10^{-3}}{2} = 3.98 \times 10^{-3}$$

$$[Ni^{2+}] = \frac{3.98 \times 10^{-3}}{\frac{25}{1000}} = 0.159 \text{ mol dm}^{-3}$$ [1]

(iv) To remove OH^- ions which stuck on the surface of the residue. [1]

CE04_02b

Warm the substance with NaOH / CaO / KOH. [1]

$NH_4Cl(s)$ reacts with NaOH(aq) to give an alkaline gas / a gas with a pungent odour, while $KCl(s)$ does not. [1]

OR, Heat substances in a test tube.

$NH_4Cl(s)$ sublimes upon heating while $KCl(s)$ does not.

CE04_07a

(i) Transfer the solution to a 250 cm^3 volumetric flask. (All washings should also be transferred to the volumetric flask.) [1]

Add distilled (deionized) water to the flask until the bottom of the meniscus reaches the mark of the flask. [1]

(ii) From colourless to pink / red. [1]

(iii) (1) $$\text{mole of NaOH used} = 0.100 \times \frac{25.7}{1000} = 2.57 \times 10^{-3}$$ [1]

(2) mole of ionizable hydrogen $= 2.57 \times 10^{-3} \times 10$ [1]

mole of solid acid used $= \frac{1.15}{90} = 0.0127$ [1]

Basicity of solid acid $= \frac{2.57 \times 10^{-2}}{0.0127} = 2.01 = 2$ (an integer) [1]

CE05_03

(a) (i) Sodium hydroxide is very corrosive. [1]

(ii) Use calcium hydroxide instead. [1]

(b) (i) Copper cannot displace $H^+(aq)$ from HCl(aq). [1]

(ii) Add Zn/Mg/Fe to HCl(aq). [1]

(c) (i) When water is added to concentrated H_2SO_4, a lot of heat is produced. This heat can cause splashing out of the corrosive acid solution. [1]

(ii) Add concentrated H_2SO_4 to water slowly and stir the mixture. [1]

CE05_10

(a) When dissolved in water, citric acid gives $H^+(aq)$ which reacts with $HCO_3^-(aq)$ to give $CO_2(g)$. [1]

$H^+(aq) + HCO_3^-(aq) \longrightarrow H_2O(l) + CO_2(g)$ [1]

(b) (i) 0.098 g [1]

(ii) No. of moles of $NaHCO_3$ = No. of moles of CO_2

$= \frac{0.098}{12 + 16 \times 2} = 2.23 \times 10^{-3}$ [1]

Mass of $NaHCO_3 = 2.23 \times 10^{-3} \times (23+1+12+16\times3) = 0.187$ g [1]

(iii) Any ONE of the following: [1]

- during the experiment, the change of mass is very small
- more accurate / sensitive
- experiment results in the form of graph can be obtained immediately, time can be saved for the interpretation of experimental results

(iv) Graph [2]

(During the reaction, the slope of the graph should be greater than the original one indicating increase in rate. The reaction time needed is shorter. When the reaction stops, the mass should be the same as that indicated by the original one.)

CE06_04

(a) $Ag^+(aq) + Cl^-(aq) \longrightarrow AgCl(s)$ [1]

(b) Filtration / decantation [1]

(c) Iron(III) hydroxide [1]

(d) The presence of $NH_4^+(aq)$ ions can be shown by warming solution Z. An alkaline gas will evolve. [1]

The presence of $K^+(aq)$ ions cannot be shown. As in flame test, the lilac flame of potassium will be masked by the brilliant yellow flame of sodium. [1]

(e) Yellow [1]

CE06_09

(a) Use a burette to contain HCl(aq). [1]

Rinse the burette with distilled water (deionized water) and then with the 0.18M hydrochloric acid. [1]

Add the indicator to the flask, and titrate the acid from the burette until the indicator changes from yellow to orange. [1]

(b) (i) $\frac{20.10 + 19.90 + 20.00}{3} = 20.00\ cm^3$ [1]

(ii) $CO_3^{2-} + 2H^+ \longrightarrow H_2O + CO_2$

mole of $H^+(aq)$ used $= 0.18 \times \frac{20}{1000} = 3.6 \times 10^{-3}$ [1]

mole of Na_2CO_3 in diluted solution $= \frac{3.6 \times 10^{-3}}{2}$

mole of Na_2CO_3 in 2.0 g of the sample $= \frac{3.6 \times 10^{-3} \times 10}{2} = 0.018$ [1]

mass of $Na_2CO_3 = 0.018 \times 106 = 1.908$ g

% by mass of $Na_2CO_3 = \frac{1.908}{2} \times 100\% = 95.4\%$ [1]

(c) Use a pH meter / pH senser [1]

(d) Na_2CO_3 is used to remove hardness in fresh water. Mg^{2+} and Ca^{2+} ions in hard water react with CO_3^{2-} to form insoluble metal carbonates. [1] [1]

CE07_05

(a) $Zn + 2H^+ \longrightarrow Zn^{2+} + H_2$ [1]

OR, $Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

(b) No further gas evolved. [1]

(c) To wash away Zn^{2+}/ Cl^- / H^+ / $ZnCl_2$ / HCl / acid left behind. [1]

(d) Copper will be oxidized / become copper(II) oxide / copper reacts with oxygen (or air). [1]

(e) % by mass of $Zn = \frac{2.00 - 1.75}{2.00} \times 100\% = 12.5\%$ [2]

CE07_10

(a) $10.0cm^3$ of the acid is transferred into a $250.0cm^3$ volumetric flask using a pipette. [1]

Distilled water is added up to the graduation mark. [1]

(b) mole of $NaOH = 0.0176 \times 0.025 = 4.40 \times 10^{-4}$

mole of H_3PO_4 in dilute solution $= \frac{4.40 \times 10^{-4}}{2} = 2.20 \times 10^{-4}$

$[H_3PO_4] = \frac{2.20 \times 10^{-4} \times 10}{\frac{10}{1000}} = 0.22\ M$ [3]

(c) Neutralization is a quick process. [1]

As titration proceeds, concentration of acid decreases, less chance of NaOH to contact with the acid / rate of reaction decreases. [1]

(d) (i) A solution of known concentration. [1]

(ii) Not appropriate. Solid sodium hydroxide absorbs water / CO_2 readily in air. [1]

CE08_04

(a) Colourless bubbles / gas evolve / magnesium dissolves. [1]

$Mg + 2HCl \longrightarrow MgCl_2 + H_2$ [1]

OR, $Mg + 2H^+ \longrightarrow Mg^{2+} + H_2$

(b) The reaction between magnesium and hydrochloric acid is exothermic / increase the temperature. [1]

Solubility of carbon dioxide in the carbonated water decreases so that more carbon dioxide gas evolves. [1]

CE08_11

(a) (i) (1) $H_2SO_4 + CuO \longrightarrow CuSO_4 + H_2O$ [1]

OR, $2H^+ + CuO \longrightarrow Cu^{2+} + H_2O$

(2) To make sure that all the sulphuric acid has been reacted. [1]

OR, To make sure that the product is not contaminated with sulphuric acid.

(ii) Filtration / filtering [1]

(iii) The solubility of $CuSO_4$ decreases when the temperature of the solution drops. [1]

(iv) (1) Anhydrous $CuSO_4$ / CuO will be obtained. [1]

OR, $CuSO_4$ will be decomposed.

OR, The water of crystallization will be removed.

(2) Absorb the water by filter paper / place it in a desiccator. [1]

(b) (i) No. of moles of copper(II) sulphate = No. of moles of sulphuric acid

$= 1 \times 0.15$

$= 0.15$ (mole) [1]

(ii) Molar mass of $CuSO_4 \cdot 5H_2O = 249.6$ g

No. of moles of $CuSO_4 \cdot 5H_2O = 16.2 / 249.6 = 0.065$ (mole) [1]

(iii) Should be different. / Answer in (ii) < (i)

Some $CuSO_4$ dissolved in the solution and did not crystallize out. [1]

CE08_13

Chemical knowledge

Principle	Process	Observation	
		1M H_2SO_4	1M HNO_3
Redox	Add Zn	No brown gas evolved	Brown gas evolved
Precipitation	Add $BaCl_2$(aq) / $CaCl_2$(aq) / etc.	White precipitate	No white precipitate
Basicity	Titrate with NaOH(aq)	More NaOH(aq) needed to reach the end point for H_2SO_4 than HNO_3	

[6]

Effective communication [3]

CE09_01

(a) Calcium carbonate / $CaCO_3$ [1]

(b) Limestone dissolves. / Gas (bubbles) given out. [1]

$CaCO_3 + 2H^+ \longrightarrow Ca^{2+} + H_2O + CO_2$ [1]

(c) (i) $CaCO_3 \longrightarrow CaO + CO_2$ [1]

(ii) Decomposition of calcium carbonate is an endothermic process. [1]

OR, Carbon dioxide evolved can extinguish fire.

CE09_07

(a) Pour the mixture in water with stirring until no more solid can be dissolved. [1]

Filter the mixture and the residue is calcium sulphate. [1]

(b) Add acidified silver nitrate solution to both solution. [1]

The one with white precipitate formed is potassium chloride solution. [1]

OR, Add chlorine water / gas to both solutions.

The one with brown / yellow colour formed is potassium bromide solution.

CE09_11

(a) $Al(OH)_3 + 3HCl \longrightarrow AlCl_3 + 3H_2O$ [1]

OR, $Al(OH)_3 + 3H^+ \longrightarrow Al^{3+} + 3H_2O$

(b) Pour all the solution obtained from Step I to a (250 cm^3) volumetric flask. [1]

Rinse all the solution left in the beaker by distilled water and transfer the washing to the volumetric flask. [1]

Add distilled water to the mark of the volumetric flask and shake the volumetric flask thoroughly. [1]

(c) Methyl orange: from red to orange / yellow [2]

OR, phenolphthalein: colourless to pink

(d) (i) mole of excess HCl = mole of NaOH $= 0.20 \times \frac{20.8}{1000} = 4.16 \times 10^{-3}$ [1]

(ii) mole of HCl used to react with $Al(OH)_3$

$= 0.05 \times 1.0 - 4.16 \times 10^{-3} \times \frac{250}{25} = 0.0084$ [1]

mole of $Al(OH)_3$ in the tablet $= \frac{0.0084}{3} = 2.8 \times 10^{-3}$ [1]

CE10_02

(a) (i) Orange, dichromate / $Cr_2O_7^{2-}$ ion [1]

(ii) Heat with sodium hydroxide / potassium hydroxide / calcium hydroxide / calcium oxide / soda lime. [1]

A colourless gas is evolved which has a characteristic / pungent smell / which turns moist red litmus paper blue. [1]

(b) (i) $(NH_4)_2Cr_2O_7 \longrightarrow Cr_2O_3 + N_2 + 4H_2O$ [1]

(ii) Test with anhydrous / dry cobalt(II) chloride paper. [1]

Water vapour changes it from blue to pink. [1]

OR, Test with anhydrous / dry copper(II) sulphate.

Water vapour changes it from white to blue.

CE10_06

(a) Limewater turns milky and then turns clear again. [1]

$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$ [1]

$CaCO_3 + H_2O + CO_2 \longrightarrow Ca(HCO_3)_2$ [1]

(b) No. Sodium carbonate is soluble in water. [1]

(c) No. The percentage of carbon dioxide in air is very low and similar observations would not be made in a short period of time. [1]

OR, Yes. Air contains a low percentage of carbon dioxide and similar observations would be made in a sufficiently long period of time.

(d) $Na_2CO_3 + 2H^+ \longrightarrow 2Na^+ + H_2O + CO_2$ [1]

CE10_10

(a) Pipette [1]

(b) Wash with deionized / distilled water. [1]

Then rinse with 0.50M sulphuric acid. [1]

(c) $H^+ + OH^- \longrightarrow H_2O$ [1]

(d) As neutralization is exothermic, temperature of the solution rose when sulphuric acid was added into sodium hydroxide solution. [1]

When the sodium hydroxide was just completely reacted, the temperature reached a maximum value. [1]

After that, the addition of excess cold sulphuric acid lowered the temperature of the reaction mixture. [1]

(e) $\text{mole of NaOH} = 2 \times 0.5 \times \frac{15}{1000} = 1.5 \times 10^{-2}$ [1]

$[\text{NaOH(aq)}] = \frac{1.5 \times 10^{-2}}{\frac{25}{1000}} = 0.60 \text{ M}$ [1]

CE10_13

Chemical knowledge [6]

(a) The higher the concentration of hydrogen ions, the lower is the pH.

(b) Concentration: The more concentrated an acid is, normally the more concentrated is the hydrogen ions.

(c) Strength: A strong acid has a higher degree of ionization / dissociation in water to give hydrogen ions.

Correct examples of strong acid and weak acid (e.g. 1M HCl and 1M CH_3COOH)

(d) Basicity: An acid with a higher basicity normally gives a higher concentration of hydrogen ions.

Correct examples of acids with different basicity (e.g. 1M H_2SO_4 and 1M HCl)

Effective communication [3]

CE11_01

(b) Golden yellow flame implies the salt contains sodium ions. [1]

The white precipitate formed is calcium sulphate ($CaSO_4$), this implies the salt contains sulphate ions. [1]

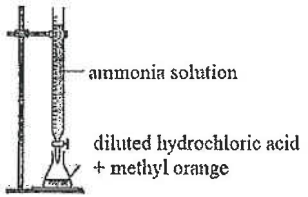
The salt should be sodium sulphate. [1]

CE11_09

(a) pipette / volumetric flask [1]

(b) $[\text{HCl(aq)}] = 2 \times \frac{25}{250} = 0.2 \text{ M}$ [1]

(c) [3]



(d) from red to orange [1]

(e) $HCl + NH_3 \longrightarrow NH_4Cl$ [1]

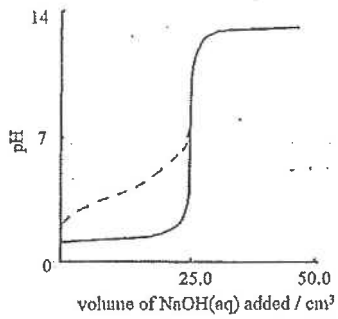
OR, $H^+ + NH_3 \longrightarrow NH_4^+$

(f) $\text{mole of } NH_3 = 0.2 \times \frac{25}{1000} = 5.0 \times 10^{-3}$ [1]

$[NH_3(aq)] = \frac{5.0 \times 10^{-3}}{\frac{22.9}{1000}} = 0.22 \text{ M}$ [1]

AL99(I)_04

(a)



[½]

(b) Thymolphthalein [½]

The pH range of the color change of thymolphthalein falls into the steepest / vertical part of the titration curve. [1]

AL99(I)_04

For the pH 2 HCl(aq), $[H^+] = 10^{-2}$ M [½]

No. of mole of HCl required for the preparation $= 10^{-2} \times 1.0 = 10^{-2}$ [1]

Mass of constant boiling HCl(aq) $= \frac{10^{-2}(1 + 35.5)}{0.202}$ [1]

$= 1.80$ g [½]

AL00(I)_04

$NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l)$

$[OH^-]$ remained $= \frac{0.105 - 0.095}{2} = 5 \times 10^{-3}$ M [1]

$pOH = -\log(5 \times 10^{-3}) = 2.30$

$pH = 14 - pOH = 14 - 2.30 = 11.70$ [1]

AL00(II)_02

Mass of HNO_3 in 1 $dm^3 = 1420 \times 0.68 = 965.6$ [1]

Concentration of the acid $= \frac{965.6}{(1 + 14 + 16 \times 3)} = 15.3$ M [1]

(accept answer from 15.0 to 15.6 M)

ASL00(II)_11

Dropwise addition of NaOH(aq) into two samples solution until in excess respectively. [1]

$Mg(NO_3)_2(aq)$ give white precipitate in the excess NaOH(aq). [½]

$Mg^{2+}(aq) + 2OH^-(aq) \longrightarrow Mg(OH)_2(s)$ [½]

$Al(NO_3)_3(aq)$ give white precipitate, and those precipitate redissolves in excess NaOH(aq). [1]

$Al^{3+}(aq) + 3OH^-(aq) \longrightarrow Al(OH)_3(s)$ [½]

$Al(OH)_3(s) + OH^-(aq) \longrightarrow Al(OH)_4^-(aq)$ [½]

ASL00(II)_12

Digestion of food in mouth gives acids. [1]

$NaHCO_3$ dissolves in water and dissocates to $Na^+(aq)$ and $HCO_3^-(aq)$, which $HCO_3^-(aq)$ consumes $H^+(aq)$ and increase the pH of silva. [1]

$HCO_3^-(aq) + H^+(aq) \longrightarrow H_2O(l) + CO_2(g)$

AL01(I)_07

Weigh a piece of office paper [½]

Immerse paper in excess HCl(aq) [½]

When no CO_2 evolves from the mixture, decant acid and wash paper with distilled water. [1]

Dry the paper in an oven (110 °C) [½]

Weigh the paper again [½]

% by mass of $CaCO_3 = \frac{\text{change in mass of paper}}{\text{original mass of paper}} \times 100$ [1]

Alternative answers

Weigh a piece of office paper [½]

Immerse in a known volume of standard HCl (excess) [1]

Titrate excess HCl using standard KOH (aq) / NaOH (aq) [1]

Calculate mass of $CaCO_3$ from the titration result [½]

% by mass of $CaCO_3 = \frac{\text{mass of } CaCO_3}{\text{mass of paper}} \times 100$ [1]

Alternative answers

Weigh a piece of office paper [½]

Burn the paper completely (in a crucible) [1]

Weigh the CaO (s) produced, (m) [½]

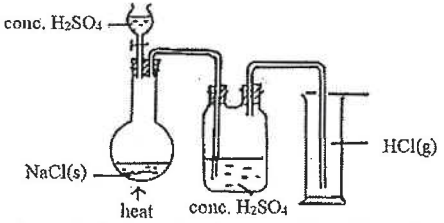
mass of $CaCO_3 = \frac{m}{40+16} \times 100$ [1]

% by mass of $CaCO_3 = \frac{\text{mass of } CaCO_3}{\text{mass of paper}} \times 100$

(For other appropriate methods, award 1 mark for the principle, 2 marks for procedure, 1 mark for calculation.) [1]

AL01(I)_07

Heat NaCl(s) with concentrated H_2SO_4; use conc. H_2SO_4 to dry HCl; connect dried HCl by downward delivery / in a gas syringe. [1]



[3]

Deduct 1 mark for diagram indicating a closed system and 1 mark for using water to remove water vapor in HCl.

AL01(II)_04 (modified)

In aqueous solutions, HCl, HBr and HI are of **comparable strength** because **both compounds ionize completely.** [1]

OR, HI is a stronger acid than HBr and HCl when dissolved in ethanoic acid (or other weak acid)

AL03(I)_01 (modified)

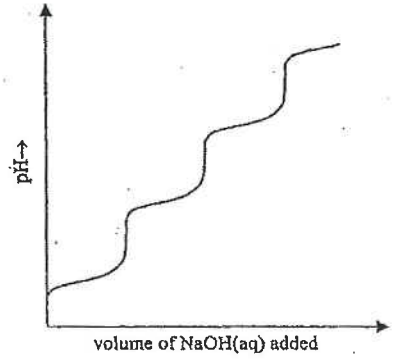
(a) $H_3PO_4(aq) \rightleftharpoons H_2PO_4^-(aq) + H^+(aq)$ [1]

$H_2PO_4^-(aq) \rightleftharpoons HPO_4^{2-}(aq) + H^+(aq)$ [½]

$HPO_4^{2-}(aq) \rightleftharpoons PO_4^{3-}(aq) + H^+(aq)$ [½]

(b) After the removal off a hydrogen ion, the remaining species has an additional negative charge that attracts the remaining hydrogen ions more strongly. [1]

(c) [3]



2 marks for a curve showing the neutralization of $H_3PO_4(aq)$, $H_2PO_4^-(aq)$ and $HPO_4^{2-}(aq)$, 1 mark for labeling the axes.

Remarks: 3 vertical parts for tribasic acid.

AL04(I)_07

Step 1: A standard NaOH(aq) should not be prepared using the method as described. [½]

Explanation: NaOH(s) is not a primary standard / is hygroscopic / NaOH(s) reacts with $CO_2(g)$ in air. [½]

Correction: it is necessary to standardize the NaOH(aq) before use. [½]

Step 3: The burette should not be rinsed with water only. [½]

Explanation: Water that remains in the burette will cause a dilution of the NaOH(aq). [½]

Correction: The burette needs to be rinsed with deionized water and then with the NaOH(aq) prepared. [½]

Step 4: Methyl orange is not a suitable indicator. [½]

Explanation: The experiment involves a titration of a weak acid with a strong alkali. pH at the end point is about 8 to 9. [½]

Correction: Phenolphthalein should be used. [½]

Step 5: Calculation should not be based on the result of one titration only. [½]

Explanation: There may be errors in the titration [½]

Correction: Repeat the titration at least 3 times. Use the mean titre for the calculation. (Ignore the result of the trial titration, if necessary). [½]

ASL04(II)_11

(a) Observation: misty fumes [1]

HCl(g) dissolves in water vapor in air to form HCl(aq). The highly polarized HCl(aq) cause water to condense to water droplets. [1]

(b) Place a glass rod wetted with aqueous ammonia near the mouth of the reagent bottle. [1]

Dense white fumes are formed. [1]

AL05(I)_08

The person did not wear laboratory coat. Should wear a laboratory coat. [1]

The person did not have eye protection. Should weak safety spectacles / goggles. [1]

Should not detect $NH_3(g)$ by smelling while heating the reaction mixture. The mixture may shoot his face. Should detect $NH_3(g)$ by the use of a piece of wet red litmus paper that can change it from red to blue [1]

OR, by HCl(aq) that can form a white fumes with HCl(aq).

OR, should smell $NH_3(g)$ after turning off the Bunsen burner.

AL05(II)_01

(a) $2X(s) + 6HCl(aq) \longrightarrow 2XCl_3(aq) + 3H_2(g)$ [1]

$X_2O_3(s) + 6HCl(aq) \longrightarrow 2XCl_3(aq) + 3H_2O(l)$ [1]

(b) According to the equations, $2X \equiv X_2O_3$

For complete reaction with 6 mole of HCl, the mass of X(s) required is less than that of X_2O_3.

Greatest possible value of RAM of X can be calculated by assuming that the sample contains X only.

No. of mole of HCl(aq) used = (0.0954)(6) = 0.5724 mol [1]

Since the sample consists of pure X & 1 mole of X reacts with 3 moles of HCl

No. of moles of X = 0.5724 ÷ 3 = 0.1908 mol

Greatest possible RAM of X = 16.5 ÷ 0.1908 = 86.5 [1]

Smallest possible value off RAM of X can be calculated by assuming that the sample contains X_2O_3 only.

Since 1 mole of X_2O_3 reacts with 6 moles of HCl

No. of mole of X_2O_3 = 0.5724 ÷ 6 = 0.0954 mol [1]

Let the RAM of X be A

$$\frac{16.5}{2A + 16 \times 3} = 0.0954$$

Smallest possible RAM of X = 62.5 [1]

(c) The only trivalent metal with RAM in the range of 62.5 to 86.5 is gallium, Ga [1]

AL05(II)_04

(a) Paths I: $2Al(s) + 3H_2SO_4(aq) \longrightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$ [1]

$Al_2(SO_4)_3(aq) + 6NaOH(aq) \longrightarrow 2Al(OH)_3(s) + 3Na_2SO_4(aq)$ [1]

Path II: $2Al(s) + 2NaOH(aq) + 6H_2O(l) \longrightarrow 2Na[Al(OH)_4](aq) + 3H_2(g)$ [1]

$2Na[Al(OH)_4](aq) + H_2SO_4(aq) \longrightarrow Na_2SO_4(aq) + 2H_2O(l) + 2Al(OH)_3(s)$ [1]

(b) Path I:

Production of 2 mole of $Al(OH)_3$ requires 3 mol of $H_2SO_4(aq)$ and 6 mol of NaOH [½]

Path II:

Production of 2 mole of $Al(OH)_3$ requires 1 mol of $H_2SO_4(aq)$ and 2 mol of NaOH [½]

(c) Path II is better because less reactants are used [1]

and less heat is produced. [1]

AL06(I)_02

(a) Limestone / marble / chalk / anhydrite / gypsum / fluorite [1]

(b) Amount of $H^+(aq)$ exchanged = $0.020 \times 15 \times 10^{-3} = 3.0 \times 10^{-4}$ mol [1]

Total no. of mole of $Ca^{2+}(aq)$ / $Mg^{2+}(aq)$ = $3.0 \times 10^{-4} \div 2 = 1.5 \times 10^{-4}$ mol

Total hardness of the water sample = $\frac{1.5 \times 10^{-4}}{50 \times 10^{-3}} = 3.0 \times 10^{-3}$ mol dm^{-3} [1]

ASL06(I)_03

Not agree

'A is stronger acid than B' only means the degree of ionization of A is larger than that of B. [1]

However, pH of an acid solution depends on both the degree of ionization and concentration of it.

As such, the stronger acid A may have a higher pH than the weaker acid B if the concentration of acid B is higher than that of A by an adequate amount. [1]

ASL07(I)_03

(a) $CO(NH_2)_2(aq) + 2H^+(aq) + H_2O(l) \longrightarrow CO_2(g) + 2NH_4^+(aq)$ [1]

(b) No. of moles of urea in 2 pieces of chewing gum

$= \frac{1.5 \times 10^{-3}}{(12 + 16 + 14 \times 2 + 1 \times 4)} = 5 \times 10^{-5}$ [1]

no. of moles of H^+ that can be neutralized = 1×10^{-4} [1]

(c) Digestion of food in mouth gives acids. [½]

Chewing urea-containing chewing gum increases the pH of saliva. [½]

The equilibrium position shifts to the left and the demineralization of hydroxyapatite is not favored. [1]

ASL07(I)_07

(a) Primary standard: a standard solution of the substance can be prepared by dissolving a known mass of the substance in a solvent and making up the solution to a known volume. [1]

(b) (i) $Br_2(l)$ is volatile. It is difficult to weigh a sample of $Br_2(l)$ accurately. [1]

(ii) KOH(s) absorbs water moisture / absorbs CO_2. [1]

ASL07(I)_09

Prepare a saturated solution of KCl(s) by dissolving the salt in water until in excess. [1]

Place the flask containing the saturated solution in water bath/thermostat kept at 298 K. [½]

Filter the solution at 298 K to remove the undissolved KCl(s). [½]

Weigh a clean and dry evaporating dish (w_1). [½]

Transfer a portion of the saturated solution to the evaporating dish and weigh the dish together with the solution (w_2). [½]

Evaporate the solution to dryness in an oven (by the use of an appropriate method). [½]

Weigh the dish and the solid residue.

Repeat the evaporating and weighing process until the dish and the solid residue reach a constant mass (w_3). [½]

Solubility of KCl(s) at 298 K = $\frac{w_3 - w_1}{w_2 - w_3} \times 100$ g per 100 g of water [1]

AL07(II)_01

Use a pipette to transfer 10.0 cm^3 of 0.10 M $AgNO_3(aq)$ to a 100.0 cm^3 volumetric flask. [1]
(*OR* 25.0 cm^3 of 0.10 M $AgNO_3(aq)$ to a 250.0 cm^3 volumetric flask)

Add deionized water to the flask until the bottom of the meniscus reaches the graduation mark. [1]

Swirl the solution thoroughly.

ASL08(I)_08

Preparation of $CuSO_4 \cdot 5H_2O(s)$:

Heat excess Cu metal with concentrated H_2SO_4 in a fume cupboard. [1]

$Cu + 2H_2SO_4 \longrightarrow CuSO_4 + 2H_2O + SO_2$

Add water to the resulting mixture and filter off any excess Cu metal. Evaporate the solution to give saturated $CuSO_4(aq)$. [1]

Allow the solution to cool to obtained $CuSO_4 \cdot 5H_2O(s)$. Dry the crystals in a desiccator. [1]

AL09(I)_07c

Dilution of conc. H_2SO_4 is highly exothermic process. The heat evolved can vaporize the water and cause splashing out of the acid. [1]

ASL09(II)_03

(a) Red to orange [1]

(b) In the titration, no. of moles of NaOH used = $0.0941 \times 16.48 \times 10^{-3} = 1.55 \times 10^{-3}$ [1]

No. of moles of H+ originally present = $0.955 \times 25 \times 10^{-3} \times 2 = 0.0478$

No. of moles of H+ that react with Mg

$= 0.0478 - 1.55 \times 10^{-3} \times 10 = 0.0322$ [1]

$Mg + 2H^+ \longrightarrow Mg^{2+} + H_2$

No. of mole of Mg in the ribbon = 0.0161

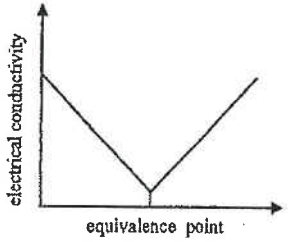
Relative atomic mass = $0.420 \div 0.0161 = 26.05$ [1]

(c) Some of the Mg has been oxidized to MgO [1]

ASL10(I)_09

(a) Electrical conductivity / pH [1]

(b)

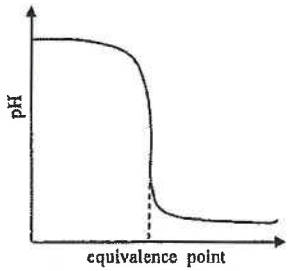


[1]

Electrical conductivity decreases before the equivalence point because the concentration of the highly conducting $OH^-(aq)$ decreases as it reacts with $H^+(aq)$ to give $H_2O(l)$. [½]

After the equivalent point, the increase in conductivity is due to the increase in $[H^+(aq)]$. [½]

OR, pH



[1]

pH drops before the equivalent point because $OH^-(aq)$ ions are removed by $H^+(aq)$ ions. [½]

$OH^-(aq) + H^+(aq) \longrightarrow H_2O(l)$

When it is close to the equivalence point, both $[H^+(aq)]$ and $[OH^-(aq)]$ are small. Addition of a drop of $H_2SO_4(aq)$ can lead to a significant decrease in pH. [½]

AL10(I)_07

Allow a known volume (v) of the water sample to pass through a proton-exchange resin column. The $Ca^{2+}(aq)$ in the sample will be quantitatively exchanged by $H^+(aq)$ ions. [1]

Ca^{2+}(in sample) $+ 2H^+$(from resin) $\longrightarrow Ca^{2+}$(on resin) $+ 2H^+$(in sample)

Titrate the eluent with standard NaOH(aq) using phenolphthalein as indicator, to determine the no. of moles of $H^+(aq)$. The mixture changes from colorless to pale pink when the end-point is reached. [½] [½]

Hardness due to $Cu^{2+}(aq) = \frac{1}{2} \times \frac{\text{molarity of NaOH(aq)} \times \text{volumeof titrant}}{v}$ [1]

AL11(I)_07

(b) (i) Add HCl(aq) / KCl(aq) / aqueous solution of a water-soluble chloride. Only $Pb^{2+}(aq)$ gives a white precipitate. [1]

$Pb^{2+}(aq) + 2Cl^-(aq) \longrightarrow PbCl_2(s)$

OR, Add NaOH(aq). Only $Pb^{2+}(aq)$ gives a white precipitate (which is soluble in the excess alkali)

$Pb^{2+}(aq) + 2OH^-(aq) \longrightarrow Pb(OH)_2(s)$

$Pb(OH)_2(s) + 2OH^-(aq) \longrightarrow [Pb(OH)_4]^{2-}(aq)$

[NOT accept a test with SO_4^{2-}, both Ba^{2+} and Pb^{2+} forms white precipitate.]

(ii) Add acidified $AgNO_3(aq)$. $Cl^-(aq)$ gives a white precipitate, while $Br^-(aq)$ gives a pale yellow precipitate. [1]

$Ag^+(aq) + Cl^-(aq) \longrightarrow AgCl(s)$ [1]

OR, Add $Cl_2(aq)$. Only $Br^-(aq)$ gives a brown solution.

$Cl_2(aq) + 2Br^-(aq) \longrightarrow Br_2(aq) + 2Cl^-(aq)$

OR, Treat solution wit acidified KMnO4(aq). $Cl^-(aq)$ causes decolorization slowly; $Br^-(aq)$ gives a orange solution.

$10X^-(aq) + 2MnO_4^-(aq) + 16H^+(aq) \longrightarrow 5X_2(g/l) + 2Mn^{2+}(aq) + 8H_2O(l)$

AL11(II)_06

(c) Observation: white precipitate is formed and the precipitate dissolves in excess alkali to give a cholorless solution. [1]

$Al^{3+}(aq) + 3OH^-(aq) \longrightarrow Al(OH)_3(s)$ [1]

$Al(OH)(s) + OH^-(aq) \longrightarrow Al(OH)_4^-(aq)$ [1]

ASL13(I)_09a (modified)

(i) $$[NaClO] = \frac{\frac{1 \times 5.25\%}{74.5}}{1 \times 10^{-3}} = 0.705 \text{ M}$$ [1]

(ii) Moles of cyclohexanol used= $\frac{5.0 \times 0.948}{100} = 0.0474$ [1]

moles of NaClO in 25 cm^3 of bleach $= 0.705 \times 25 \times 10^{-3} = 0.0177$ [1]

Minimum no. of portions of bleach used $> \frac{0.0474}{0.0177} = 3$ [1]

DSE11SP_01

(b) False. Dilution of concentrated H_2SO_4 is a highly exothermic process. [1]

The heat evolved may cause the acid to splash out. [1]

(c) False. 'A is a stronger acid than B' only means the degree of ionization of A is larger than that of B. However, the **pH of an acid solution depends on both the degree of ionization and its concentration.** [1]

As such, the stronger acid A may have a higher pH than the weaker acid B if the concentration of acid B is higher than that of A by an adequate amount. [1]

DSE11SP_08

(a) zinc granules dissolve / a colorless gas is produced / solution gets warm [1]

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$ [1]

OR, $Zn + 2H^+ \longrightarrow Zn^{2+} + H_2$

(b) Green precipitate is formed / The green color of the solution becomes paler (colorless). [1]

$FeSO_4 + 2NaOH \longrightarrow Fe(OH)_2 + Na_2SO_4$ [1]

OR, $Fe^{2+} + 2OH^- \longrightarrow Fe(OH)_2$

DSE11SP_09

3 sets of tests needed each of which carries 2 marks:

- Suitable test matches the intention to distinguish certain compounds [3]
- Correct observation / result [3]

Effective communication [1]

- Conduct flame test using the samples.
  Only two sodium compounds (NaOCl and Na_2SO_4) give a golden yellow flame.

- Heat samples with NaOH(aq).
  Only the two ammonium compounds (NH_4Cl and NH_4NO_3) give an alkaline gas / ammonia.

- Add HCl(aq)
  Only NaOCl(aq) gives greenish yellow gas / chlorine.

- Touch with moist litmus paper / color flower petal.
  Only NaOCl gives bleaching effect.

- Added acidified $BaCl_2(aq)$ to aqueous solution of the two sodium compounds.
  Only $Na_2SO_4(aq)$ gives a white precipitate.

- Add acidified $AgNO_3(aq)$ to aqueous solutions of the two ammonium compounds.
  Only $NH_4Cl(aq)$ gives a white precipitate.

DSE12PP_01

(a) (i) $ZnO + H_2SO_4 \longrightarrow ZnSO_4 + H_2O$ [1]

OR, $ZnO + 2H^+ \longrightarrow Zn^{2+} + H_2O$

(ii) Unreacted ZnO(s) can be seen. [1]

(iii) To ensure that the product is not contaminated with sulphuric acid. [1]

OR, The unreacted ZnO(s) can be removed by filtration, but it is difficult to remove the excess $H_2SO_4(aq)$.

(b) Remove a drop of the solution with a glass rod, and see whether any solid forms when the drop cools. [1]

(c) Washing with distilled water can remove the water-soluble impurities. [1]

Using a small amount of water / cold water helps to reduce loss of the salt. [1]

(d) Any ONE of the following: [1]

- Drying the crystals between filter papers
- Putting the crystals in a desiccator.

(DO NOT accept methods which involve strong heating.)

(e) $Zn / Zn(OH)_2 / ZnCO_3$ [1]

DSE12PP_04

(a) Dissolve 1.14 g of $M_2CO_3(s)$ in some distilled water / deionized water in a beaker. [1]
Transfer the solution to a **100.0 cm^3 of volumetric flask.**
Wash the beaker with distilled water / deionized water and transfer the washings into the volumetric flask. [1]
Add distilled water / deionized water **up to the graduation mark of the volumetric flask.** [1]
Shake the volumetric flask to ensure its content is well mixed.

(b) mole of $H^+(aq)$ used $= 0.085 \times \frac{25.30}{1000} = 2.15 \times 10^{-3}$ [1]

$M_2CO_3 + 2H^+ \longrightarrow 2M^+ + CO_2 + H_2O$

moles of M_2CO_3 in the solid sample $= 2.15 \times 10^{-5} \times \frac{100}{10} \times \frac{1}{2} = 0.01075$ [1]

$\frac{1.14}{2M + 12 + 16 \times 3} = 0.01075$ [1]

$M = 23$

M is likely to be Na [1]

DSE12_06

Dissolve solid lead(II) nitrate in water. [1]
Then mix with (excess) sulphuric acid / K_2SO_4 / Na_2SO_4 solution. [1]
Filter the mixture to obtain the residue ($PbSO_4$), wash it with deionized water and then dry in oven. [1]
Effective communication [1]

DSE12_07

(a) $NH_4^+ + OH^- \longrightarrow NH_3 + H_2O$ [1]
(b) The KOH is (very) corrosive. / NH_4NO_3 is explosive / NH_4NO_3 is flammable / HCl is corrosive. [1]
(c) Prevent sucking back as $NH_3(g)$ is very soluble / Increase the surface area for dissolving $NH_3(g)$ [1]
(Accept prevent HCl sucking upwards or similar descriptions)
(d) (i) Pipette [1]
(ii) Changes from red to orange [1]
(iii) mole of HCl in the beaker $= 0.100 \times \frac{41}{1000} \times \frac{100}{25} = 0.0164$ [1]
mole of $NH_3(g)$ produced $= 0.0485 - 0.0164 = 0.0321$ [1]
% by mass of $NH_4NO_3 = \frac{0.0321 \times 80}{3.150} \times 100\% = 81.5\%$ [1]
(Accept 81.52% / 82.5% / 82.54%)
(e) Flame test – gives a lilac flame [1]

DSE13_04

(b) $H_2C_2O_4(aq) \rightleftharpoons C_2O_4^{2-}(aq) + 2H^+(aq)$ [1]
OR, $H_2C_2O_4(aq) \rightleftharpoons HC_2O_4^-(aq) + H^+(aq)$
OR, $H_2C_2O_4$ is a weak acid. It undergoes incomplete ionization in water.
As pH = $-\log[H^+(aq)]$ and $[H^+(aq)]$ in 0.05 M $H_2C_2O_4(aq)$ is less than 0.1 M, it pH is thus greater than 1. [1]
(c) NaOH(aq) **is deliquescent / hygroscopic / absorbs water from the atmosphere.** [1]
OR, NaOH(s) **reacts with $CO_2(g)$** in the atmosphere.
∴ The mass of NaOH(s) cannot be accurately determined by weighing.
(d) (i) From colorless to pink [1]
(ii) $M_AV_AB_A = M_BV_BB_B$
$(0.05)(25)(2) = M_B(17.20)(1)$ [1]
$M_B = 0.145$ mol dm^{-3} [1]
(e) (i) Rinsing the conical flask with $H_2C_2O_4(aq)$: **Some $H^+(aq)$ ions / acid / $H_2C_2O_4(aq)$ remain in the flask**, and more alkali (as revealed from the burette reading) than actually required is used to reach the titration end-point. [1]
(Do not accept the concentration of $H^+(aq)$ increase.)
(ii) NaOH(aq) clinging onto the stem of funnel may **fall into the burette.** The volume of alkali used (as revealed from the burette reading) is smaller than what is expected. [1]

DSE14_05

(a) Wearing protective gloves or plastic gloves or gown or safety googles or any suitable PPE [1]
OR, Adding concentrated acids into water when diluting the concentrated acids
OR, Use a fume cupboard.
Not accepted: maintain a good ventilation.
(b) No, the strength of an acid is not related to its concentration. Not all concentrated acids, e.g. ethanoic acid, are strong acids / use a concrete example to illustrate. [1]

DSE14_07

(a) Mass of HCl present in 1000 cm^3 of the concentrated acid = 1180×36% = 425 g [1]
Formula mass of HCl = 36.5
Concentration $= \frac{425}{36.5} = 11.6$ mol dm^{-3} [1]
(Accept 11.5 – 11.644, maximum 3 decimal places)
(b) (i) **Weigh accurately the amount of sodium carbonate needed and dissolve it using deionized water / distilled water.** [1]
(accept using "a known amount of sodium carbonate", not accept if state "water" only.)
Transfer all the solution made to a volumetric flask, add deionized water to the flask until the bottom of the meniscus reaches the graduate mark of the **flask**, and mix the content thoroughly. [1]

(ii) Mole of H^+ present in the diluted acid= $1.06 \times 10 \times 10^{-3} \times 2 = 0.0212$ [1]

Concentration of the acid $= \frac{0.0212}{20.30 \times 10^{-3}} \times 10 = 10.4 \text{ mol dm}^{-3}$ [2]

(c) Some HCl **escaped / vaporized** from the concentrated acid as HCl(g) / Concentrated hydrochloric acid is volatile. [1]

DSE14_09

(a) (i) **A blue precipitate** is obtained. [1]

(ii) $Cu^{2+}(aq) + 2OH^-(aq) \longrightarrow Cu(OH)_2(s)$ [1]

OR, $CuSO_4 + 2NaOH \longrightarrow Cu(OH)_2 + Na_2SO_4$

(State symbols are not required)

DSE15_02

(a) **A white precipitate** / solid is firstly formed / It turns milky; the precipitate **dissolves** in the presence of excess CO_2(g). [1]

$Ca(OH)_2(aq) + CO_2(g) \longrightarrow CaCO_3(s) + H_2O(l)$ [1]

$CaCO_3(s) + CO_2(g) + H_2O(l) \longrightarrow Ca(HCO_3)_2(aq)$ [1]

DSE15_04

(c) Lead / lead compounds are toxic / harmful. [1]

OR, Sulphuric acid is corrosive / irritant.

NOT accept answers like "lead compounds are pollutants / heavy metal"

NOT accept answers like 'acid cause harm the environment".

(d) (i) **Pour a small amount of the concentrated sulphuric acid to a large amount of water.** [2]

Accept answers like "add concentrated sulphuric acid to a large amount of water."

Constant stirring is required (if the amounts of water and acid are not mentioned) [1]

Wear goggle / face shield / safety spectacles / safety glasses

(ii) Mole of sulphuric acid$= \frac{2.48}{98.1} = 0.0253$ [1]

Molarity of sulphuric acid$= \frac{0.0253}{5 \times 10^{-3}} = 5.06$ M [1]

DSE15_05

- **Equation:** $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$ [1]
- **Explanation:** ammonia ionizes slightly in water / The ionization of ammonia in water is incomplete. [1] [1]
- **Method:** measure the pH / electrical conductivity / enthalpy change of neutralization / temperature change in neutralization of both NH_3(aq) and NaOH(aq). [1]
- **Observation:** pH / electrical conductivity / enthalpy change of neutralization / temperature rise in neutralization of NH_3(aq) is lower than that of NaOH(aq). [1]
- **Fair comparison** between NH_3(aq) and NaOH(aq)

pH measurement – same concentration of NH_3(aq) and NaOH(aq)

electrical conductivity measurement – same concentration of NH_3(aq) and NaOH(aq)

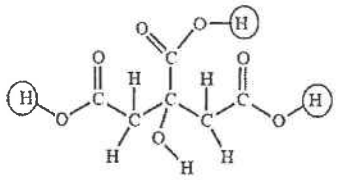
enthalpy change of neutralization – same amount / known amount of NH_3(aq) and NaOH(aq) [1]

determine the temperature rise in neutralization – same volume and concentration of NH_3(aq) and NaOH(aq)

- **Effective communication**

DSE16_06

(a) [1]



(b) (i) Volumetric flask [1]

(ii) mole of NaOH(aq) $= 0.123 \times 0.01845 = 2.27 \times 10^{-3}$ [1]

mole of citric acid $= \frac{2.27 \times 10^{-3}}{3} = 7.56 \times 10^{-4}$

Moles of citric acid in the sample $= 7.56 \times 10^{-4} \times 10 = 7.56 \times 10^{-3}$ [1]

% by mass of citric acid $= \frac{7.56 \times 10^{-3} \times 192}{1.65} \times 100\% = 88.0\%$ [1]

(c) (i) (Colorless) **gas bubbles** form. / **Effervescence** occurs. / Carbon dioxide gas is given out. [1]

Do not accept "the powder dissolves".

(ii) $H^+ + HCO_3^- \longrightarrow H_2O + CO_2$ [1]

DSE16_09

- **Dissolve** the solids separately **in water.** [1]
- Add **aqueous ammonia / NaOH(aq)** to each of the solutions obtained until excess. [1]
- White precipitate formed initially for all of them. But only the precipitate of $ZnSO_4$ **dissolves** in excess aqueous ammonia / NaOH(aq). [1]
- **Heat** respectively the two remaining solids in a test tube and place a piece of dry $CoCl_2$ paper in the mouth of the tube. [1]
- Only $MgSO_4 \cdot 7H_2O$ can turns dry $CoCl_2$ paper from blue to pink / anhydrous $CuSO_4$(s) from white to blue. [1]
- Effective communication [1]

DSE16_11

(a) To ensure fair comparisons between the trials. [1]

OR, To ensure the **concentration of NaOH(aq) / reactant** is the only variable.

OR, The volume of NaOH(aq) used can represent the **concentration of NaOH(aq) / reactant** in the reaction mixtures.

(Not accept if the answer is expressed in terms of "amount of NaOH(aq)")

(b) $[OH^-(aq)] = 2.0 \times (4.0/5.0) = 1.6$ mol dm^{-3} [1]

$pH = 14 - (-\log[OH^-(aq)]) = 14 - (-\log(1.6)) = 14.20$ [1]

DSE17_01

(b) (i) The gas (ammonia) is less dense than air. [1]

(Should be answered in terms of density. Not accept: The gas is lighter than air.)

(ii) The gas (ammonia) is soluble (in water). [1]

Accept: the gas will be absorbed by water / The gas will react with water.

(Not accept: The gas is slightly soluble in water.)

(c) (i) White solid forms / white precipitate forms / heat evolves / temperature rises [1]

(Accept: milky mixture forms / cloudy mixture forms / white suspension forms.)

(ii) (1) When $H_2SO_4(aq)$ is added to it, $BaSO_4(s)$ (and $H_2O(l)$) are formed, the **concentration / number of mobile ions in the mixture decreases / $[Ba^{2+}]$ and $[OH^-]$ decrease.** [1]

(2) Excess $H^+(aq)$ and $SO_4^{2-}(aq)$ ions are introduced into the solution. [1]

The concentrations / amount / number of $H^+(aq)$ and $SO_4^{2-}(aq)$ ions in the solution increase.

The concentrations / amount / number of (mobile) ions increases when H_2SO_4 is in excess.

(Accept only H^+ or SO_4^{2-} is mentioned in the answer.)

DSE17_02

(c) $(1.0 \times 10^{-8} \times 1000) \div 207.2$ [1]

$= 4.83 \times 10^{-6}$ mol dm^{-3} [1]

DSE17_06

(a) Oxidizing and corrosive [1]

(b) (i) The reaction between concentrated sulphuric acid and NaOH(aq) is highly exothermic. [1]

OR, Concentrated NaOH / H_2SO_4 is corrosive.

OR, Avoid to fill the burette more than once.

OR, Use less chemicals.

(Do not accept answer like "splashed out" without mentioning of "highly exothermic.")

(ii) Red to orange [1]

Do not accept "red to yellow".

(iii) No. of moles of NaOH used $= 0.189 \times 22.20 \times 10^{-3} = 4.20 \times 10^{-3}$ [1]

Concentration of the concentrated H_2SO_4

$= 4.20 \times 10^{-3} \div (2 \times 25 \times 10^{-3}) \times (1000 \div 5)$ [1]

$= 16.8$ mol dm^{-3} [1]

Accept 16.76, 16.78, 16.783, 16.784, 16.80

Do not accept 16.7832 mol dm^{-3}

Alternative Molarity of dilute sulphuric acid

$(M_{dilute})(25)(2) = (0.189)(22.2)(1)$

$M_{dilute} = 0.0839$ mol dm^{-3}

Molarity of concentrated sulphuric acid

$M_{conc}(5) = (0.0839)(1000)$

$M_{conc.} = 16.8$ mol dm^{-3}

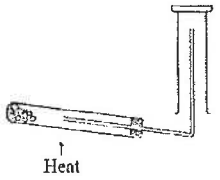
DSE18_02

(a) Set-up for preparation – boiling tube with reagents and HEAT (with stopper) [1]

(Accept heating the reagents in a flask)

Upward delivery of ammonia gas (without stopper) [1]

(Accept collecting the gas with a gas syringe.)



(b) (i) **Ammonia is soluble in water / Ammonia reacts with water to form aqueous ammonia.** [1]

As all ammonia dissolves, the atmospheric pressure forces the water in the trough to inject into the flask through the glass tubing / the pressure inside the flask is reduced. [1]

(ii) The water in the flask turns from colorless to pink. [1]

It is because aqueous ammonia is alkaline. [1]

DSE18_07

(a) Conical flask [1]

(b) Yellow to orange (Do not accept red) [1]

(c) moles of $B_4O_7^{2-}(aq) = \dfrac{0.125 \times 0.01898}{2} = 1.187 \times 10^{-3}$ [1]

$\dfrac{0.452}{201.2 + 18n} = 1.187 \times 10^{-3}$ [1]

$n = 10$ [1]

(d) (i) Solutions with accurately **known concentrations.** [1]

(ii) It can be used to determine the concentration of another reagent / number of water of crystallization / molar mass, etc. via titration / to prepare a calibration curve. [1]

DSE18_08

(a) An acid which can (almost) completely ionize / dissociate to H^+ ions in water. [1]

DSE19_03

Gas X may be ammonia / NH_3. [1]

$NH_3(aq) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$ [1]

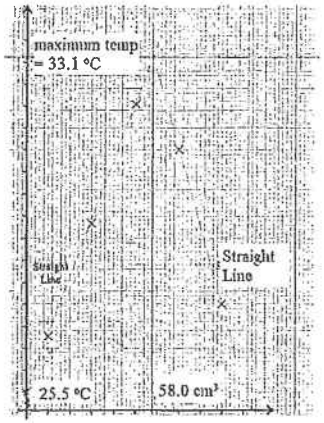
(State symbols not required) (Ignore incorrect state symbols) (Accept single arrow)

$OH^-(aq)$ turns phenolphthalein pink. [1]

OR, **Ammonia/the gas/the solution is alkaline,** and it turns phenolphthalein pink.

DSE19_08

(a) [1]



Maximum temperature = 33.1 °C

Drawing 2 best-fit slant straight lines to show how to obtain the possible maximum temperature using the volume of NaOH(aq) (58.0 cm^3).

(b) (i) moles of NaOH(aq) used $= 1.0 \times \frac{58}{1000} = 0.0058$ [1]

$\because$ At equivalent point, moles of NaOH(aq) used = moles of HCl(aq) reacted

$\therefore$ moles of HCl(aq) reacted = 0.058

concentration of HCl(aq) $= \frac{0.058}{\frac{42.0}{1000}} = 1.38$ M [1]

DSE19_04

(a) (i) To dissolve the solid by adding **deionised / distilled water to the solid** in a beaker. [1]

Transfer the solution with rinsing (with deionised / distilled water) into a 250.0 cm^3 **volumetric flask** and add **deionised / distilled water** to the graduation **mark** of the flask. Shake thoroughly. [1]

(ii) molarity of the standard solution $= \frac{1.12}{204.1} \div 0.2500 = 0.022$ M [2]

(Also accept 0.02195, 0.02196, 0.0220; Not accept 0.02192, 0.0210)

(Accept max. 4 significant figures, i.e. 0.02195)

(Accept answer without an unit, but NOT accept answer with an incorrect unit.)

(b) If it ionises completely in water, $[H^+(aq)] = 0.06$ (mol dm^{-3}) then the pH will be 1.22. [1]

However **the actual pH (3.3) is higher than** 1.22, therefore **the** –COOH in potassium hydrogenphthalate **only ionises partly** in water. [1]

Also accept:

The $[H^+(aq)]$ in pH 3.30 solution is 0.0005 (mol dm^{-3}).

However **the actual** $[H^+(aq)]$ (0.0005 mol dm^{-3}) **is lower than** 0.06 mol dm^{-3}, therefore the –COOH in potassium hydrogenphthalate **only ionises partly** in water.)

DSE19_10

Dissolve the sample in (distilled) water / Add water to the sample. [1]

Add excess Zn(s) to the sample solution. [1]

Filter to collect $ZnSO_4(aq)$ / filtrate / solution / Filter off the solid / Cu(s) and excess Zn(s) / Cu(s) / Zn(s) [1]

Evaporate the filtrate, allow $ZnSO_4$ solid crystallises out / collect crystals and then dry (with filter paper / in a desiccator) [1]

OR Heat (to concentrate/saturate) the filtrate, cool down to allow crystallisation / collect crystals and then dry

OR Set the filtrate aside to allow crystallisation / collect crystals and then dry

(Do not accept "heat to dryness", "put the filtrate into an oven", "dry the crystals in an oven")

Communication mark [1]

(Chemical knowledge = 0 to 2, communication mark = 0

Chemical knowledge = 3 to 4, communication mark = 0 or 1

Incomplete answer or difficult to understand, communication mark = 0)

Need to indicate excess Zn(s) has been used at least once in the answer to give a complete answer.

DSE20_01

1. (a) 2, 8, 18, 7 — 1

(b) 

1

(Accept answer with correct inner shell electrons)
(Not accept answer with incorrect inner shell electrons, if inner shell electrons are drawn)

(c) (i) $K_2SO_3(s) + 2HCl(aq) \rightarrow 2KCl(aq) + H_2O(l) + SO_2(g)$ / $K_2SO_3(s) + 2H^+(aq) \rightarrow 2K^+(aq) + H_2O(l) + SO_2(g)$ — 2
Correct states (1 mark)
Balanced equation (1 mark)
(No mark if the chemical species shown in the equation are incorrect)

(ii) (Reddish brown / brown) changes to colourless. / The solution changes to colourless. — 1
(Not accept incorrect initial colour. Not accept pale brown)
$Br_2 + SO_2 + 2H_2O \rightarrow 2Br^- + SO_4^{2-} + 4H^+$ — 1
(State symbols not required) (Ignore incorrect state symbols)
OR $Y_2 + SO_2 + 2H_2O \rightarrow 2Y^- + SO_4^{2-} + 4H^+$

(iii) **Y** and **Z** have the same number of electrons / seven electrons in the outermost shells, hence similar chemical properties (leading to similar observation). — 1
(Not accept "Same chemical properties")

DSE20_04

4. (a) To increase the surface area of eggshell for increasing the reaction rate. — 1

(b) To dissolve organic substances in eggshell. — 1

(c) Speed up the reaction between the calcium carbonate in the sample with HCl(aq). / Shorten the time needed for the reaction. / To make sure that the reaction is complete. — 1

(d) † phenolphthalein — 1

(e) Number of moles of $CaCO_3$ in the sample
$= (0.200 \times 25.00 - 0.102 \times 16.85) \times 10^{-3} \times ½$ — 1*
$= 1.64 \times 10^{-3}$
Percentage by mass of $CaCO_3$ in the sample
$= 1.64 \times 10^{-3} \times 100.1 \div 0.204 \times 100\%$ — 1*
= 80.5 % (Accept 80.4 – 80.5%. Accept answer with max. 3 decimal places.) — 1

DSE20_05

5. (a) Carboxyl (group) / $-CO_2H$ (group) / –COOH (group) / $-CO_2H$ / –COOH / CO_2H / COOH — 1
(Not accept: acid / alkanoic acid / organic acid / COOH– / CHO_2 / $HO_2CCH_2CH_2CO_2H$ / carboxylic acid group)

(b) (i) $HO_2CCH_2CH_2CO_2H$ / $HOOCCH_2CH_2COOH$ / $(CH_2COOH)_2$ — 1
(Not accept: $HOOCC_2H_4COOH$)
$HO_2CCH(CH_3)CO_2H$ / $HOOCCH(CH_3)COOH$ — 1
$HO_2CCH_2COOCH_3$ / $HO_2CCOOCH_2CH_3$ — (1)

(ii) • The enthalpy change when solutions of an acid and an alkali / a base react together / neutralise under standard conditions to produce 1 mole of water. — 1
(Accept: 25°C (298K) and one atmospheric pressure (760 mmHg, 103 kPa))
• As indicated in the equation, the reaction produces 2 moles of water, hence **y** / 2 represents the standard enthalpy change of neutralisation. — 1
(Accept: No unit)

(iii) • Less negative than –57.3 kJ mol^{-1} — 1
• **W** is a weak acid when compared with HCl(aq), energy / heat energy / heat is needed to ionise the hydrogen in the carboxyl / $-CO_2H$ group. — 1
/ **W** is a weak(er) acid, energy / heat energy / heat is needed to ionise the hydrogen in the carboxyl / $-CO_2H$ group.
(Accept: absorb energy to break the O–H bond in carboxyl group.)
(Not accept: dissociate)

DSE20_07

7. (a) • Put a moist red litmus paper / moist pH paper near the mouth of the conical flask. — 1
• Ammonia / NH_3 gas dissolves in water to give OH^- ions / is alkaline which turn red litmus paper to blue / pH paper to blue. — 1

• Put a glass rod with conc. HCl / HCl(g) near the mouth of the conical flask. — (1)
• After reaction, (dense) white fumes containing $NH_4Cl(s)$ is formed. — (1)

• Deliver the gas produced into water, then use a pH meter to measure the pH of the solution formed. — (1)
• Ammonia / NH_3 gas dissolves in water to give OH^- ions / an alkaline solution with pH > 7. — (1)

(b) Alkali is a water soluble substance reacts with an acid to give salt and water only. — 1
/ Alkali is a substance when dissolved in water to give hydroxide ions as the only anion.
/ Alkali is a soluble base that reacts with an acid to give salt and water only.
(Not accept: alkali reacts with acid to give salt and water only.)
(Not accept: alkalis are water soluble base.)
(Not accept: alkali is a solution with $[OH^-]$ higher than $[H^+]$.)

(c) (i) $Ba(s) + 9H_2(g) + 5O_2(g) \rightarrow Ba(OH)_2 \cdot 8H_2O(s)$ $\Delta H^\ominus = -3345$ kJ mol^{-1} — 1
/ $Ba(s) + 9H_2(g) + 5O_2(g) \rightarrow Ba(OH)_2 \cdot 8H_2O(s)$ $\Delta H = -3345$ kJ mol^{-1}
(Not accept: $Ba(s) + 9H_2(g) + 5O_2(g) \rightarrow Ba(OH)_2 \cdot 8H_2O(s)$ $\Delta H < 0$)
(Correct state symbols and units)

(ii) $\Delta H^\ominus = (-859) + 10\times(-286) + 2\times(-46) - (-3345) - 2\times(-314)$ — 1*
$= +162$ kJ mol^{-1} (Show correct unit) — 1
(Accept: +162.0 kJ mol^{-1})
(Not accept: 'wrong unit', 'missing unit', 'no plus sign', etc.)

(iii) (As the reaction has $\Delta H > 0$,) the reaction is endothermic / absorbs heat, thus the temperature would decrease. — 1

SECTION 5 Fossil Fuels and Carbon Compounds

Multiple-Choice Questions

Part 1: (a) hydrocarbons, (b) homologous series and (c) alkanes and alkenes

CE90_06

The boiling points of some hydrocarbons are given in the table below:

Hydrocarbon	Ethane	Ethene	Propene
Boiling point /°C	−89	−104	−48

If a mixture of these three hydrocarbons at −110°C is allowed to warm up gradually to −80°C, which of the following will happen?

A. Ethene will remain in the liquid state.
B. Propene will remain in the liquid state.
C. Ethane and ethene will remain in the liquid state.
D. Ethane, ethene and propene will exist in the gaseous state.

CE90_18

Which of the following statements concerning acid rain is NOT correct?

A. Acid rain can be caused by the burning of fossil fuel.
B. Acid rain can corrode buildings.
C. Acid rain can make the soil infertile by removing the minerals from the soil.
D. Acid rain can attack the human respiratory system.

CE90_21

Which of the following pairs of substances would react to produce hydrogen?

(1) iron and steam
(2) sodium and ethanol
(3) magnesium and concentrated sulphuric acid

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE91_05

Tetrachloromethane is a common solvent in the chemistry laboratory. Which of the following hazard warning labels should be displayed on a bottle of tetrachloromethane?

(1)

(2)

(3)

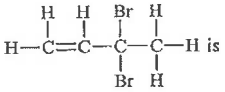
A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE91_22

Propene reacts with acidified potassium permanganate solution to form

A. $CH_3CH_2CH_2OH$
B. $CH_3CH(OH)CH_3$
C. $CH_3CH(OH)CH_2OH$
D. $CH_2OHCH(OH)CH_2OH$

CE91_24

The IUPAC name for  is

A. 3-dibromobut-1-ene
B. 2-dibromobut-4-ene
C. 3,3-dibromobut-1-ene
D. 2,2-dibromobut-4-ene

CE91_34

The rain-water samples collected in Tsuen Wan District are found to be more acidic than those collected in Central District. Which of the following air pollutants would be responsible for this phenomenon?

(1) carbon monoxide
(2) sulphur dioxide
(3) nitrogen dioxide

A. (2) only
B. (3) only
C. (1) and (2) only
D. (1) and (3) only

CE91_36

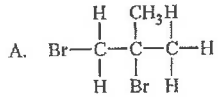
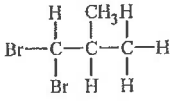
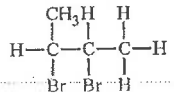
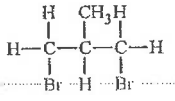
Equal moles of chlorine and methane are allowed to react in diffused sunlight. Which of the following statements concerning the reaction is/are correct?

(1) The reaction is violent.
(2) The final product contains CH_3Cl and HCl only.
(3) The final product contains CH_3Cl, CH_2Cl_2, $CHCl_3$, CCl_4 and HCl.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE92_21

When 2-methylpropene reacts with bromine in tetrachloromethane, the product is

A. 
B. 
C. 
D. 

CE92_24

Which of the following statements concerning CH_3CH_3, $CH_3CH_2CH_3$ and $CH_3CH(CH_3)CH_3$ is correct?

A. They have different boiling points.
B. They belong to different homologous series.
C. They burn in excess oxygen to form carbon monoxide and water.
D. They readily decolourize bromine in tetrachloromethane.

CE92_49

1st statement	2nd statement
A solution of hydrogen chloride in methylbenzene can turn blue litmus paper red.	Hydrogen chloride dissolves in methylbenzene to form hydrogen ions.

CE93_29

$$C_{10}H_{22} \xrightarrow{\text{catalyst, heat}} C_6H_{14} + 2X$$

In the above process, which of the following combinations is correct?

	Process	X
A.	fractional distillation	an alkane
B.	fractional distillation	an alkene
C.	cracking	an alkane
D.	cracking	an alkene

CE93_32

Which of the following substances can react with propene?

(1) concentrated sodium hydroxide solution
(2) acidified potassium permanganate solution
(3) ethanol

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE93_33

Which of the following statements about fossil fuels is correct?

A. They are liquid or gases.
B. They are all formed from plants which died millions of years ago.
C. They can be recycled to help conserve energy resources.
D. They cause air pollution when burnt.

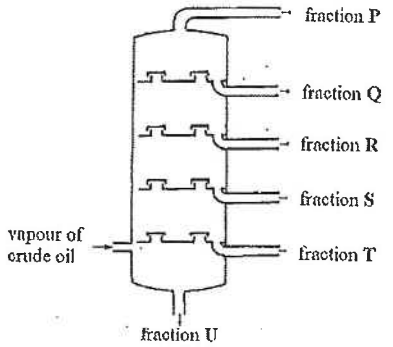
CE94_21

A solution of chlorine in tetrachloromethane is shaken with an aqueous solution of a compound X in a test tube. On standing, two layers are formed in test tube and the lower layer is violet in colour. X may be

A. sodium fluoride
B. sodium bromide
C. sodium iodide
D. sodium sulphite

CE94_22

Direction: Q.22 and Q.23 refer to the following diagram which shows a fractionating column of an oil refinery.



Which of the following fractions is NOT cracked to produce more useful products?

A. P
B. R
C. S
D. T

CE94_23

Which if the following statements is correct?

A. Fraction P has the highest boiling point.
B. Fraction T is used for surface roads.
C. Fraction U is the least viscous.
D. Fraction S burns with a more sooty flame than fraction Q.

CE94_32

Which of the following label(s) should be placed on a bottle containing tetrachloromethane?


(1)

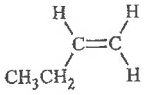

(2)


(3)

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE94_41

A compound has the following structure:



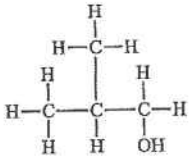
Which of the following statements about this compound are correct?

(1) It can decolourize bromine water.
(2) It can be polymerized.
(3) It can burn in air.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE95_15

The structural formula of a certain compound is shown below:



The name of this compound is

A. butan-1-ol
B. butan-2-ol
C. 2-methylpropan-1-ol
D. 2-methylpropan-2-ol

CE95_20

Which of the following statements concerning alkenes is **INCORRECT**?

A. They can decolourize a solution of bromine in 1,1,1-trichloroethane.
B. They can decolourize red litmus solution.
C. They can decolourize acidified potassium permanganate solution.
D. They can be polymerized to form addition polymers.

CE95_23

Which of the following substances can cause acid rain?

A. lead compounds from the burning of leaded petrol in motor cars.
B. carbon dioxide from the complete combustion of town gas.
C. carbon soots from the incomplete combustion of coal.
D. nitrogen dioxide from the burning of fuels in power stations.

CE95_39

Which of the following substances can conduct electricity?

(1) molten zinc chloride
(2) an aqueous solution of magnesium sulphate
(3) a mixture of ethanol and water

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE96_13

Which of the following substances is NOT derived from petroleum?

A. bleach
B. ethanol
C. polystyrene
D. soapless detergent

CE96_14

One mole of each of the following compounds is burnt completely in oxygen. Which compound requires the greatest volume of oxygen, measured at the same temperature and pressure, for complete combustion?

A. carbon monoxide
B. ethane
C. ethene
D. ethanol

CE96_20

Which of the following methods can be used to minimize the air pollutant mentioned?

A. increase the air supply to remove nitrogen dioxide produced by burning heavy oil
B. using catalytic converters to remove lead compounds produced by burning leaded petrol
C. using scrubbers remove carbon monoxide produced by the incomplete combustion of diesel
D. using electrostatic precipitators to remove particulates produced by burning coal

CE97_10

Which of the following combinations is **INCORRECT**?

	Chemical	**Method of storage**
A.	calcium	under water
B.	potassium	under paraffin oil
C.	ethanol	in a cool place
D.	potassium permanganate solution	in a brown bottle

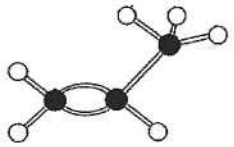
CE97_16

Which of the following compounds represents the first member of a homologous series?

A. ethane
B. ethene
C. ethanol
D. ethanoic acid

CE97_18

The model shown below represents a compound containing 6 hydrogen atoms (white spheres) and 3 carbon atoms (black spheres).



Which of the following statements concerning the compound is INCORRECT?

A. Its structural formula is C_3H_6.
B. It can be prepared by cracking petroleum fractions.
C. It can decolourize bromine in 1,1,1-trichloroethane.
D. It can undergo polymerization.

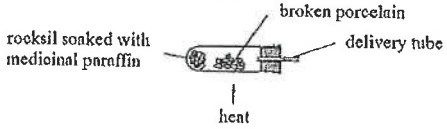
CE97_19

Which of the following compounds CANNOT be produced directly from ethene?

A. carbon dioxide
B. ethanol
C. ethyl ethanoate
D. 1,2-dibromoethane

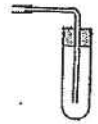
CE97_23

Direction: Q.23 and Q.24 refer to the following experiment:

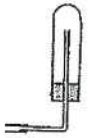


Which of the following set-ups should be connected to the delivery tube to collect the gaseous products formed?

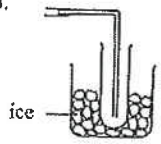
A.



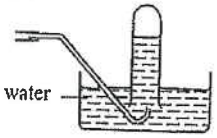
C.



B.



D.



CE97_24

Which of the following reactions is involved in this experiment?

A. cracking
B. redox
C. catalytic hydration
D. destructive distillation

CE97_33

Which of the following statements concerning the reaction of methane with bromine is/are correct?

(1) It is an addition reaction.
(2) It is a substitution reaction.
(3) A similar reaction will occur if propane is used instead of methane.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE97_38

Which of the following statements about using ethanol as a car fuel is correct?

(1) Ethanol is a cleaner fuel than petrol.
(2) Using ethanol as a car fuel is economical in agricultural countries with sugar cane as the main crop.
(3) A car engine has to be suitably modified when using ethanol as a fuel.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE97_42

Which of the following measures can reduce the formation of acid rain?

(1) installing catalytic oxidizers in cars
(2) using leaded petrol in cars
(3) using fuels of low sulphur content in cars

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE98_03

Which of the following substances is the main constituent of town gas?

A. hydrogen
B. methane
C. carbon monoxide
D. gaseous naphtha

CE98_07

Which of the following environmental problems is NOT caused by excessive burning of fossil fuels?

A. the corrosion of marble statues
B. the formation of smog
C. a higher incidence of liver disease
D. global warming

CE98_14

Which of the following statements concerning propene is correct?

A. It can be converted by catalytic hydration to an alkanol with molecular formula C_3H_8O.
B. It can undergo condensation polymerization.
C. It can be manufactured by fractional distillation of crude oil.
D. It can undergo substitution reaction with a solution of bromine in 1,1,1-trichloroethane.

CE98_29

X is a compound containing four carbon atoms. It gives negative results with the following tests.

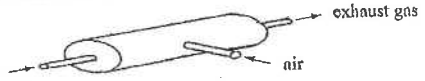
Test
(1) Treating X with sodium hydrogencarbonate solution.
(2) Treating X with a solution of bromine in 1,1,1-trichloroethane
(3) Heating X with acidified potassium dichromate solution.

The structural formula of X may be

A. $CH_3CH_2CH{=}CH_2$
B. $CH_3CH_2CH_2CH_2OH$
C. $CH_3CH_2CH_2CO_2H$
D. $CH_3CO_2CH_2CH_3$

CE98_39

The diagram below shows a catalytic converter fitted to the exhaust system of a car.



Which of the following pollutants from the car engine undergo reactions in the catalytic converter to produce less harmful products?

(1) carbon monoxide
(2) hydrocarbons
(3) nitrogen monoxide

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE98_47

1st statement	2nd statement
The use of leaded petrol has been banned in Hong Kong.	Lead compounds in car exhaust can cause damage to human brains.

CE99_03

Which of the following has the lowest boiling point?

A. ethanol
B. propan-1-ol
C. propane
D. butane

CE99_30

Which of the following combinations is INCORRECT?

	Pollutant	Harmful effect
A.	hydrocarbons	causing liver diseases
B.	carbon monoxide	causing unconsciousness
C.	lead compounds	causing brain damage
D.	carbon particles	causing respiratory diseases

CE99_32

Which of the following substances can react with acidified potassium permanganate solution?

(1) ethene
(2) copper(II) sulphate solution
(3) iron(II) sulphate solution

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE99_35

The label below is displayed on a container for chemical X:

Which of the following chemicals may X be?

(1) bromochlorodifluoromethane
(2) ethanol
(3) potassium

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE99_44

Which of the following statements concerning the reaction of an alkane with bromine are correct?

(1) The reaction occurs faster under sunlight than in darkness.
(2) The reaction is a substitution.
(3) The colour of the reaction mixture fades.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE00_06

Which of the following pairs of compounds can be distinguished by treating with an acidified potassium dichromate solution?

A. ethane and ethene
B. ethanol and propan-1-ol
C. sodium carbonate and sodium hydrogencarbonate
D. sodium sulphite and sodium sulphate

CE00_08

Which of the following statements concerning members of a homologous series is **INCORRECT**?

A. They contain carbon and hydrogen only.
B. They can be represented by the same general formula.
C. They have similar chemical properties.
D. Their boiling points increase with their relative molecular masses.

CE00_14

Which of the following solutions can react with bromine water to give a colourless solution?

A. sodium chloride solution
B. sodium sulphite solution
C. sodium iodide solution
D. sodium hypochlorite solution

CE00_21

Which of the following processes requires a catalyst?

A. preparation of ethyl ethanoate from ethanoic acid and ethanol
B. conversion of sulphur trioxide to concentrated sulphuric acid
C. manufacture of chlorine bleach from brine
D. reduction of iron(III) oxide to iron

CE00_25

Which of the following processes is endothermic?

A. cracking of petroleum fractions
B. fermentation of glucose solution
C. manufacture of ammonia by Haber process
D. oxidation of sulphur dioxide to sulphur trioxide in the contact process

CE00_27

Which of the following changes occurs in a catalytic converter installation in a motor car?

A. Nitrogen monoxide changes to nitrogen dioxide.
B. Carbon monoxide changes to carbon dioxide.
C. Unburnt hydrocarbons change to carbon particles.
D. Sulphur changes to sulphur dioxide.

CE00_40

Which of the following measures can reduce the emission of pollutants from a coal-fired power station?

(1) installation of scrubbers
(2) installation of electrostatic precipitators
(3) increasing the height of the chimney

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE01_03

Which of the following processes is exothermic?

A. melting of ice
B. evaporation of ethanol
C. sublimation of iodine
D. dissolving of sodium hydroxide pellets in water

CE01_07

Which of the following statements concerning water is correct?

A. It reacts with calcium to give a colourless gas.
B. It is a strong electrolyte.
C. It turns anhydrous cobalt(II) chloride from pink to blue.
D. It is immiscible with ethanol.

CE01_12

Which of the following processes is NOT involved in the production of ethanol from crude oil?

A. cracking
B. fermentation
C. catalytic hydration
D. fractional distillation

CE01_14

Which of the following pairs is correctly matched?

	Pollutant	Effect
A.	carbon monoxide	global warming
B.	sulphur dioxide	darkening of building walls
C.	lead compounds	liver disease
D.	unburnt hydrocarbons	lung cancer

CE01_31

Which of the following measures can reduce the emission of sulphur dioxide from a factory using diesel fuel?

(1) the installation of catalytic converters
(2) the installation of scrubbers
(3) the installation of electrostatic precipitators

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE01_32

The formulae of three straight-chain hydrocarbons are listed below:

(1) C_2H_6

(2) C_3H_6

(3) C_4H_8

Which of these hydrocarbons is/are unsaturated?

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE01_41

Which of the following statements concerning oil spillage on the sea are correct?

(1) Petroleum is toxic to marine lives.

(2) Petroleum can block the oxygen supply to marine lives.

(3) Petroleum can cause the outbreak of fire on the sea.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE02_05

Consider the aqueous solution listed below:

(1) 1 M ethanoic acid

(2) 1 M hydrochloric acid

(3) 1 M ammonia solution

Which of the following represents the increasing order of pH of the solutions?

A. (1), (2), (3)
B. (2), (1), (3)
C. (3), (1), (2)
D. (3), (2), (1)

CE02_09

Which of the following equations represents a cracking reaction?

A. $C_4H_8 + H_2 \longrightarrow C_4H_{10}$

B. $C_4H_{10} \longrightarrow C_3H_6 + CH_4$

C. $C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$

D. $C_4H_9OH \longrightarrow C_4H_8 + H_2O$

CE02_12

Which of the following reactions does NOT require the use of a catalyst?

A. conversion of ammonia to nitrogen monoxide

B. hydration of ethene to give ethanol

C. oxidation of ethanol to ethanoic acid

D. fermentation of glucose to give ethanol

CE02_33

Which of the following reactions is/are endothermic?

(1) the fermentation of glucose

(2) the cracking of naphtha

(3) the reaction of lime with dilute hydrochloric acid

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE02_34

Upon complete combustion, gaseous hydrocarbon **X** gives an equal number of moles of carbon dioxide and water. Which of the following hydrocarbons may **X** be?

(1) ethane

(2) ethene

(3) propene

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE02_43

In which of the following processes will carbon dioxide be produced?

(1) the fermentation of glucose solution

(2) the biodegradation of animal faeces

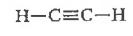
(3) the treatment of car exhaust in a catalytic converter

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE02_44

Both ethene and ethyne are gaseous hydrocarbons. Their structures are shown below:

ethene



ethyne

Which if the following statements concerning ethene and ethyne are correct?

(1) Both are unsaturated hydrocarbons.

(2) Both are insoluble in water.

(3) Ethyne burns with a more sooty flame than ethene.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE02_48

1st statement	2nd statement
The basicity of methanoic acid is different from that of ethanoic acid.	The number of hydrogen atoms in a molecule of methanoic acid is different from that in a molecule of ethanoic acid.

CE03_08

Which of the following combinations is correct?

	Homologous series	General formula
A.	alkanes	C_nH_{2n}
B.	alkenes	C_nH_{2n+2}
C.	alkanols	$C_nH_{2n}OH$
D.	alkanoic acids	$C_nH_{2n+1}CO_2H$

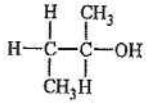
CE03_10

Which of the following combinations is correct?

	Chemical	Hazardous nature
A.	sodium	oxidizing
B.	mercury	toxic
C.	ethyl ethanoate	irritant
D.	potassium dichromate	explosive

CE03_17

An organic compound has the following structure:



The systematic name of this compound is

A. 1,2-dimethylethanol
B. 1-methylpropan-1-ol
C. 1-methylpropan-2-ol
D. butan-2-ol

CE03_31

Propene is an unsaturated hydrocarbon. Which of the following reactions is/are characteristic of the unsaturated nature of propene?

(1) It undergoes incomplete combustion to give carbon monoxide.
(2) It decolourizes acidified potassium permanganate solution.
(3) It undergoes polymerization to give polypropene.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE03_33

Ethane reacts with bromine under suitable conditions. Which of the following statements concerning this reaction is/are correct?

(1) The reaction occurs readily in the dark.
(2) The reaction is a substitution.
(3) The reaction gives a mixture of organic products.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE03_37

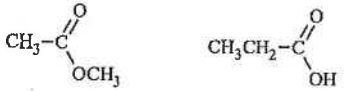
Which of the following statements concerning the manufacture of town gas in Hong Kong is/are correct?

(1) Town gas is produced from coal.
(2) Town gas contains hydrogen as the major component.
(3) Oxygen is added to enhance the flammability of town gas prior to its delivery to customers.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE03_38

The structure of two organic compounds are shown below:



Which of the following statements concerning these two compounds is/are correct?

(1) They have the same relative molecular mass.
(2) They have the same chemical properties.
(3) They are both soluble in water.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE05SP_16

Which of the following natural substances is essentially a single compound?

A. air
B. coal
C. petroleum
D. quartz

CE05SP_19

Which of the following compounds is the least soluble in water?

A. ethanol
B. ethanoic acid
C. ethyl ethanoate
D. sodium ethanoate

CE04_21

A gaseous mixture consists of methane and ethane in a mole ratio of 1:1. It has a volume of 200 cm^3 at room temperature and pressure. What is the volume of oxygen required, measured at room temperature and pressure, for the complete combustion of the mixture?

A. 400 cm^3
B. 550 cm^3
C. 700 cm^3
D. 1100 cm^3

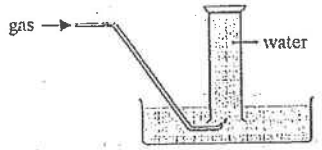
CE04_28

Ethene can be prepared by heating ethanol with excess concentrated sulphuric acid. The reaction involved can be represented by the equation:

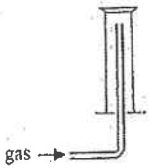
$$CH_3CH_2OH \xrightarrow{\text{conc. } H_2SO_4} CH_2{=}CH_2 + H_2O$$

Which of the set-ups shown below can be used to collect the ethene produced?
(Relative atomic masses: H = 1.0, C =12.0, N = 14.0, O = 16.0)

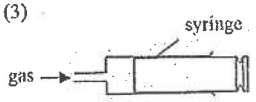
(1)



(2)



(3)



A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE04_37

After heavy rain, the Air Pollution Index becomes lower. Which of the following air pollutants are likely to have been removed by the rain water?

(1) particulates
(2) carbon monoxide
(3) nitrogen dioxide

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE04_42

The structure of two organic compounds are shown below:

$CH_3CH_2CH_2CH_3$ $\qquad$ $H_3C-\underset{\displaystyle H}{\overset{\displaystyle CH_3}{\underset{|}{\overset{|}{C}}}}-CH_3$

Which of the following statements concerning the two compounds are correct?

(1) Both compounds are members of the same homologous series.
(2) Both compounds have the same molar volume at room temperature and pressure
(3) Both compounds undergo sublimation when treated with bromine.

A. (1) and (2) only
B. **(1) and (3) only**
C. (2) and (3) only
D. (1), (2) and (3)

CE04_45

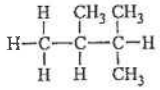
1st statement	2nd statement
Both but-1-ene and but-2-ene can decolourize a solution of bromine in 1,1,1-trichloroethane.	Both but-1-ene and but-2-ene have the same molecular formula.

CE04_46

1st statement	2nd statement
Methanoic acid is a non-electrolyte.	Methanoic acid is a covalent compound.

CE05_01

What is the systematic name of the following hydrocarbon?



A. 1,1,2-trimethylpropane
B. 2,3,3-trimethylpropane
C. 1,2-dimethylbutane
D. 2,3-dimethylbutane

CE05_02

Upon cracking, one molecule of decane ($C_{10}H_{22}$) gives two molecules of propene and one molecule of an alkane (X). What is X?

A. C_4H_6
B. C_4H_{10}
C. C_7H_{14}
D. C_7H_{16}

CE05_04

What is the type of reaction involved when hydrogen bromide reacts with ethene to form bromoethane?

A. addition
B. cracking
C. polymerization
D. substitution

CE05_12

Which of the following reactions is endothermic?

A. $Zn(s) + Cu^{2+}(aq) \longrightarrow Zn^{2+}(aq) + Cu(s)$
B. $CaCO_3(s) + 2H^+(aq) \longrightarrow Ca^{2+}(aq) + H_2O(l) + CO_2(g)$
C. $2C_4H_{10}(g) + 13O_2(g) \longrightarrow 8CO_2(g) + 10H_2O(l)$
D. $C_9H_{20}(l) \longrightarrow C_2H_6(g) + C_3H_6(g) + C_4H_8(g)$

CE05_21

Which of the following molecule formulae represents an alkanoic acid?

A. CH_2O
B. CH_2O_2
C. $C_2H_2O_2$
D. $C_2H_6O_2$

CE05_28

Which of the following processes affect the amount of carbon dioxide in the atmosphere?

(1) burning of fossil fuels
(2) photosynthesis in plants
(3) absorption by sea water

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE05_37

Methane burns completely in oxygen according to the following equation:

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

What is the mass of oxygen required for the complete combustion of 48 g of methane?
(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0)

A. 48 g
B. 96 g
C. 192 g
D. 384 g

CE05_43

Consider the reaction represented by the equation below:

$C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$

Which of the following statements concerning this reaction are correct?

(1) It is a reversible reaction.
(2) The raw materials for the reactants are readily available in nature.
(3) The product mixture formed can be used as a gaseous fuel.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE05_46

Which of the following energy conversions is involved in the system?

A. chemical energy $\longrightarrow$ heat energy
B. light energy $\longrightarrow$ heat energy
C. chemical energy $\longrightarrow$ light energy $\longrightarrow$ heat energy
D. light energy $\longrightarrow$ chemical energy $\longrightarrow$ heat energy

CE05_47

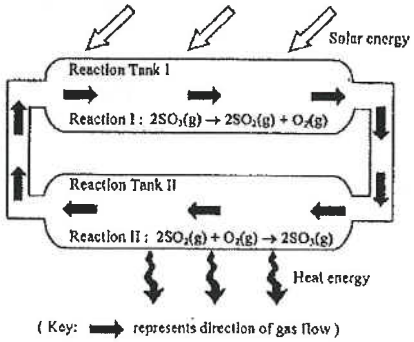
Which of the following statements concerning the system are correct?

(1) Reaction I is endothermic.
(2) $SO_2(g)$ and $O_2(g)$ should be pumped into Reaction Tank II from time to time.
(3) A catalyst is required in Reaction Tank II.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE05_45

Obtaining energy from the sun provides many advantages over that from combustions of fossil fuels. The diagram below shows a closed system which can be used to convert solar energy to heat energy by means of two chemical reactions.



(Key: ➡ represents direction of gas flow)

The gases in the diagram are circulated around the system. Energy is stored by means of Reaction I and later released by means of Reaction II.

What are the advantages of obtaining energy from the sun over that from combustion of fossil fuels?

(1) Supply of solar energy is unlimited.
(2) Solar energy is always available.
(3) Using solar energy produces no waste products.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE06_11

Which of the following statements about acids is correct?

A. Nitric acid is used in car batteries.
B. Hydrochloric acid is produced in human stomach.
C. Ethanoic acid is a strong oxidizing agent.
D. The following hazard warning label should be displayed on a bottle of concentrated sulphuric acid.

CE06_12

Consider the following information:

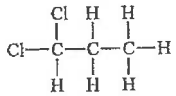
Compound	Relative molecular mass
CH_3CH_2OH	46
$CH_3CH_2OCH_3$	60
$CH_3CH_2CO_2CH_3$	88
$C_6H_{12}O_6$	180

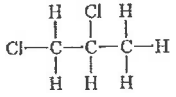
When 1 g of each of these compounds undergoes complete combustion, which one will produce the greatest number of moles of carbon dioxide?

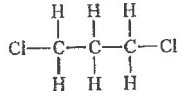
A. CH_3CH_2OH
B. $CH_3CH_2OCH_3$
C. $CH_3CH_2CO_2CH_3$
D. $C_6H_{12}O_6$

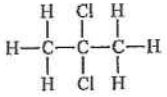
CE06_16

Which of the following compounds is formed from the reaction of propene with chlorine?

A. 

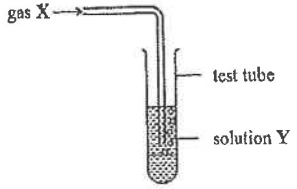
B. 

C. 

D. 

CE06_17

Gas X is bubbled into solution Y as shown below:



Which of the following combinations would give no visible change in the test tube?

	X	Y
A.	sulphur dioxide	sodium iodide solution
B.	ethane	acidified potassium permanganate solution
C.	chlorine	litmus solution
D.	carbon dioxide	calcium hydroxide solution

CE06_22

Which of the following processes is/are application(s) of neutralization?

(1) using scrubbers to remove sulphur dioxide from fuel gas in a power station
(2) using catalytic converters to remove nitrogen oxides in car exhaust
(3) using sodium hydroxide solution to remove copper(II) ions in industrial waste water

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE06_23

Rain water samples collected in industrial areas have pH lower than those collected in the countryside. Which of the following air pollutants is/are responsible for this phenomenon?

(1) carbon dioxide
(2) nitrogen dioxide
(3) particulates

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE06_30

1st statement	2nd statement
In Hong Kong, taxis have switched from using diesel to using natural gas as fuel.	Burning natural gas poses less harm to the environment than burning diesel.

CE06_44

Which of the following statements concerning a catalyst are correct?

(1) A catalyst can alter the rate of reaction.
(2) The mass of a catalyst remains unchanged at the end of the reaction.
(3) A catalyst should be in the same physical state as the reaction.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE06_45

In an experiment to prepare a polymer, equal volumes of styrene and kerosene are mixed and then heated under reflux for about an hour. After cooling, the resulting mixture is poured into a large volume of methanol. A white waxy solid is formed. Which of the following statements concerning the experiment are correct?

(1) The experiment should be conducted in a fume cupboard.
(2) The mixture of styrene and kerosene is heated under reflux because kerosene is volatile.
(3) Methanol reacts with styrene to form the waxy solid.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE06_46

There are two unlabeled bottles in the laboratory. One of the bottles contains an aqueous solution of common salt and the other contains antiseptic alcohol. Which of the following methods can be used to distinguish the substances in the bottles?

(1) adding a small amount of water
(2) detecting their odour
(3) measuring their electrical conductivity

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE07_02

Which of the following substances has a sharp boiling point?

A. petrol
B. red wine
C. molten wax
D. liquid ammonia

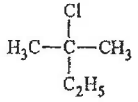
CE07_04

Which of the following statements concerning members of a homologous series is correct?

A. The members of the same molecular formula.
B. The relative molecular mass of each successive member differs by 14.
C. The volatility of the members increases with relative molecular mass.
D. The members with more carbon atoms in their molecules burn more readily.

CE07_08

What is the systematic name of the following compound?



A. 2-chloro-2-ethylpropane
B. 2-chloro-2-methylbutane
C. 1-chloro-1,1-dimethylpropane
D. 2-chloro-2,2-dimethylpropane

CE07_10

Which of the following suggestions for storing chemicals is acceptable?

A. storing sodium in a brown glass bottle.
B. storing silver nitrate solution in an iron can.
C. storing ethyl ethanoate in an expanded polystyrene container.
D. storing concentrated sulphuric acid in a polyvinyl chloride bottle.

CE07_14

How many moles of ethane contain y hydrogen atoms?
(L represents the Avogadro's constant.)

A. y / L
B. L / y
C. y / 6L
D. 6y / L

CE07_26

Which of the following statements concerning the measures to reduce air pollutants is / are correct?

(1) Scrubber can be used to reduce carbon monoxide.
(2) Catalytic converter can be used to reduce nitrogen monoxide.
(3) Electrostatic precipitator can be used to reduce unburnt hydrocarbons.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE07_30

1st statement	2nd statement
Carbon can form a large number of compounds with long carbon chains.	Carbon atoms can share electrons with one another.

CE07_33

50 cm^3 of carbon monoxide burns completely in 50 cm^3 of oxygen. Assuming that all volumes are measured at room temperature and pressure, what is the final gaseous volume at the end of the combustion?
(Molar volume of gas at room temperature and pressure = 24 dm^3)

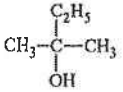
A. 50 cm^3
B. 75 cm^3
C. 100 cm^3
D. 150 cm^3

CE07_49

1st statement	2nd statement
Cracking is an endothermic reaction.	Cracking results in an increase of number of molecules.

CE08_06

An organic compound has the following structure:



The systematic name of this compound is

A. 2-ethylpropan-2-ol.
B. 2-methylbutan-1-ol.
C. 2-methylbutan-2-ol.
D. 1,1-dimethylpropan-1-ol.

CE08_14

Which of the following petroleum fractions has the highest carbon content?

A. diesel
B. petrol
C. kerosene
D. naphtha

CE08_27

Which of the following substances are sources of organic chemicals?

(1) wood
(2) rock
(3) crude oil

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE08_29

1st statement	2nd statement
The boiling point of butane is higher than that of methane.	The van der Waals' forces between butane molecules are stronger than the forces between methane molecules.

CE08_49

1st statement	2nd statement
Fractional distillation can convert large alkane molecules to smaller alkane molecules and alkene molecules.	Fractional distillation involves breaking and forming of covalent bonds.

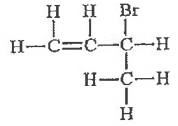
CE09_03

Which of the following properties is NOT possessed by both carbon and nitrogen?

A. They can form multiple bonds.
B. They can exit in giant covalent structures.
C. They are chemically stable at room temperature.
D. They react with oxygen under suitable conditions to form acidic oxides.

CE09_11

What is the systematic name of the following compound?



A. 2-bromobut-3-ene
B. 3-bromobut-1-ene
C. 1-bromo-1-methylpropene
D. 3-bromo-3-methylpropene

CE09_16

Which of the following is/are renewable energy source(s)?

(1) natural gas
(2) wind power
(3) nuclear energy

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE09_21

Which of the following methods are used to treat solid wastes in Hong Kong?

(1) recycling of metal wastes
(2) using plastic wastes as fuel
(3) burying domestic solid wastes in landfill sites

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE09_25

Which of the following hazard warning labels should be displayed on the reagent bottle of methanol?

(1)

(2)

(3)

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE09_26

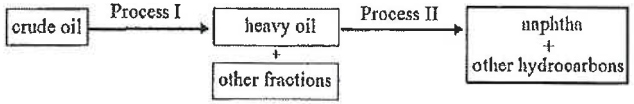
Which of the following measures can help reduce the level of carbon monoxide at the road side?

(1) using liquefied petroleum gas as fuel for motor vehicles
(2) installing catalytic converter for motor vehicles
(3) installing electrostatic precipitators for motor vehicles

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE10_02

Consider the industrial processes as shown below:

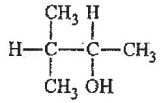


Which of the following combinations is correct?

	Process I	Process II
A.	is a chemical change.	is a physical change.
B.	is a chemical change.	is a chemical change.
C.	is a physical change.	is a physical change.
D.	is a physical change.	is a chemical change.

CE10_12

The structure of compound R is shown below:



The systematic name of R is

A. 2-methylbutan-3-ol.
B. 3-methylbutan-2-ol.
C. 1,1-dimethylpropan-2-ol.
D. 3,3-dimethylpropan-2-ol.

CE10_25

Which of the following measures can help improve the air quality in Hong Kong?

(1) Use natural gas to replace coal in generating electricity.
(2) Use electricity to replace petrol in drive cars
(3) Use fuel with lower sulphur content to drive ferries.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE10_27

Which of the following environmental problems may be reduced by installing catalytic converters in petrol-driven cars?

(1) acid rain
(2) greenhouse effect
(3) photochemical smog

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

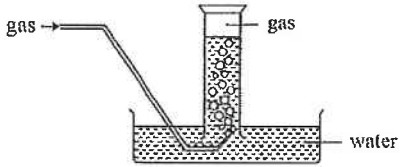
CE10_29

1st statement	2nd statement
When using a Bunsen burner with the air hole closed, the burner gives a non-luminous flame.	When using a Bunsen burner with the air hole closed, the fuel undergoes incomplete combustion.

CE10_50

1st statement	2nd statement
The reaction of charcoal with oxygen is endothermic.	Charcoal that is placed in fire can be ignited.

CE11_10



The set-up shown in the above diagram can be used to collect

A. ethene.
B. ammonia.
C. sulphur dioxide .
D. hydrogen chloride.

CE11_18

The equation below represents the complete combustion of organic compound X :

$$2X + 9O_2 \longrightarrow 6CO_2 + 8H_2O$$

What is X?

A. C_3H_6
B. C_3H_8
C. C_3H_6O
D. C_3H_8O

CE11_22

Which of the following statements concerning cracking and fractional distillation in petrochemical industry is / are correct?

(1) Both processes involve heating.
(2) Both processes are chemical changes.
(3) Both processes produce extra alkenes.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE11_38

Hydrocarbon X contains 80% of carbon by mass. What is the empirical formula of X?
(Relative atomic masses: H = 1.0, C = 12.0)

A. CH
B. CH_2
C. CH_3
D. CH_4

CE11_42

The exhaust pipe of a petrol-driven car will corrode easily because

(1) there are nitrogen oxides passing through the exhaust pipe.
(2) there are unburnt hydrocarbons passing through the exhaust pipe.
(3) the exhaust pipe usually becomes hot when the car engine is running.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

Part 2: (d) addition polymers

CE91_26

Teflon, a polymer used for coating and non-stick cooking utensils, has the structure given below:

Which of the following is the monomer for Teflon?

A. 1,2-difluoroethane
B. 1,2-difluoroethene
C. 1,1,2,2-tetrafluoroethane
D. 1,1,2,2-tetrafluoroethene

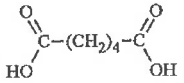
CE91_27

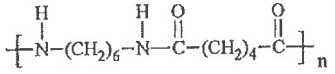
A sample of polymer gives acid fumes on strong heating. The polymer is probably

A. nylon
B. polypropene
C. polystyrene
D. polyvinyl chloride

CE92_25

The polymer formed by $H_2N–(CH_2)_6–NH_2$ and





A. has a formula of
B. is a thermosetting plastic.
C. has cross-linkages.
D. burns with a floral smell.

CE92_43

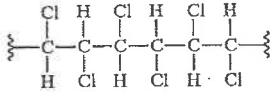
Which of the following polymers is/are NOT suitable for making a container for boiling water?

(1) perspex
(2) urea-methanal
(3) polyvinyl chloride

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE93_35

A polymer has the following structure:



Its monomer is

A. chloroethene.
B. 1,1-dichloroethane.
C. 1,2-dichloroethene.
D. 1,2-dichloroethane.

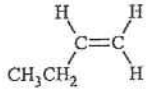
CE94_20

X is a synthetic polymer. On gentle heating, it softens and chars. On strong heating, it burns with an acidic smell. X is probably

A. polypropene.
B. polystyrene.
C. polyvinyl chloride.
D. perspex.

CE94_41

A compound has the following structure:



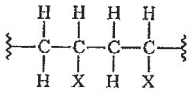
Which of the following statements about this compound are correct?

(1) It can decolourize bromine water.
(2) It can be polymerized.
(3) It can burn in air.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE95_22

The formula below can be used to represent the structure of some polymers.



(X represents an atom or a group of atoms.)

Which of the following combination is **INCORRECT**?

	X	Name of polymer
A.	H	polyethene
B.	Cl	polyvinyl chloride
C.	CH_3	perspex
D.	C_6H_5	polystyrene

CE95_35

Which of the following substances, when mixed with lemon juice, would give off gas bubbles?

(1) iron nails
(2) milk of magnesia
(3) polyethene wrap

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

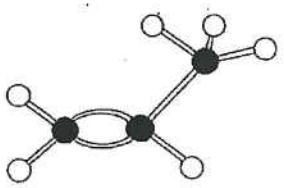
CE96_05

Which of the following materials are suitable for making the base and handle of a frying pan?

	Base	Handle
A.	Aluminium	Polyvinyl chloride
B.	Copper	Urea-methanol
C.	Titanium	Polyvinyl chloride
D.	Zinc	Urea-methanol

CE97_18

The model shown on the right represents a compound containing 6 hydrogen atoms (white spheres) and 3 carbon atoms (black spheres).



Which of the following statements concerning the compound is **INCORRECT**?

A. Its structural formula is C_3H_6.
B. It can be prepared by cracking petroleum fractions.
C. It can decolourize bromine in 1,1,1-trichloroethane.
D. It can undergo polymerization.

CE97_40

Which of the following methods can be used to solve the pollution problems associated with the disposal of plastic waste?

(1) recycling of plastics
(2) making biodegradable plastics
(3) burning plastic waste in incinerators with tall chimneys

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE98_14

Which of the following statements concerning propene is correct?

A. It can be converted by catalytic hydration to an alkanol with molecular formula C_3H_8O.
B. It can undergo condensation polymerization.
C. It can be manufactured by fractional distillation of crude oil.
D. It can undergo substitution reaction with a solution of bromine in 1,1,1-trichloroethane.

CE98_49

	1st statement	2nd statement
	Wash bottles used in the chemistry laboratory are commonly made of polyethene.	Polyethene is an addition polymer.

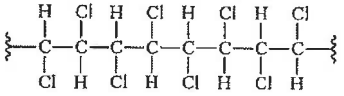
CE99_28

Which of the following substance is a thermoplastic as well as a condensation polymer?

A. nylon
B. perspex
C. polyethene
D. urea-methanal

CE99_41

Plastic X has the following structure:

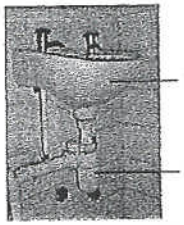


Which of the following statements concerning X are correct?

(1) The monomer of X is CHCl=CHCl.
(2) X can be used to make electric sockets.
(3) The flue gas produced by the incineration of X can cause the formation of acid rain.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE00_38



Some concentrated sulphuric acid was poured into a sink connected to a catchpot made of polyvinyl chloride (PVC). After some time, the catchpot becomes deformed. Which of the following explanations for the deformation of the catchpot is/are correct?

(1) The heat liberated when the concentrated sulphuric acid mixed with the water in the catchpot caused PVC to soften.
(2) PVC was decomposed into its monomer by the concentrated sulphuric acid.
(3) PVC was oxidized by the concentrated sulphuric acid.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE01_09

Which of the following statements concerning uses of plastics is correct?

A. Perspex is used for making ash trays.
B. Polyvinyl chloride is used for making raincoats.
C. Polystyrene is used for making floor tiles.
D. Nylon is used for making packing materials for electrical appliances.

CE01_17

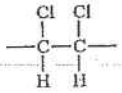
Which of the following compounds is a monomer of polyvinyl chloride (polychloroethene)?

A. $CH_2=CHCl$
B. $CH_2=CCl_2$
C. $CHCl=CHCl$
D. $CCl_2=CCl_2$

CE02_20

The monomer of polymer X is chloroethene. Which of the following statements concerning X is correct?

A. X is a condensation polymer.
B. X is a thermosetting plastic.
C. X is used in making drainage pipes.
D. The repeating unit of X is as follows:



CE02_30

Starch, a natural polymer, is a carbohydrate. When concentrated sulphuric acid is added dropwise to some starch, a black substance is formed. The reaction involved is

A. dehydration
B. depolymerization
C. redox reaction
D. neutralization

CE03_31

Propene is an unsaturated hydrocarbon. Which of the following reactions is/are characteristic of the unsaturated nature of propene?

(1) It undergoes incomplete combustion to give carbon monoxide.
(2) It decolourizes acidified potassium permanganate solution.
(3) It undergoes polymerization to give polypropene.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE03_36

Which of the following statements concerning thermoplastics is/are correct?

(1) They soften upon heating.
(2) They are cross-linked polymers.
(3) They are addition polymers.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE03_48

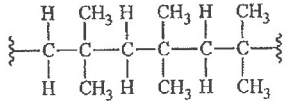
1st statement	2nd statement
Polyethene is used for making the handle of frying pans.	The shape of the polyethene handle remains unchanged during the frying process.

CE05SP_48

1st statement	2nd statement
Polyethene is used to make food wrap.	Polyethene is an addition polymer.

CE04_15

The structure of polymer X can be represented by



What is the monomer of X?

A. 1,1-dimethylethene
B. 1,2-dimethylethene
C. methylpropene
D. but-1-ene

CE04_41

Which of the following statements concerning polyvinyl chloride (PVC) are correct?

(1) PVC is used in making raincoats.

(2) PVC softens upon gentle heating.

(3) When PVC is strongly heated, fumes with an irritating odour are emitted.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE06_49

1st statement	2nd statement
Both ethene and polyethene can decolourize a solution of bromine in an organic solvent.	Both ethene and polyethene belong to the same homologous series.

CE07_09

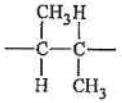
Which of the following items can be made from polystyrene?

A. clothing
B. food wrap
C. electric socket
D. packaging material

CE07_27

Which of the following statements concerning but-2-ene are correct?

(1) It has the same molecular formula as but-1-ene.

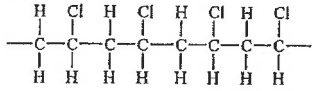
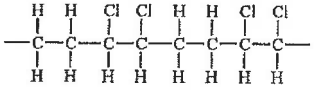
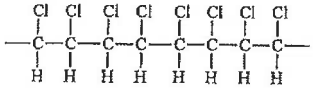
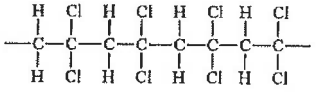
(2) It can form a polymer with  as the repeating unit.

(3) It can decolourize acidified potassium permanganate solution.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE10_10

The polymer formed from the polymerization of 1,1-dichloroethene is commonly used in making food wrap for microwave cooking. Which of the following can represent a part of the structure of the polymer?

A. 
B. 
C. 
D. 

CE11_17

Plastic wastes containing polychloroethene (PVC) should NOT be treated by incineration. The main reason is to prevent the production of dioxins and

A. carbon dioxide.
B. sulphur dioxide.
C. nitrogen dioxide.
D. hydrogen chloride.

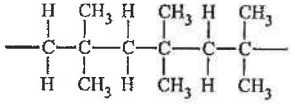
DSE11SP_01

Upon cracking, one molecule of decane ($C_{10}H_{22}$) gives two molecules of propene and one molecule of an alkane (X). What is X?

A. C_4H_6
B. C_4H_{10}
C. C_7H_{14}
D. C_7H_{16}

DSE11SP_04

The structure of polymer X is shown below:



What is the monomer of X?

A. 1,1-dimethylethene
B. 1,2-dimethylethene
C. Methylpropene
D. But-1-ene

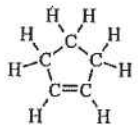
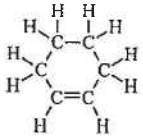
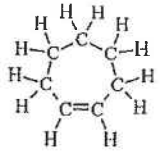
DSE11SP_09

Which of the following statements concerning alkenes is INCORRECT?

A. They can decolorize a solution of bromine.
B. they can decolorize red litmus solution.
C. They can decolorize acidified potassium permanganate solution.
D. They can be polymerized to form addition polymers.

DSE12PP_10

The structures of three cycloalkenes are shown below:

Cycloalkenes can be represented by a general formula. Which of the following is the general formula for cycloalkenes? (In these formulae, n is an integer greater than 2.)

A. C_nH_{2n-4}
B. C_nH_{2n-2}
C. C_nH_{2n}
D. C_nH_{2n+2}

DSE12PP_11

The equation below represents the cracking of a hydrocarbon:

$$C_{22}H_{46} \longrightarrow C_{14}H_{30} + 2X$$

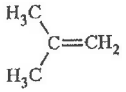
What is the chemical formula of compound X?

A. C_3H_6 B. C_4H_8

C. C_8H_{16} D. $C_{14}H_{28}$

DSE12PP_21

Consider the following organic compound:



Which of the following statements about this compound is/are correct?

(1) Its systematic name is 1,1-dimethylethene.

(2) It can decolorize an acidified solution of potassium permanganate.

(3) It is the monomer of Perspex.

A. (1) only B. (2) only

C. (1) and (3) only D. (2) and (3) only

DSE12_11

Compound X has the following structure:

CH_2=$CHCH_2OH$

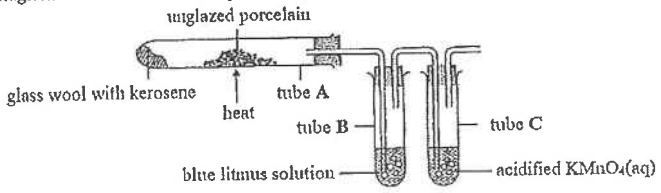
The systemic name of X is

A. Prop-1-en-3-ol B. Prop-2-en-1-ol

C. 3-hydroxypropene D. 1-hydroxyprop-3-ene

DSE12_17

The diagram below shows the set-up of an experiment:



The unglazed porcelain in tube A is strongly heated and the glass wool is occasionally heated.

Which of the following statements is/are correct?

(1) A chemical reaction occurs at the glass wool.

(2) There is NO color change in the solution in tube B.

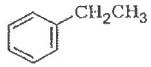
(3) There is NO color change in the solution in tube C.

A. (1) only B. (2) only

C. (1) and (3) only D. (2) and (3) only

DSE12_21

Which of the following compounds can be used as monomers to make addition polymers?

(1) CF_2=CF_2 (2) CH_2=$C(CH_2CH_3)CN$ (3) 

A. (1) and (2) only B. (1) and (3) only

C. (2) and (3) only D. (1), (2) and (3)

DSE12_22

Which of the following processes involve redox reaction?

(1) Mixing methanol and ethanol

(2) Mixing chlorine and methane under sunlight

(3) Mixing ethane and acidified $KMnO_4$(aq)

A. (1) and (2) only B. (1) and (3) only

C. (2) and (3) only D. (1), (2) and (3)

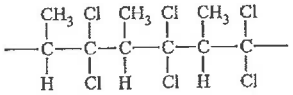
DSE12_24

1st statement	2nd statement
Burning fossil fuels can cause acid rain.	Burning fossil fuels produces carbon dioxide.

DSE13_14

A portion of the structure of an addition polymer X is shown below:

Which of the following is the systematic name of the monomer of X based on the given structure?

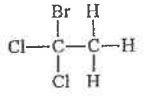


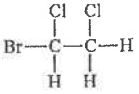
A. 1,1-dicloro-2-methylethene B. 1,1-dichloropropene

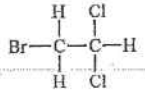
C. 1,2-dichloropropene D. 3,3-dichloropropene

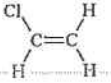
DSE14_08

Which of the following compounds would be formed when bromoethene reacts with chlorine in a suitable organic solvent?

A. 

B. 

C. 

D. 

DSE14_10

One mole of methane is allowed to react with two moles of chlorine in the presence of light. Which of the following best describes the organic product(s) that would be formed?

A. One mole of CCl_4
B. One mole of CH_2Cl_2
C. A mixture containing only CCl_4 and CH_2Cl_2
D. A mixture containing CH_3Cl, CH_2Cl_2, $CHCl_3$ and CCl_4

DSE14_17

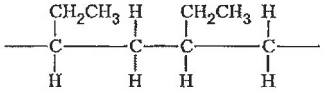
What are the advantages of using natural gas over using coal as a fuel in power stations?

(1) In comparing with coal, natural gas burns more completely.
(2) In comparing with coal, natural gas has less sulphur-containing substances.
(3) Natural gas is a renewable energy source, but coal is not.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE15_10

The structure of a certain polymer is shown below :



Which of the following is the systematic name of the monomer of this polymer?

A. Propene
B. But-1-ene
C. But-2-ene
D. Methylpropene

DSE15_19

Which of the following pairs of substances can be distinguished by using acidified $KMnO_4(aq)$?

(1) Pent-1-ene and Pent-2-ene
(2) Cyclohexane and Cyclohexene
(3) polyethene and Poly(chloroethene)

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE15_22

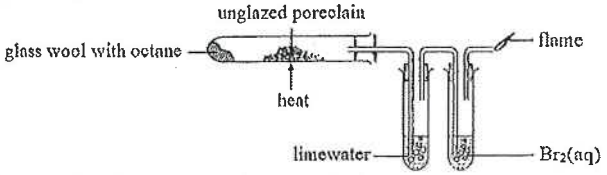
Which of the following are renewable energy sources?

(1) nuclear energy
(2) tidal energy
(3) biomass

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE15_20

The set-up of an experiment is shown below:



Which of the following observations would be expected?

(1) Limewater turns milky.
(2) $Br_2(aq)$ changes from brown to colorless.
(3) The flame is brick red in color.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE16_09

1 mol of a hydrocarbon requires 9 mol of oxygen for complete combustion. Which of the following may be this hydrocarbon?

A. C_6H_6
B. C_6H_{10}
C. C_6H_{12}
D. C_6H_{14}

DSE16_10

Which of the following CANNOT be converted into substances that are less harmful when passed through a catalytic converter?

A. Nitrogen oxides
B. Sulphur dioxide
C. Carbon monoxide
D. Unburnt hydrocarbons

DSE16_17

Which of the following statements concerning petroleum is/are correct?

(1) It is a source of aliphatic hydrocarbons
(2) It can be separated into liquids of different viscosity by a separating funnel.
(3) It is a fossil fuel derived rom ancient marine organisms.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE16_19

The hazard warning label below is displayed on a bottle containing chemical Z:

Which of the following chemicals may Z be?

(1) Sodium
(2) Trichloromethane
(3) Concentrated aqueous ammonia

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE17_05

Which is the systematic name of $Cl_2CH–CH=CH–CH=CH_2$?

A. 1-dichloropenta-2,4-diene
B. 5,5-chloropenta-1,3-diene
C. 1,1-dichloropenta-2,4-diene
D. 5,5-dichloropenta-1,3-diene

DSE17_18

The structures of organic compound A and B are shown below:

A B

Which of the following statements concerning the two compounds is/are correct?

(1) A and B belong to the same homologous series.
(2) A and B can be distinguished by acidified $KMnO_4(aq)$,
(3) Complete combustion of 1.0 g of A and complete combustion of 1.0 g of B would form the same mass of $CO_2(g)$.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE17_20

Which of the following are characteristics exhibited by members of a homologous series?

(1) They have similar chemical properties.
(2) They display a gradation in physical properties.
(3) They can be represented by the same general formula.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE17_22

Which of the following statements concerning burning coal under room conditions are correct?

(1) Burning coal forms both acidic and non-acidic substances.
(2) Burning coal forms both gaseous and non-gaseous substances.
(3) Burning coal forms both poisonous and non-poisonous substances.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE18_08

Which of the following molecular formulae can represent an alkanoic acid?

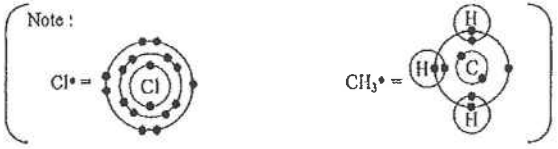
A. CH_2O
B. $C_2H_6O_2$
C. $C_4H_8O_2$
D. $C_4H_{10}O_2$

DSE18_13

The reaction below involves several steps.

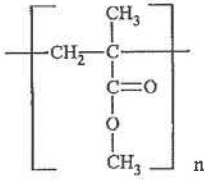
$$CH_4(g) + Cl_2(g) \xrightarrow{\text{sunlight}} CH_3Cl(g) + HCl(g)$$

Which of the following steps can lead to a termination of the reaction?



A. $Cl_2 \longrightarrow 2Cl\bullet$
B. $CH_3\bullet + Cl\bullet \longrightarrow CH_3Cl$
C. $CH_4 + Cl\bullet \longrightarrow CH_3\bullet + HCl$
D. $CH_3\bullet + Cl_2 \longrightarrow CH_3Cl + Cl\bullet$

DSE18_14



Which of the following statements concerning the polymer is correct?

A. It is a polyester.
B. It can be polymerized from $(CH_3)_2CHCO_2CH_3$
C. Its monomer can decolorize acidified $KMnO_4(aq)$.
D. It can be made from its monomer through condensation.

DSE18_15

Which of the following mixtures can be separated by this apparatus?

A. Rock salt and sand
B. Propan-2-ol and water
C. Hexane (C_6H_{14}) and water
D. Methanoic acid and ethanoic acid

DSE18_20

Which of the following hazard warning labels should be displayed on a bottle containing propan-2-ol?

(1)

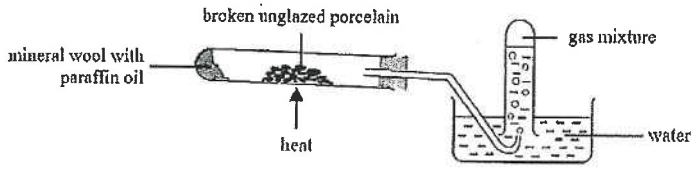
(2)

(3)

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE19_07

The set-up of an experiment is shown below:

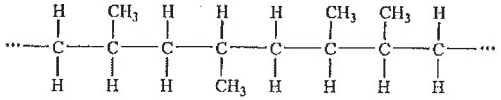


Which of the following statements is INCORRECT ?

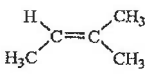
A. The broken unglazed porcelain acts as a catalyst.
B. Fractional distillation is performed in the set-up.
C. The gas mixture turns acidified potassium permanganate solution from purple to colorless.
D. When no more gas can be collected, the delivery tube should be taken out of the water before removing the heat source.

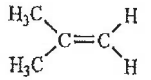
DSE19_10

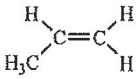
A part of the structure of a polymer is shown below :

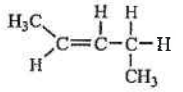


Which of the following can be a monomer of this polymer?

A. 

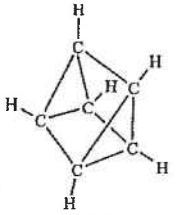
B. 

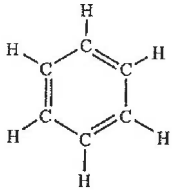
C. 

D. 

DSE19_18

Consider the following two compounds:





Which of the following statements is / are correct?

(1) They are both soluble in water.
(2) They have the same empirical formula.
(3) They are in the same homologous series.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE20_6

6. What is the product of the reaction between chloroethene and bromine dissolved in an organic solvent ?

A. 2-chloro-1,2-dibromoethane
B. 1,2-dibromo-1-chloroethane
C. 2-chloro-1,1-dibromoethane
D. 2,2-dibromo-1-chloroethane

DSE20_23

23. Which of the following hazard warning labels should be displayed on a bottle containing methanol ?

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE20_24

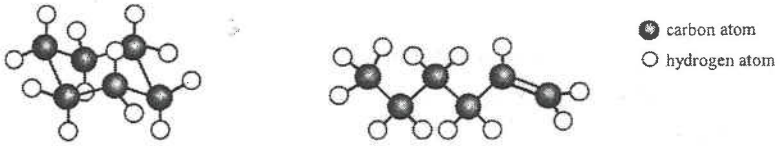
24. Consider the following statements and choose the best answer :

1st statement	2nd statement
Perspex can be used to make shopping bags.	Perspex is a condensation polymer.

A. Both statements are true and the 2nd statement is a correct explanation of the 1st statement.
B. Both statements are true but the 2nd statement is NOT a correct explanation of the 1st statement.
C. The 1st statement is false but the 2nd statement is true.
D. Both statements are false.

DSE21_8

8. Consider two compounds with their structures shown below :



Which of the following statements is correct ?

A. Both of them are flammable.
B. They have different empirical formulae.
C. They belong to the same homologous series.
D. Both of them can decolourise bromine solution in the dark.

DSE21_11

11. The monosubstitution of methane with chlorine under diffuse sunlight involves several steps. Which of the following steps initiates the reaction ?

A. $Cl_2 \rightarrow 2\ Cl\bullet$
B. $CH_4 \rightarrow CH_3\bullet + H\bullet$
C. $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$
D. $CH_4 + Cl_2 \rightarrow CH_3Cl + H\bullet + Cl\bullet$

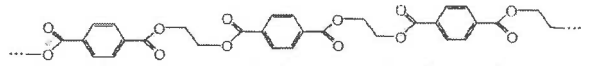
DSE21_17

17. What is the systematic name of $CH_2BrCHBrCH_2CH_2I$?

A. 1-iodo-3,4-dibromobutane
B. 4-iodo-1,2-dibromobutane
C. 1,2-dibromo-4-iodobutane
D. 3,4-dibromo-1-iodobutane

DSE21_20

20. The structure of a portion of a polymer is shown below :



Which of the following statements concerning the polymer is / are correct ?

(1)  is the repeating unit of it.

(2)  is a monomer of it.

(3) $HOCH_2COOH$ is a monomer of it.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

Structural Questions

Part 1: (a) hydrocarbons, (b) homologous series and (c) alkanes and alkenes

CE90_03a

Hong Kong imports naphtha (mainly C_7H_{12}), from which town gas is produced.

(i) What is the raw material from which naphtha is obtained? How is naphtha obtained from this raw material?

(ii) Town gas is produced by reacting with steam. Write an equation for this reaction. Name two major components in town gas.

(iii) What is observed when town gas is passed through a sample of citrated blood? Explain your answer.

(iv) What is observed when town gas is passed over heated copper(II) oxide in a combustion tube? Explain your answer and write appropriate equations.

(v) State two potential hazards associated with the use of town gas.

(vi) If you suspect there is a leakage of town gas in your home, explain why

(1) you should open all windows at once.

(2) you should NOT use your telephone to call for help.

(13 marks)

CE90_05c(ii)

When sulphur dioxide gas reacts with water, the following equilibrium is established:

$SO_2(g) + H_2O(l) \rightleftharpoons 2H^+(aq) + SO_3^{2-}(aq)$ [ΔH is negative]

Sulphur dioxide gas is a common pollutant found in exhaust fumes from factories, and it can be removed by using aqueous sodium hydroxide.

(1) Why is sulphur dioxide gas present in the exhaust fumes?

(2) Give TWO reasons why sulphur dioxide gas should be removed from the exhaust fumes.

(3 marks)

CE91_02a

A student wished to find out which of the two commercial brands of vinegar, A and B, was the better buy, i.e. of lower price per gram of ethanoic acid (CH_3COOH).

The following table listed some of the information about these two brands:

Brand	Price	Volume of vinegar	Concentration of ethanoic acid
A	\$3.00	250 cm^3	50 g dm^{-3}
B	\$6.00	500 cm^3	UNKNOWN

The student carried out a titration experiment to determine the concentration of ethanoic acid in Brand B as follows:

25 cm^3 of the vinegar was first diluted to 250 cm^3 with distilled water. 25.0 cm^3 portions of the diluted solution were then titrated against 0.10 M sodium hydroxide solution, using a suitable indicator, until the end-point was reached.

The following results were obtained:

Titration / Burette reading	1	2	3	4
Final reading (cm^3)	25.50	25.70	26.20	25.90
Initial reading (cm^3)	0.00	1.00	1.30	1.10

(i) Describe, giving the names of the apparatus used, how 25.0 cm^3 of the vinegar should be diluted to 250.0 cm^3.

(ii) Suggest a suitable indicator for this titration and state its color change at the end-point.

(iii) Based on the titration results, calculate a reasonable average for the volume of the sodium hydroxide solution used.

(iv) Write the equation for this reaction. (Ionic equation will not be accepted.)

(v) Calculate the molarity of ethanoic acid in Brand B.

(vi) Show by calculation which brand of vinegar is the better buy.

(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0)

(13 marks)

CE91_03a

Petroleum, often referred to as a 'fossil' fuel, can be separated into various fractions by fractional distillation. The following table shows the annual production and consumption of petroleum fractions in a certain country.

Petroleum fraction	Annual production (in million tonnes)	Annual consumption (in million tonnes)
Petrol	10	25
Naphtha	5	5
Kerosene	20	20
Diesel oil	15	35
Heavy oil	40	5
Liquefied petroleum gas	6	4

(i) Why is petroleum referred to as a 'fossil' fuel?

(ii) Why can the various petroleum fractions be obtained from petroleum by fractional distillation?

(iii) According to the above table, some fractions are produced in excess while some others are not sufficient to meet the annual consumption requirements.

(1) Identify a fraction that is produced in excess and can be converted into those which are not sufficient.

(2) Suggest a chemical method for the above conversion.

(iv) A sample of liquefied petroleum gas is known to contain propene and propane.

(1) Draw the structural formula of

(I) propene, and

(II) propane.

(2) (I) Write the equation for the complete combustion of propane in air.

(II) Explain whether the combustion of propene or propane would produce a more sooty flame.

(3) How would you show that propane consists of
(I) carbon, and
(II) hydrogen?

(4) Apart from combustion, describe another chemical test to distinguish propene from propane.

(13 marks)

CE92_01c

In motor car engines, petrol is mixed with air and burn to produce power.

(i) Using C_8H_{18} to represent petrol, write a balanced equation for the complete combustion of petrol. Explain why this reaction can produce power.

(ii) What would happen if the supply of air is insufficient for the combustion of petrol in the car engine?

(iii) Leaded petrol has been used for a long time in Hong Kong. In April 1991, unleaded petrol was introduced.
(1) (II) Why is petrol leaded?
(2) Explain why unleaded petrol has been introduced in Hong Kong.

(7 marks)

CE93_01e

Alkenes can be obtained from petroleum fractions by a process called 'cracking'. Using a suitable petroleum fraction, a student carried out this process in the laboratory and collected the gaseous product over water.

(i) What is 'cracking'?

(ii) Draw a labelled diagram of a laboratory set-up that can be used for carrying out the process and collecting the gaseous product.

(iii) An important safety precaution in the experiment is to prevent sucking back.
(1) What is the potential hazard if sucking back occurs?
(2) How can sucking back be prevented?

(iv) If the gaseous product decolorizes a solution of bromine in tetrachloromethane, can you conclude that the gaseous product is ethene? Explain your answer.

(8 marks)

CE93_01d

Chemical reactions play important roles in our daily life. Some are beneficial to us while others are not.

In the case of a motor car, chemical reactions occur both when it is in motion and at rest. With reference to these reactions, answer the following questions:

(i) State ONE reaction that is beneficial. Explain your answer.

(ii) (1) State ONE reaction that is not beneficial. Explain your answer.
(2) How can the undesirable effect of this reaction be minimized?

(5 marks)

CE93_03b

In school laboratories, chemical wastes such as concentrated hydrochloric acid, methylbenzene and tetrachloromethane produced during practical work are to be stored in containers and then sent to a chemical waste treatment plant for disposal.

(iii) When chemical wastes such as methylbenzene and tetrachloromethane are burnt in the incinerator in the plant, several pollutants including sulphur dioxide are produced.
(1) Explain why sulphur dioxide is emitted from the incinerator.
(2) Name TWO pollutants other than sulphur dioxide which are emitted from the incinerator and state ONE harmful effect for each pollutant.

(5 marks)

CE94_05

(iii) If heptane, C_7H_{16}, is used as a fuel in the internal combustion engine.
(1) Write an equation for the complete combustion of heptane.

(iv) Explain why car exhaust fumes usually contain oxides of nitrogen.

(3 marks)

CE95_02

In each of the following groups of substances, there is ONE substance which different from the others in terms of their properties. In each group, identify the substance which is different from the others and explain your choice.

(d) carbon monoxide, hydrogen, methane, nitrogen

(2 marks)

CE95_08a

The fumes emitted from a factory using diesel fuel contain several gaseous pollutants. One of these pollutants, Z, has a choking smell and can decolourize bromine water.

(i) (1) What is Z?
(2) What is the effect of Z on the environment?
(3) Suggest ONE way to reduce the amount of Z in the fumes.

(ii) (1) Suggest ONE other pollutant that is present in the fumes.
(2) Explain how this pollutant is formed.
(3) What is the effect of this pollutant on the environment?
(4) Suggest ONE way to reduce the amount of this pollutant in the fumes.

(iii) If a fire is caused by the burning of diesel fuel, what type of fire extinguisher should not be used to put out the fire?

(8 marks)

CE96_01a(3)

A student suggested the following immediate actions to deal with three domestic accidents. However, these actions are considered inappropriate.

Accident	Suggested action
Leakage of town gas occurs in a kitchen.	Turn on an exhaust fan in the kitchen to remove the town gas.

Explain why the action is inappropriate and suggest a proper action.

(3 marks)

CE96_02

The relative molecular mass of an alkanol **X** is 60.0. **X** contains 60% of carbon by mass.

(a) Calculate the number of moles of carbon in one mole of **X** and hence deduce the molecular formula of **X**.

(b) Draw ONE possible structure of **X** and give its systematic name.
(Relative atomic mass: C = 12.0)

(5 marks)

CE96_03

'Fossil fuels' such as petroleum and coal constitute the world's major source of energy. However, many countries have been developing alternative energy sources.

(a) Why are petroleum and coal called 'fossil fuels'?

(b) Give TWO reasons why it is necessary to develop alternative energy sources.

(c) Nuclear power is used as an alternative to fossil fuels in many countries. Suggest ONE advantage and ONE disadvantage of using nuclear power.

(d) Suggest ONE energy source, other than nuclear power, that can be used as an alternative to fossil fuels.

(6 marks)

CE97_05

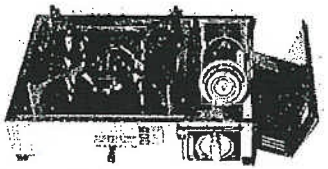
In March 1989, the oil tanker *Exxon Valdez* was wrecked off the coast of Alaska and split a large amount of crude oil into the sea. The oil spillage caused serious environmental problems.

Briefly explain why oil spillage in the sea can cause serious environmental problems and suggest ONE method of treating the split oil.

(8 marks)

CE97_09a

The photograph below shows a gas burner with a can of fuel. The can contains 250 g of liquefied butane.



(i) Write the structural formula of butane.

(ii) (1) Write the chemical equation for the complete combustion of butane.

(2) Suggest a chemical test for EACH of the products formed when butane is completely burnt in air.

(3) Calculate the volume of the gaseous product formed, measured at room temperature and pressure, if all the butane contained in the can is completely burnt in air.

(iii) Explain why it is dangerous to use such gas burners in a poorly-ventilated room.
(Relative atomic masses: H = 1.0, C =12.0, O = 16.0;
molar volume of gas at room temperature and pressure = 24.0 dm^3)

CE98_02

For each of the following experiments, state the expected observation and write a relevant chemical equation.

(a) Ethene is passed into an acidified potassium permanganate solution.

(b) A mixture of butane and bromine vapour is exposed to diffused sunlight.

(4 marks)

CE99_03

The illustration below shows the exhaust from a motor car using unleaded petrol.

(a) Explain why the exhaust contains carbon monoxide.

(b) (1) Write TWO chemical equations for the formation of acid rain from nitrogen oxides.

(2) State ONE undesirable effect of acid rain.

(c) State ONE health hazard associated with particulates.

(d) Suggest ONE other pollutant that may be found in the exhaust.

(e) Suggest a device that can be installed in the motor car to reduce the emission of carbon monoxide and nitrogen oxides.

(7 marks)

CE99_09b

Cracking of naphtha gives alkane **X** (relative molecular mass 44), alkene **Y** (relative molecular mass 42) and other products.

(i) What is the meaning of the term 'cracking'?

(ii) Suggest a chemical test to distinguish between **X** and **Y**.

(iii) Deduce the molecular formula of **Y**.

(5 marks)

CE00_08a

Crude oil is a mixture consisting mainly of alkanes. Fractional distillation of crude oil gives different petroleum fractions. The table below lists the length of carbon chain of the alkanes in some of the fractions.

Fraction	Length of carbon chain
petrol/naphtha	$C_5 - C_{10}$
kerosene	$C_{11} - C_{18}$
diesel	$C_{18} - C_{25}$
X	$C_{20} - C_{34}$

(i) Describe the principle underlying the fractional distillation of crude oil.

(ii) (1) Explain why global demand for petrol is greater than that for kerosene.

(2) Cracking kerosene can produce petrol. State the conditions required for the cracking process.

(iii) In Hong Kong, naphtha instead of coal is used to manufacture town gas.

(1) State ONE advantage of using naphtha instead of coal to manufacture town gas. (You are NOT required to consider the price of the materials.)

(2) Explain why an additive with a foul smell is added to town gas before it is delivered to the customers.

(iv) Give ONE use of fraction **X** in cars.

(9 marks)

CE00_08b

In some countries, 'gasohol' (a mixture of petrol and ethanol) is used as fuel for cars.

(i) Explain why burning gasohol causes less air pollution than burning petrol.

(ii) Ethanol can be manufactured from a petroleum product. Name the manufacturing process and write the chemical equation for the reaction involved.

(iii) Ethanol can also be manufactured by another process. Name this process.

(iv) Of the two processes you have mentioned in (ii) and (iii), which one is better for the manufacture of ethanol in gasohol? Explain your answer.

(5 marks)

CE00_09b

Carbon dioxide constitutes about 0.03% of the atmosphere. Over millions of years, the concentration of carbon dioxide in the atmosphere has remained almost constant because of a number of processes.

(i) Suggest ONE process by which carbon dioxide is added to the atmosphere.

(ii) Suggest ONE process by which carbon dioxide in the atmosphere is consumed.

(iii) Carbon dioxide is one of the greenhouse gases in the atmosphere.

(1) Explain why carbon dioxide can cause the greenhouse effect.

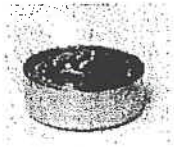
(2) State the importance of the greenhouse gases in the atmosphere to living things on earth.

(3) Increasing the concentration of the greenhouse gases in the atmosphere leads to global warming. State ONE harmful effect of global warming.

(6 marks)

CE01_01

The photograph below shows a burning candle:



(a) The candle wax is a petroleum product. What type of compounds is mainly present in the wax?

(b) (i) In which of the states does wax act as the fuel in a burning candle?

solid, liquid, vapour

(ii) State the conditions required for the combustion of wax.

(iii) Suggest a reason why a burning candle can be extinguished by a strong wind.

(c) Explain why it is hazardous to add cold water to a tray containing molten wax at a higher temperature.

CE01_07b

For environmental reasons, the Hong Kong Government has launched a plan for taxis to switch from using diesel to using diesel liquefied petroleum gas (LPG).

(i) Both LPG and diesel are petroleum products. State the origin of petroleum.

(ii) With reference to their chemical constituents, explain why LPG is a cleaner fuel than diesel.

(iii) State ONE problem that may occur in the initial stage in launching this plan.

(5 marks)

CE02_08a

Sulphur dioxide is formed when coal is burnt in a power station.

(i) The coal used in the power station contains 1.5% of sulphur by mass. Calculate the volume of sulphur dioxide released, measured at room temperature and pressure, when 1.0 kg of the coal is burnt.
(You may assume that all the sulphur in coal is converted to sulphur dioxide upon burning.)

(ii) State ONE environmental problem associated with the emission of sulphur dioxide into the atmosphere.

(iii) Suggest ONE measure to reduce the emission of sulphur dioxide from the power station.

(iv) Particulates are also present in the flue gas generated in the power station.
(1) State ONE environmental problem associated with the discharge of particulates into the atmosphere.
(2) Suggest ONE way to remove particulates from flue gas.

(Relative atomic masses: O = 16.0, S = 32.0;
molar volume of gas at room temperature and pressure = 24 dm^3)

(7 marks)

CE03_07b

Cracking is an important process in petrochemical industry.

(i) What is the meaning of the term 'cracking'?

(ii) Account for the importance of cracking in petrochemical industry.

(iii) Octane (C_8H_{18}) is used in an experiment to study cracking in a school laboratory. Cracking of octane gives a mixture of products, some of which are gases.
Draw a labelled diagram for the set-up used in the experiment, including the collection of the gaseous products.

(iv) One of the reactions involved in the cracking of octane gives two hydrocarbons, each containing the same number of carbon atoms.
(1) Write the chemical equation for this reaction.
(2) Suggest a chemical test to distinguish the two hydrocarbons from each other.

(9 marks)

CE03_09c

Organic wastes can be used as an alternative energy source. Under suitable conditions, the wastes can be digested by bacteria to give a gaseous mixture containing a high proportion of methane. Methane can be used as a fuel.

(i) Suggest ONE organic waste that can be used for this purpose.

(ii) Write the chemical equation for the complete combustion of methane.

(iii) Suggest ONE advantage of using organic wastes as an alternative energy source.

(iv) Suggest ONE reason why organic wastes are not yet widely used as an energy source.

(4 marks)

CE04_03

(a) Suggest how iodine tincture can be prepared in a school laboratory.

(b) A student split some iodine tincture on his laboratory coat. His classmate suggested the following two methods to remove the iodine stain from the laboratory coat:
(1) treating the stain with sodium sulphite solution
(2) treating the stain with 1,1,1-trichloroethane
State the principle underlying each method. Decide and explain which method is better.

(5 marks)

CE04_04

Acid rain is a serious environmental problem. Discuss the formation of acid rain in relation to human activities, and suggest possible way to reduce its formation.

(9 marks)

CE05_05

Both pentane (C_5H_{12}) and octane (C_8H_{18}) are members of the same homologous series.

(a) Using pentane and octane as examples, illustrate TWO characteristics of the members of a homologous series.

(4 marks)

(b) Which compound, pentane or octane, will burn with a more sooty flame? Explain your answer.

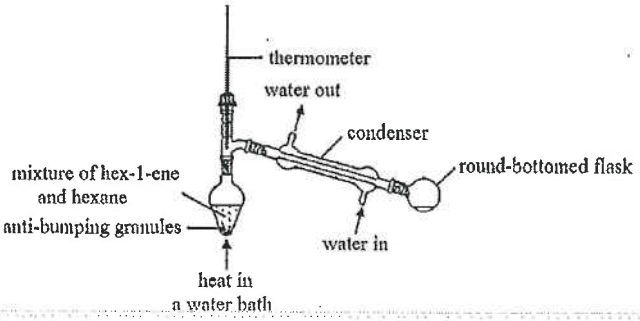
(2 marks)

(c) Draw TWO structures which have the same molecular formula C_5H_{12}.

(2 marks)

CE06_01b

A student suggested using the set-up shown below to separate hex-1-ene from a mixture of hex-1-ene and hexane.
(At atmospheric pressure, the boiling points of hex-1-ene and hexane are 64 °C and 69 °C respectively.)



(i) Explain why it is dangerous to use the above set-up to carry out the experiment. Suggest a modification to the set-up so that the experiment can be carried out safely.

(ii) After the set-up has been modified as suggested in (i), can it be used to separate hex-1-ene from hexane effectively? Explain your answer.

(iii) Suggest a chemical test to distinguish hex-1-ene from hexane.

(5 marks)

CE06_06

Carbon dioxide and methane are two major greenhouse gases in the atmosphere. The table shows the average concentrations of the two gases in the atmosphere in 1900 and in 2000.

Gas	Average concentration in the atmosphere (arbitrary units)	
	Year 1900	Year 2000
carbon dioxide	300 000	400 000
methane	1 000	2 000

(a) Suggest TWO reasons why there was a large increase in concentration of carbon dioxide in the atmosphere in the past ten decades.

(2 marks)

(b) Suggest ONE reason why there was a large increase in concentration of methane in the atmosphere in the past ten decades.

(1 mark)

(c) The presence of greenhouse gases in the atmosphere is important to life on Earth. However, too much greenhouse gases in the atmosphere can cause global warming, which may lead to severe environmental consequences.

(i) State the importance of greenhouse gases to life on Earth.

(ii) State ONE severe environmental consequence associated with global warming.

(iii) Suggest ONE possible way to prevent further increase in the concentration of each of the following greenhouse gases in the atmosphere without sacrificing our present standard of living:

(I) carbon dioxide

(II) methane

(4 marks)

CE07_02

A student performed an experiment to crack paraffin oil and collect the gaseous products by using a boiling tube.

(a) Draw a labelled diagram to show how the experiment can be performed in the laboratory.

(3 marks)

(b) (i) The student added a few drops of bromine water into the boiling tube containing the gaseous products. The brown colour of bromine water disappeared immediately. Why?

(ii) The student then dropped more bromine water into the boiling tube until the brown colour persisted. After about 10 minutes, the brown colour disappeared. Why?

(4 marks)

CE07_07

This question involves how to distinguish four unlabeled test tubes, each containing one of the following colourless liquids.

Methanol, concentrated sodium hydroxide solution, distilled water, hexane

(a) By heating a small amount of each of the colouless liquids to dryness, ONE of the liquids can be distinguished. Suggest which liquid can be distinguished, and state the observation involved.

(2 marks)

(b) By applying a flame directly to a small amount of each of the colouless liquids, TWO of the liquids would catch fire.

(i) Suggest which two liquids would catch fire.

(ii) For the two liquids that would catch fire, the observations involved during combustion are different. Suggest the difference in these observations, and explain your answer.

(iii) Without using other chemicals apart from the above colourless liquids, suggest another method to distinguish the two liquids that would catch fire. State the expected observation. (Smelling is not accepted.)

(4 marks)

CE08_07

Crude oil can be separated into different products such as petrol, diesel oil and fuel oil by a process called 'A'. The fuel oil obtained can then be converted into smaller molecules by another process called 'B'.

(a) Name process A and process B.

(2 marks)

(b) (i) Explain whether petrol or diesel oil has a higher viscosity.

(ii) Explain whether petrol or diesel is a cleaner fuel.

(2 marks)

(c) (i) Suggest one importance of process B in industry.

(ii) One of the compounds in fuel oil is $C_{28}H_{58}$, which can be converted into smaller molecules as shown in the following equation.

$$C_{28}H_{58} \longrightarrow C_{20}H_{42} + 2\ D$$

(1) Suggest a possible structure of D, and state its systematic name.

(2) Suggest a chemical test to distinguish D from $C_{20}H_{42}$, and state the expected observation.

(5 marks)

CE11_01a

A non-luminous flame is obtained when the air hole of a Bunsen burner is fully open. Methane is one of the components of the gaseous fuel used in the Bunsen burner. With reference to methane only and aided by a chemical equation, explain why the flame obtained is non-luminous.

(3 marks)

CE11_06

To reduce air pollution caused by vehicles, several measures have been adopted in recent years.

(a) Many taxis and mini-buses have switched from using diesel to liquefied petroleum gas (LPG) as fuel.

(i) Give the name of a compound which is a major component of LPG.

(ii) Why is LPG considered to be a 'cleaner' fuel than diesel?

(2 marks)

(b) Catalytic converters have been installed in most petrol-driven vehicles.

(i) State TWO functions of catalytic converters.

(ii) State one harmful product emitted from catalytic converters.

(3 marks)

(c) Some regions supply ultra low sulphur diesel (ULSD) for diesel vehicles. Explain how this measure reduces air pollution.

(2 marks)

Part 2: (d) addition polymers

CE90_01a

The table below describe some reactions of liquid propan-1-ol:

EXPERIMENT	RESULT
Propan-1-ol is heated and the vapour passed over heated broken porcelain.	Gas Z is produced.

(iv) Z can undergo addition polymerization to form a polymer.

(1) Name the polymer formed and draw the repeating unit.

(2) State one household articles that can be made from the polymer.

(3 marks)

CE91_02b

The following diagrams show three plastic items. The universal adaptor is made of thermosetting plastic while the other two are made of thermoplastics.

Universal adaptor | Foam lunch box | Food wrap

(i) Explain why thermoplastic are not suitable for making universal adaptor.

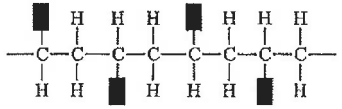
(ii) The foam lunch box is made from a plastic containing a trapped gas. Name the plastic that is commonly used and state the purpose of trapping a gas within the plastic.

(iii) (1) Name a plastic that is commonly used to make food wrap, and write an equation to show the formation of the plastic from its monomer.

(5 marks)

CE92_04a

(i) The structure of polymer X can be represented by the following diagram:



Where ■ represents a group containing carbon and hydrogen atoms only.

(1) Draw the structure of the monomer of X.

(2) Name an example of a polymer with the structure of X.

(3) Two separate pieces of X are strongly heated as shown in diagram A and B below:

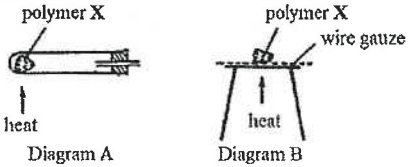


Diagram A | Diagram B

What would be observed in each case?

Explain your answer.

(ii) Upon analysis, 5.00 g of the monomer of X are found to contain 4.62 g carbon. If the relative molecular mass of the monomer is 104, deduce its molecular formula.
(Relative atomic masses: H = 1.0, C = 12.0)

(9 marks)

CE93_02a

Turning knobs on radios are often made of plastics with metal coating.

(i) State TWO reasons why plastics are used in the manufacture of turning knobs.

(2 marks)

CE95_06a

The illustration below shows the plastic bottle of a domestic toilet cleaner and its label.

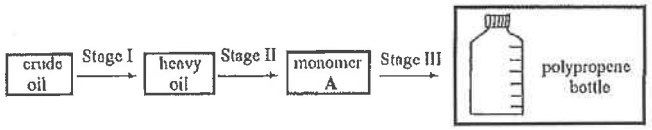
(iv) (1) Explain why plastic is used for making the bottle for the toilet cleaner.

(2) Name ONE plastic material suitable for making the bottle for the toilet cleaner.

(2 marks)

CE96_07b

The flow diagram below shows the three key stages involved in the production of polypropene bottles from crude oil.



(i) What is the process involved in obtaining heavy oil from crude oil in Stage I?

(ii) (1) Draw the structure of monomer A.

(2) What are the TWO main processes involved in the production of monomer A from heavy oil in Stage II?

(iii) What are the TWO main processes involved in the production of polypropene bottles from monomer A in Stage III?

(iv) Suggest ONE reason why the disposal of polypropene wastes can cause pollution problems.

(v) Polypropene wastes can be recycled by melting and remoulding.

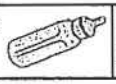
(1) What preliminary treatment of the polypropene wastes is required before recycling?

(2) Name ONE plastic which cannot be recycled by melting and remoulding.

(9 marks)

CE97_01

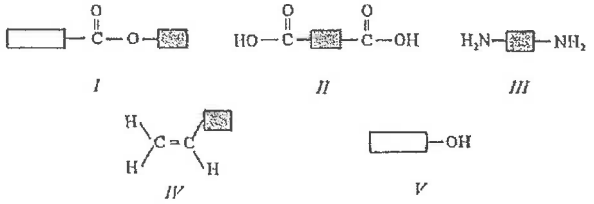
For each of the tasks listed in the table below, decide which substance on the right is the best to use to accomplish the task. Explain your answer in each case.

(c) To make feeding bottles for babies 	polyethene, polystyrene urea-methanal

(3 marks)

CE97_07b

The structure of five compounds, I, II, III, IV and V, are shown below:



In the above structures, ▨ represents a saturated hydrocarbon chain containing 1 to 6 carbon atoms and ▭ represents a saturated hydrocarbon chain containing 12 to 20 carbon atoms.

(i) Which compound can be used to make an addition polymer? Write a chemical equation to represent the addition polymerization.

(2 marks)

CE98_07b

Polyvinyl chloride (PVC) is a plastic which has a wide range of uses.

(i) Write the chemical equation for the formation of PVC from its monomers.

(ii) Plastic products made of PVC may vary greatly in rigidity.

(1) Give ONE flexible product made of PVC.

(2) Give ONE rigid product made of PVC.

(3) Explain whether PVC is suitable for making electric sockets or not.

(iii) Incineration of PVC wastes products hydrogen chloride into the atmosphere.

(1) State ONE harmful effect of the discharge of hydrogen chloride into the atmosphere.

(2) Suggest how hydrogen chloride can be removed from incinerator flue gas prior to its discharge to the atmosphere.

(3) Suppose that all the chlorine in PVC is converted to hydrogen chloride upon incineration. Calculate the volume of hydrogen chloride produced, measured at room temperature and pressure, when a plastic waste containing 100 kg of PVC is incinerated.

(You may assume that no other chlorine-containing compounds are present in the waste.)

(Relative atomic masses: H = 1.0, C =12.0, O = 16.0, Cl = 35.5;
molar volume of gas at room temperature and pressure = 24.0 dm^3)

(9 marks)

CE99_01

Each of the tasks listed in the table below can be accomplished by using material A or B.

Task	Materials	
	A	B
(a) To make water pipes	polyvinyl chloride	iron
(b) To make lenses	perspex	glass
(c) To make shopping bags	polyethene	paper

In each case, state an advantage of

(i) using A over B to accomplish the task.

(ii) using B over A to accomplish the task.

(You are not required to consider the price of the materials.)

(6 marks)

CE99_09b

Cracking of naphtha gives alkane **X** (relative molecular mass 44), alkene **Y** (relative molecular mass 42) and other products.

(i) What is the meaning of the term 'cracking'?

(ii) Suggest a chemical test to distinguish between **X** and **Y**.

(iii) Deduce the molecular formula of **Y**.

(iv) **Y** can be used as a starting material for the production of plastic **Z**.

(1) Write the chemical equation for the formation of **Z** from **Y**.

(2) Suggest how plastic cups can be made from **Z**.

(v) Suggest an advantage and a disadvantage of using plastic wastes as an energy source.

(Relative atomic mass: H = 1.0, C =12.0)

(10 marks)

CE00_07b

Polystyrene can be prepared in the laboratory by heating a mixture of styrene and kerosene under reflux.

(i) Draw a labeled diagram of the set-up used for heating the mixture under reflux.

(ii) Suggest ONE safety precaution that should be taken when heating the mixture. Explain your answer.

(iii) Styrene has the following structure:

$C_6H_5CH{=}CH_2$

(1) What characteristic in the structure of styrene enables it to act as a monomer?

(2) Write the chemical equation for the polymerization.

(iv) Disposable lunch boxes are commonly made of expanded polystyrene.

(1) Suggest ONE reason why polystyrene should be expanded before it is used to make disposable lunch boxes.

(2) State whether you agree with the following statement. Explain your answer.

'Landfilling is better than incineration for the disposal of polystyrene wastes.'

(8 marks)

CE01_07a

Polystyrene is used in making shopping bags and its monomer is ethene.

(i) Draw the electronic diagram of ethene, showing electrons in the outermost shells only.

(ii) Name the type of polymerization involved in the production of polyethene.

(iii) State ONE property of polyethene that makes it suitable for making shopping bags.

(iv) (1) Suggest ONE way to dispose of polyethene wastes.

(2) Give ONE advantage and ONE disadvantage of the way you have suggested in (1).

(6 marks)

CE02_05

Using alkenes as an example, describe the characteristics of members of a homologous series.

(9 marks)

CE03_05

Plastic wastes cause environmental problems in modern cities. Suggest possible ways of treating plastic wastes, and discuss their advantages and disadvantages.

(9 marks)

CE04_06c

Pyrolysis is one of the methods commonly used for treating plastic wastes. During pyrolysis, plastic wastes are decomposed at high temperature in the absence of air to give a mixture of products, including methane and ethene.

(i) Explain why it is necessary to carry out the pyrolysis in the absence of air.

(ii) Suggest a method that can be used to separate methane from other pyrolysed products.

(iii) Give ONE major use of methane and ONE major use of ethene in industry.

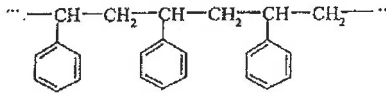
(iv) (1) Suggest another method which is commonly used for treating plastic wastes.

(2) For each of the two methods, pyrolysis and the method you have suggested in (1) above, state ONE advantage.

(7 marks)

CE05_06

(a) Polystyrene is a plastic with a wide range of uses. It has the following structure:

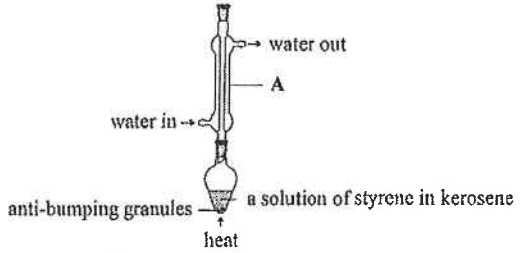


(i) Draw the structure of styrene, the monomer of polystyrene.

(ii) Suggest why polystyrene does NOT have a constant relative molecular mass.

(2 marks)

(b) Polystyrene can be prepared from styrene using the set-up shown below:



(i) Name apparatus A.

(ii) Suggest, with explanation, a safety precaution that should be taken in the preparation.

(iii) Name the type of polymerization involve in the formation of polystyrene from its monomer.

(4 marks)

(c) Plastics are very useful materials. Many objects previously made with metals are now made with plastics. For each of the following objects, suggest ONE advantage of using plastics over using metals in making the object.

(i) the casting for an electric rice cooker

(ii) a drainage pipe

(iii) a helmet for a soldier

(3 marks)

CE06_11

Plastics can be classified into thermoplastics and thermosetting plastics according to their thermal properties.

(a) Explain, in terms of bonding and structure, why thermoplastics and thermosetting plastics behave differently upon heating.

(3 marks)

(b) Polyethene (PE) is a thermoplastic commonly used in making shopping bags.

(i) Write the chemical equation for the formation of PE from its monomer.

(ii) Explain, in terms of bonding, why objects made of PE are durable.

(2 marks)

CE07_08

(a) Teflon is a plastic that can be used to make artificial hip joints. Teflon is an addition polymer of linear structure consisting of carbon and fluorine only. The ratio of the number of carbon atoms to the number of fluorine atoms in the polymer is 1 : 2.

(i) Draw the portion of the Teflon structure with 10 carbon atoms.

(ii) Write the repeating unit of Teflon, and suggest a possible monomer of Teflon.

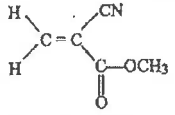
Repeating Unit:

Monomer:

(3 marks)

CE08_08

The active ingredient of a superglue has the following structure:



Superglue can join objects together quickly through the polymerization of the active ingredient in the presence of water vapour.

(a) Name the type of polymerization that the active ingredient undergoes.

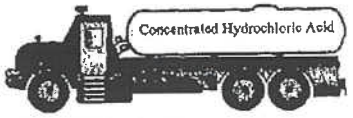
(1 mark)

(b) Write a chemical equation for the polymerization involved.

(1 mark)

CE09_04

The diagram below shows a truck with a storage tank for transporting concentrated hydrochloric acid.



(a) Suggest a hazard warning label that should be posted on the storage tank.

(1 mark)

(b) The storage tank is made of steel and the inner wall has a lining of polyethene.

(i) Draw the structural formula of polyethene.

(ii) Explain the function of the lining of polyethene in terms of the chemistry concept involved.

(3 marks)

(c) The storage tank contains 57000 kg of concentrated hydrochloric acid, which occupies a volume of 50 m^3. If the percentage by mass of HCl in the acid is 38.0%, calculate the molarity of the acid.

(2 marks)

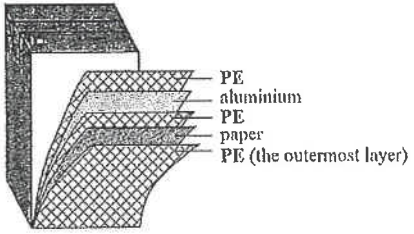
CE10_12f

Polypropene (PP) can be used to make bottles for storing drain cleaners containing strong alkalis. Write a chemical equation for the polymerization to form PP.

(1 mark)

CE11_07

The diagram below shows the structure of a common beverage box consisting of layers of paper, polyethene (PE) and aluminium.



(a) Draw the repeating unit of PE.

(1 mark)

(b) Name the type of polymerization involved in making PE.

(1 mark)

(c) Explain the function of the outermost PE layer of the beverage box.

(1 mark)

(d) Oxygen can pass through paper and PE. Explain how the box can prevent the beverage from spoilage.

(2 marks)

(e) Polychloroethene, commonly called polyvinyl chloride (PVC), is also a polymer.

(i) Draw the structure of the monomer of PVC.

(ii) PVC can be used to make food packaging material. However, it may release some substances to contaminate the food. Suggest one substance that may be released.

(2 marks)

AL99(I)_06b

(i) Briefly explain why car exhaust contains carbon monoxide and nitrogen oxides.

(2 marks)

(ii) The installation of catalytic converters onto car exhaust systems can reduce the concentrations of pollutants in car exhaust. With the help of equations, briefly describe the function of a catalytic converter.

(2 marks)

(iii) Explain why leaded petrol is not used in cars equipped with catalytic converters.

(1 marks)

ASL99(I)_07 [Similar to DSE16_05c]

Feeding bottles for babies can be made from poly(propene) which usually contains butylated hydroxytoluene (BHT).

(a) Write the repeating unit of poly(propene).

(1 mark)

(b) 'The average relative molecular mass of a sample of poly(propene) is 4.2×10^5.'

(i) Why is an average value of relative molecular mass quoted in the above statement?

(1 mark)

(ii) Calculate the average number of repeating units in a polymer chain of the sample.

(1 mark)

ASL99(II)_09 (modified)

(a) When exposed to diffused sunlight, methane and chlorine react to give chloromethane. Using the electronic diagram, outline the mechanism of this reaction.

(3 marks)

(b) The reaction of methane with chlorine also gives dichloromethane.

(i) Draw a three-dimensional structure for dichloromethane and explain whether the molecule is polar or non-polar.

(3 marks)

(ii) Explain why the reaction of methane with chlorine is not suitable for the preparation of dichloromethane.

(1 mark)

ASL99(II)_10 (modified) [Similar to DSE12_15]

(a) Car exhaust contains a high concentration of carbon monoxide, nitrogen oxides and hydrocarbons. With the help of balanced equations, briefly explain why the installation of catalyst converters onto car exhaust systems can reduce the emission of these pollutants.

(4 marks)

(b) Car exhaust also contains a high concentration of carbon dioxide.

(i) State ONE environmental problem caused by an increase in concentration of carbon dioxide in the atmosphere. Explain your answer.

(2 marks)

(ii) Suggest ONE measure to alleviate the environmental problem in (i).

(1 mark)

(c) Photochemical smog is usually associated with a brown haze.

(i) What pollutant causes the brown colour of photochemical smog?

(1 mark)

(ii) State ONE harmful effect of photochemical smog.

(1 mark)

ASL01(I)_06 [Same as DSE13_06]

Both polypropene (PP) and polyvinyl chloride (PVC) can be produced from naphtha, a petroleum fraction.

(a) State the three main processes involved in the production of PP from naphtha.

(3 marks)

(b) Why is PVC more rigid than PP?

(2 marks)

(c) Adding plasticizers to PVC can reduce its rigidity. The soft PVC produced can be used to make garden hoses.

(i) Explain how plasticizers work.

(1 mark)

(ii) Suggest one reason why PVC garden hoses become brittle after a period of time.

(1 mark)

(d) Explain why the incineration of PVC wastes causes serious environmental problems.

(1 mark)

ASL02(II)_10

Burning of coal in a power station produces flue gas which contains nitrogen monoxide and sulphur dioxide. The flue gas is treated with copper(II) oxide, ammonia and air prior to discharge into the atmosphere.

(a) Explain why nitrogen monoxide and sulphur dioxide are formed when coal is burnt.

(2 marks)

(b) In the treatment process, nitrogen monoxide reacts with ammonia and air to give nitrogen. In this reaction, copper(II) oxide acts as a catalyst.

(i) What is the meaning of the term 'catalyst'?

(1 mark)

(ii) Write a chemical equation for the conversion of nitrogen monoxide to nitrogen.

(1 mark)

(c) In the treatment process, sulphur dioxide reacts with copper(II) oxide and air to give copper(II) sulphate(VI). Write a chemical equation for this reaction.

(1 mark)

(d) The copper(II) oxide consumed in the treatment process is regenerated by heating the copper(II) sulphate(VI) formed in (iii) with methane to give sulphur dioxide, carbon dioxide and copper. The copper is subsequently converted back to copper(II) oxide.

(i) Write a chemical equation for the reaction of copper(II) sulphate(VI) with methane.

(1 mark)

(ii) Suggest how the copper formed can be converted back to copper(II) oxide.

(1 mark)

ASL03(II)_08 (modified) [Similar to DSE12_15]

Under suitable conditions, CH_4 reacts with Cl_2 to give CH_3Cl.

(a) For this reaction,

(i) state the conditions required, and

(2 marks)

(ii) outline a mechanism and give the names of the mechanistic steps involved.

(3 marks)

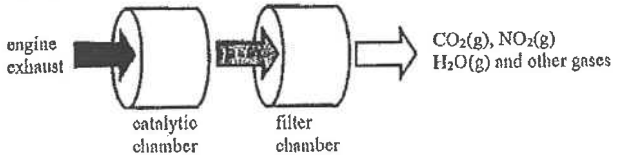
(b) Apart from CH_3Cl, what other organic products will be formed when CH_4 reacts with Cl_2?

(2 marks)

AL04(II)_06a

The exhaust of heavy-duty diesel engines contains a significant amount of particulate matter (PM) and harmful gases such as nitrogens oxides. A Continuously Regenerating Trap (CRT®) is a device which is designed for use in exhaust systems of buses and lorries running on diesel with low sulphur content to remove PM and some of the harmful gases.

The digram below shows how a CRT works:



(i) (I) With the help of chemical equations, explain why nitrogen oxides are present in the engine exhaust.

(2 marks)

(II) State one harmful effect of nitrogen oxides on the environment.

(1 mark)

(ii) Carbon monoxide and hydrocarbons are two other harmful gases present in the engine exhaust.

Use chemical equations to show how these two gases can be removed in the catalytic chamber of a CRT.

(2 marks)

(iii) A CRT is an automated, self-regenerating device which does not require cleaning of the filter. In a CRT, PM is trapped onto the filter and is then oxidized by one fo the harmful gases to less harmful products.

(I) Which element is mot abundant in PM?

(1 mark)

(II) With the help of chemical equation(s), describe how PM trapped on the filter of a CRT can be removed. Hence, explain why the filter need not cleaned.

(2 marks)

(iv) Suggest why buese and lorries equipped with CRT should not run on diesel with high sulphr content.

(1 mark)

ASL04(II)_12

(a) Polyvinyl chloride (PVC) is rigid and can easily be broken.

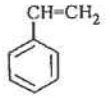
(i) Explain, in terms of intermolecular forces, why PVC is rigid.

(2 marks)

(ii) The rigidity of PVC can be reduced by the addition of suitable plasticizers. Suggest why plasticizers can help reduce the rigidity of PVC.

(1 mark)

(b) Expanded polystyrene is commonly used in making disposable lunch boxes. The monomer of polystyrene (PS) in phenylethene, which has the following structure:



(i) Write a chemical equation for the formation of PS from its monmers.

(1 mark)

(ii) Suggest ONE foaming agent suitable for making expanded PS.

(1 mark)

(iii) Explain why expanded PS has good heat insulating properties.

(2 marks)

ASL05(II)_11

The following substances are found in car exhaust:

Carbon monoxide, carbon dioxide, nitrogen oxides, hydrocarbons and particulates

(a) Explain why the following substances are present in car exhaust.

(i) Carbon monoxide

(1 mark)

(ii) Nitrogen oxides

(1 mark)

(b) For each of the following air pollutants, state one harmful effect.

(i) Nitrogen oxides

(1 mark)

(ii) Particulates

(1 mark)

(c) The instillation of catalytic converter onto car exhaust system can help reduce the emission of carbon monoxide and nitrogen oxides.
With the help of appropriate chemical equation(s), explain how a catalytic converter works.

(2 marks)

(d) Do you agree with the following statement? Explain your answer.
'The exhaust of diesel engine contains a higher concentration of particulates than that of petrol engine,'

(2 marks)

ASL08(I)_09 (modified)

Propenamide, the monomer of polypropenamide (also known as polyacrylamide), is a potential carcinogen. The melting point of propenamide is 84 °C and its solubility in water is 2.16 g cm^{-3} at 30 °C.

(a) Draw the structure of propenamide.

(1 mark)

(b) Polyacrylamide gel (PAAG) is polyacrylamide saturated with water. A sample of PAAG for break augmentation is suspected to contain about 1% propenamide. Suggest a chemical test to show the presence of propenamide in the sample.

(2 marks)

(c) Propenamide can be identified by converting it to a solid derivative and determining the melting point of the derivative. With the help of a chemical equation, suggest ONE solid derivative of propenamide suitable for this purpse.

(1 mark)

DSE11SP_02 [Similar to DSE14_03]

Polyethene is used in making shopping bags and its monomer is ethene.

(a) Draw the electronic diagram of ethene, showing electrons in the *outermost shells only*.

(1 mark)

(b) Name the type of polymerisation involved in the production of polyethene.

(1 mark)

(c) State ONE property of polyethene that makes it suitable for making shopping bags.

(1 mark)

(d) (i) Suggest ONE way to dispose of polyethene wastes.

(1 mark)

(ii) Give ONE advantage and ONE disadvantage of the way you have suggested in (i).

(2 marks)

DSE12PP_05

The fuel used in the torch for the Beijing 2008 Olympic Games was an alkane **X** with the following composition by mass:

C, 81.8% H, 18.2%

(a) Deduce what **X** could be.

(3 marks)

(b) Suggest an industrial process for obtaining **X**.

(1 mark)

(c) Kerosene was once used as a fuel for the Olympic torch. State ONE advantage of using each of the following substances as fuel for the torch.

(i) **X**

(1 mark)

(ii) Kerosene

(1 mark)

DSE12PP_07

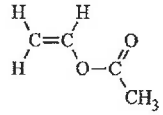
(b) (i) With reference to the properties of the materials involved, explain why

(I) a polypropene container is used to contain the calcium oxide.

(1 mark)

DSE12_02

Poly(ethenyl ethanoate) is a polymer. Its monomer is ethenyl ethanoate with the structure shown below:



(a) Ethene is the raw material used in making ethenyl ethanoate. Ethene can be produced from hydrocarbons of higher molecular mass by an important industrial process.

(i) Name this industrial process.

(1 mark)

(ii) Explain why this process is important.

(1 mark)

(b) Draw the structure of poly(ethenyl ethanoate).

(1 mark)

(c) Ethyl ethanoate is an organic solvent.

(i) Draw the structure of ethyl ethanoate.

(1 mark)

(ii) Suggest a chemical test to show to distinguish between ethenyl ethanoate and ethyl ethanoate.

(2 marks)

DSE12_10

Suggest THREE measures for reducing the emission of air pollutants upon using fossil fuels.

(3 marks)

DSE12_15 [Same as ASL99(II)_09a]

Use electron diagrams to illustrate, step by step, how CH_4 reacts with Br_2 under sunlight to form CH_3Br.

(Show electrons in the outermost shells only.)

(3 marks)

DSE13_06 [Same as ASL01(I)_06a]

Briefly describe how polypropene can be produced from naphtha.

(3 marks + 1 mark)

DSE13_10

(c) Some people have the view that cars powered by hydrogen-oxygen fuel cells are more environmentally friendly than those powdered by petrol.

Comment on this view from each of the following aspects:

(i) Source of fuel

(1 mark)

(ii) The car emissions.

(1 mark)

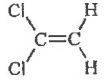
DSE14_03 [Similar to DSE11SP_02]

Both polyethene (PE) and 'Saran' can be used to make food wrap, but 'Saran' is more suitable than PE in making food wrap for use in microwave ovens.

(a) The monomer of PE is ethane. Suggest a chemical test to show that ethane is an unsaturated compound.

(2 marks)

(b) 'Saran' can be formed from the polymerization of the compound shown below:



(i) State the systematic name of this compound.

(1 mark)

(ii) Name the type of polymerization involved in forming 'Saran'.

(1 mark)

(iii) Draw the structure of 'Saran', showing at least THREE repeating units.

(1 mark)

(c) In terms of intermolecular force, explain why 'Saran' is more suitable than PE in making wrap for use in microwave ovens.

(2 marks)

(d) When incinerated, why would food wrap made from 'Saran' cause more serious pollution problem than food wrap made from PE?

(1 mark)

DSE14_06

Petrol is a commonly used motor car fuel. It can be obtained from petroleum by fractional distillation

(a) (i) Explain, from molecular level, why petrol can be obtained from petroleum by fractional distillation.

(2 marks)

(ii) Other than directly obtaining petrol from fractional distillation of petroleum, suggest a way for producing extra petrol.

(1 mark)

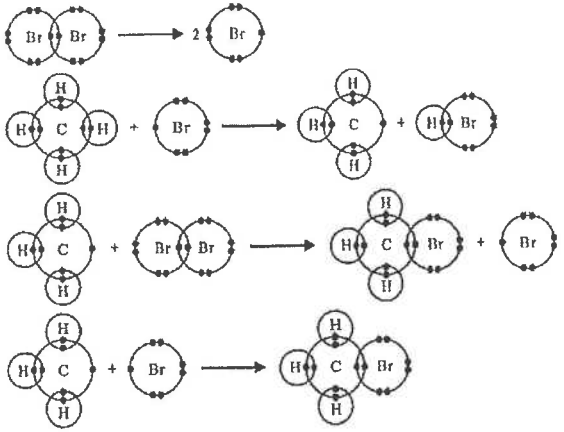
(b) Motor cars powered by petrol emit air pollutants such as nitrogen monoxide and carbon monoxide. Installing a certain device in motor cars can convert these two oxides to less harmful substances.

(i) Name this device.

(1 mark)

DSE15_06

The steps involved in the reaction of methane with bromine forming CH_3Br can be shown by the following diagram. Only electrons in the outermost shells are shown.



(a) Name the type of the reaction for the formation of CH_3Br from methane and bromine.

(1 mark)

(b) State the condition needed for the reaction to occur.

(1 mark)

(c) State the expected observation for the reaction.

(1 mark)

(d) With reference to its electronic structure, explain why the species 

has a high reactivity.

(1 mark)

(e) The reaction of methane with bromine can also form other single-carbon-containing organic compounds.

(i) Suggest one such compound.

(1 mark)

(ii) Suggest a condition so that the reaction of methane with bromine can form more CH_3Br but less other organic compounds.

(1 mark)

DSE15_08

Natural gas is an important energy source for electricity generation. It contains mainly methane (CH_4).

(a) Write the general formula of the molecules in the homologous series that methane belongs to.

(1 mark)

(b) The combustion of methane is an exothermic reaction. Its chemical equation is shown below:

$$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$$

(i) Complete the table below by stating all the covalent bond(s) that are broken and formed during the combustion of methane.

Covalent bond(s) broken	
Covalent bond(s) formed	

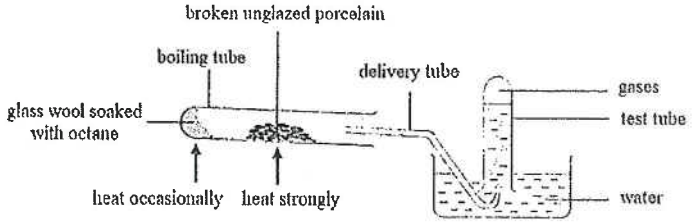
(2 marks)

(c) Some regions tend to generate electricity more by natural gas but less by coal. Give TWO reasons from environmental protection consideration.

(2 marks)

DSE16_03

The diagram below shows an experimental set-up in which the glass wool soaked with octane is heated occasionally and the broken unglazed porcelain is heated strongly. Some gases are collected in the test tube over water.



(a) Name the type of reaction that occurs in the boiling tube. Suggest one importance of this type of reaction in industry.

(2 marks)

(b) Explain why, instead of a large piece of unglazed porcelain, broken unglazed porcelain is used in this experiment.

(1 mark)

(c) Suppose that during the experiment, octane changes to ethane gas and propene gas only and they can be collected in the test tube.

(i) Write the balanced equation for the reaction of changing octane to ethane and propene.

(1 mark)

(ii) The gases collected in the test tube are shaken thoroughly with a few drops of Br_2(in CH_3CCl_3)

(1) State the expected observation.

(1 mark)

(2) Draw the structure of the product formed from the reaction between propene and Br_2.

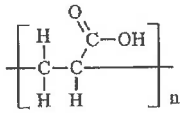
(1 mark)

(d) When no more gas can be collected, what should be done to end the experiment for safety consideration? Explain your answer.

(2 marks)

DSE16_05

Polymer B shown below can be used as water absorbing material in diapers. It can be formed from the polymerization of compound A.



polymer B

(a) Draw the structure of compound A and state its systematic name.

(2 marks)

(b) State the type of polymerization for the formation of B from A.

(1 mark)

(c) Suggest why the relative molecular mass of B is expressed using a range of values instead of a single fixed value. [Similar to ASL99(I)_07b]

(1 mark)

(d) It is known that the reaction of polymer B with NaOH(aq) forms polymer C which can absorb water better. Draw the structure of C.

(1 mark)

DSE17_03

Answer the following questions.

(a) Explain why propene can form a polymer, but propane cannot.

(1 mark)

DSE17_08

Combustion of petrol increases the concentration of carbon dioxide in the atmosphere, and may contribute to global warming. Combustion of petrol also emits poisonous air pollutants.

(a) Write a chemical equation for the complete combustion of octane (C_8H_{18}), a component in petrol.

(1 mark)

(b) Draw the electron diagram for a molecule of carbon dioxide, showing *electrons in the outermost shell* only.

(1 mark)

(c) Give one reason FOR and one reason AGAINST the following statement:

'*Switching from using petrol-driven cars to using electric cars can help alleviate global warming.*'

FOR :

AGAINST:

(2 marks)

(d) Carbon monoxide is one of the poisonous air pollutants emitted from the combustion of petrol. Under what condition would carbon monoxide be formed during the combustion of petrol?

(1 mark)

(e) (i) Name a device that can be installed in petrol-driven cars so as to reduce the emission of carbon monoxide.

(1 mark)

(ii) Suggest one air pollutant in car exhaust which cannot be removed by the device in (i).

(1 mark)

DSE18_04

Petroleum is an important source of hydrocarbons.

(a) Describe the origin of petroleum.

(2 marks)

(b) **D**, **E** and **F** are isomeric alkene containing four carbon atoms. **D** and **E** are *cis-trans* isomers.

(i) Draw the structure of **E** (*trans*-isomer).

(1 mark)

(ii) State the systematic name of one possible structure of **F**.

(1 mark)

(c) Ethene and ethane are hydrocarbons.

(i) Suggest how ethene can be converted to ethane.

(1 mark)

(ii) Suggest a chemical test to distinguish between ethane and ethene.

(2 marks)

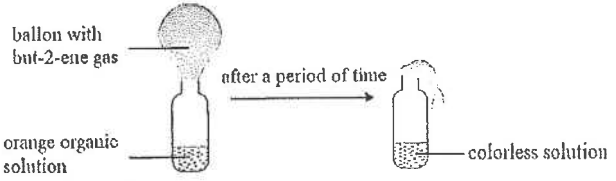
DSE18_09

Tetrafluoroethene undergoes polymerization to form a polymer called 'Teflon'. Using this example describe this type of polymerization.

(4 marks + 1 mark)

DSE19_03

An experiment was carried out as shown below:



(a) (i) Suggest what the orange organic solution may be.

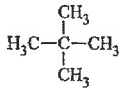
(1 mark)

(ii) With the help of a chemical equation, explain the color change in the solution.

(2 marks)

DSE19_05

The structure of a compound is shown below:



Reacting with a reagent under certain conditions, it can give two compounds with the same molecular formula $C_5H_{10}Cl_2$ but different structures

(a) Suggest what the reagent is.

(1 mark)

(b) State the condition needed for the reaction to occur at room temperature.

(1 mark)

(c) Name the type of the reaction involved.

(1 mark)

(d) (i) Draw the structure of ONE of these two compounds and give its systematic name.

(2 marks)

(ii) Draw the structure of the other compound.

(1 mark)

(iii) These two compounds are isomers. State the type of isomerism exhibited by them.

(1 mark)

DSE20_08

*8. Describe how 1,2-dibromoethane can be produced from crude oil, via an alkene, using appropriate chemicals and processes. Write the chemical equations for the reactions involved.

(6 marks)

DSE21_01(b)

Acetylene (C_2H_2) is a fuel. It can be obtained from calcium carbide (CaC_2) by two different reactions as represented by the equations shown below :

$CaC_2 + \mathbf{A} \xrightarrow{2200\ ^\circ C} C_2H_2 + Ca$ Reaction (I)

$CaC_2 + 2H_2O \xrightarrow{25\ ^\circ C} C_2H_2 + Ca(OH)_2$ Reaction (II)

(b) Write a chemical equation for the complete combustion of acetylene.

DSE21_4(a),(b),(c)(i),(c)(ii)

4. The chemical equation for a possible cracking reaction of decane ($C_{10}H_{22}$) is shown below :

$C_{10}H_{22} \rightarrow C_4H_{10} + 2\mathbf{X}$

(a) State the systematic name of **X**.

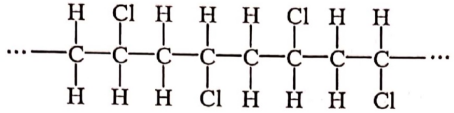
(b) Suggest a chemical test to show how **X** and butane can be distinguished.

(c) **X** can form a polymer **Z**.

(i) Suggest why **X** can form a polymer.

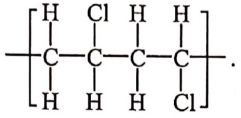
(ii) Draw the repeating unit of **Z**.

8. The structure of a portion of a polymer is shown below :



Which of the following statements concerning the polymer is correct ?

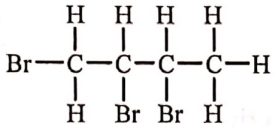
A. It can be used as a substitute for glass.

B. Its repeating unit is  .

C. It can be made from its monomer through addition polymerisation.

D. It can decolourise bromine dissolved in an organic solvent quickly.

16. The molecular formula of compound **X** is C_4H_7Br and it has one carbon-carbon double bond. It can react with Br_2 (dissolved in an organic solvent) to give the following organic product :

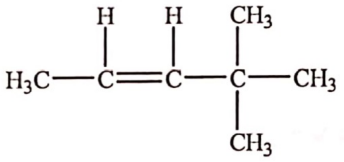


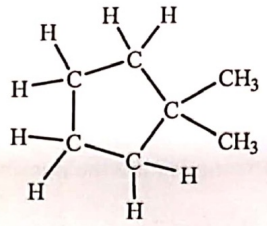
Which of the following is / are the possible structure(s) of **X** ?

(1) $CH_2BrCH_2CH=CH_2$
(2) $H_2C=CHCHBrCH_3$
(3) $CH_3CH=CHCH_2Br$

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

19. Consider the following two compounds :



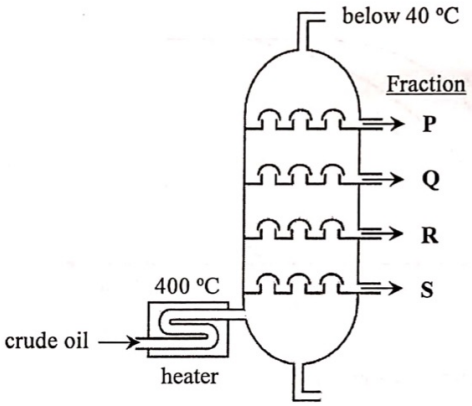


Which of the following statements is / are correct ?

(1) They belong to the same homologous series.
(2) They have the same molecular formula.
(3) They are insoluble in water.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

23. The simplified diagram below shows how different petroleum fractions can be obtained from a fractionating tower.



Which of the following statements are correct ?

(1) Fraction **S** has a darker colour than fraction **Q**.
(2) Fraction **R** has a higher viscosity than fraction **P**.
(3) Fraction **Q** is more flammable than fraction **P**.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

6. Consider the following chemical equation for the formation of CH_3Cl from methane and chlorine :

$$CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g)$$

(a) Name the type of reaction involved.

(1 mark)

(b) State the condition needed for the reaction to occur at room temperature.

(1 mark)

(c) The reaction involves three stages: initiation, propagation and termination. In the initiation stage, chlorine free radicals ($Cl\bullet$) are formed from chlorine molecules.

(i) With reference to the electronic structure, explain why a chlorine free radical ($Cl\bullet$) is a reactive chemical species.

(ii) Complete the chemical equations below by filling in a suitable chemical species in each of the following boxes :

One of the steps in the propagation stage :

$Cl\bullet + CH_4 \rightarrow$ [ ] + [ ]

One of the steps in the termination stage :

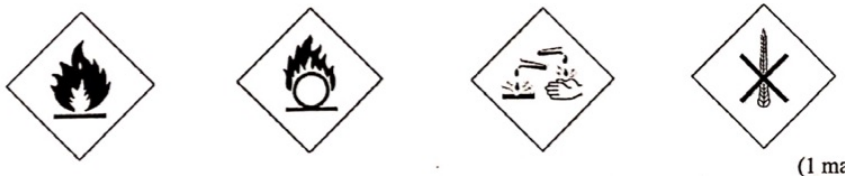
[ ] + [ ] $\rightarrow CH_3Cl$

(3 marks)

(d) Explain why CH_3Cl is not the only organic product formed in the reaction between methane and chlorine.

(1 mark)

(e) From the hazard warning labels shown below, circle a label that should be displayed on a gas cylinder containing methane.



(1 mark)

Marking Scheme

MCQ

Part 1: (a) hydrocarbons, (b) homologous series and (c) alkanes and alkenes

CE90_06	B	CE90_18	D	CE90_21	A	CE91_05	B
CE91_22	C	CE91_24	C	CE91_34	A	CE91_36	D
CE92_21	A	CE92_24	A	CE92_49	D	CE93_29	D
CE93_32	B	CE93_33	D	CE94_21	C	CE94_22	A
CE94_23	D	CE94_32	A	CE94_41	D	CE95_15	C
CE95_20	B	CE95_23	D	CE95_39	A	CE96_13	A
CE96_14	B	CE96_20	D	CE97_10	A	CE97_16	B
CE97_18	A	CE97_19	C	CE97_23	D	CE97_24	A
CE97_33	D	CE97_38	D	CE97_42	B	CE98_03	A
CE98_07	C	CE98_14	A	CE98_29	D	CE98_39	D
CE98_47	B	CE99_03	C	CE99_30	A	CE99_32	C
CE99_35	D	CE99_44	D	CE00_06	D	CE00_08	A
CE00_14	B	CE00_21	A	CE00_25	A	CE00_27	B
CE00_40	A	CE01_03	D	CE01_07	A	CE01_12	B
CE01_14	D	CE01_31	B	CE01_32	D	CE01_41	D
CE02_05	B	CE02_09	B	CE02_12	C	CE02_33	B
CE02_34	D	CE02_43	D	CE02_44	D	CE02_48	C
CE03_08	D (66%)	CE03_10	B (85%)	CE03_17	D (33%)	CE03_31	D (54%)
CE03_33	D (48%)	CE03_37	D (58%)	CE03_38	A (51%)	CE05SP_16	D
CE05SP_19	C	CE04_21	B (36%)	CE04_28	B (30%)	CE04_37	B (40%)
CE04_42	D (41%)	CE04_45	B (58%)	CE04_46	C (42%)	CE05_01	D (55%)
CE05_02	B (51%)	CE05_04	A (60%)	CE05_12	D (62%)	CE05_21	B (48%)
CE05_28	D (34%)	CE05_37	C (70%)	CE05_43	D (50%)	CE05_45	B (80%)
CE05_46	D (84%)	CE05_47	B (43%)	CE06_11	B (72%)	CE06_12	B (27%)
CE06_16	B (44%)	CE06_17	A (58%)	CE06_22	A (44%)	CE06_23	B (71%)
CE06_30	C (38%)	CE06_44	A (65%)	CE06_45	A (33%)	CE06_46	C (72%)
CE07_02	D (34%)	CE07_04	B (36%)	CE07_08	B (57%)	CE07_10	D (24%)
CE07_14	C (41%)	CE07_26	B (40%)	CE07_30	A (41%)	CE07_33	B (45%)
CE07_49	B (61%)	CE08_06	C (60%)	CE08_14	A (62%)	CE08_27	B (45%)
CE08_29	A (73%)	CE08_49	D (68%)	CE09_03	B (60%)	CE09_11	B (74%)
CE09_16	B (74%)	CE09_21	B (86%)	CE09_25	A (82%)	CE09_26	A (74%)
CE10_02	D (60%)	CE10_12	B (65%)	CE10_25	D (76%)	CE10_27	B (50%)
CE10_29	C (43%)	CE10_50	C (53%)	CE11_10	A (58%)	CE11_18	D (85%)
CE11_22	A (67%)	CE11_38	C (79%)	CE11_42	C (55%)		

Part 2: (d) addition polymers

CE91_26	D	CE91_27	D	CE92_25	A	CE92_43	C
CE93_35	C	CE94_20	C	CE94_41	D	CE95_22	C
CE95_35	A	CE96_05	B	CE97_18	A	CE97_40	A
CE98_14	A	CE98_49	B	CE99_28	A	CE99_41	B

CE00_38	A	CE01_09	B	CE01_17	A	CE02_20	C
CE02_30	A	CE03_31	D (54%)	CE03_36	A (43%)	CE03_48	D (66%)
CE05SP_48	B	CE04_15	C (41%)	CE04_41	D (67%)	CE06_49	D (58%)
CE07_09	D (57%)	CE07_27	D (53%)	CE10_10	D (82%)	CE11_17	D (66%)

DSE

DSE11SP_01	B	DSE11SP_04	C	DSE11SP_09	B	DSE12PP_10	B
DSE12PP_11	B	DSE12PP_21	B	DSE12_11	B (61%)	DSE12_17	B (50%)
DSE12_21	A (69%)	DSE12_22	C (84%)	DSE12_24	B (61%)	DSE13_14	B (81%)
DSE14_08	B (78%)	DSE14_10	D (70%)	DSE14_17	A (88%)	DSE15_10	B (82%)
DSE15_19	B (73%)	DSE15_22	C (84%)	DSE15_20	B (55%)	DSE16_09	C (77%)
DSE16_10	B (63%)	DSE16_17	C (73%)	DSE16_19	C (27%)	DSE17_05	D (63%)
DSE17_18	B (50%)	DSE17_20	D (71%)	DSE17_22	D (50%)	DSE18_08	C (82%)
DSE18_13	B (75%)	DSE18_14	C (49%)	DSE18_15	C (83%)	DSE18_20	A (63%)
DSE19_07	B	DSE19_10	C	DSE19_18	B		

DSE20_6 B
DSE20_23 C
DSE20_24 D

Structural Questions

Part 1: (a) hydrocarbons, (b) homologous series and (c) alkanes and alkenes

CE90_03a

(i) raw material: crude oil (petroleum) [1]
method: by fractional distillation [1]

(ii) $C_5H_{12} + 5H_2O \longrightarrow 5CO + 11H_2$ [1]
hydrogen and carbon monoxide [1]

(iii) The colour of citrated blood changes to cherry/ bright red. [1]
This is the colour of the compound formed between carbon monoxide and haemoglobin to form carboxyhaemoglobin. [1]

(iv) Black copper(II) oxide turned to brown copper. [1]
Copper(II) oxide is reduced by hydrogen and carbon monoxide. [1]
$CuO + H_2 \longrightarrow Cu + H_2O$ [1]
$CuO + CO \longrightarrow Cu + CO_2$ [1]
[Do NOT accept: $2CuO + H_2 + CO \longrightarrow 2Cu + H_2O + CO_2$]

(v) Town gas is poisonous / toxic and has an explosion risk. [1]

(vi) (1) for ventilation / letting in fresh air / letting out town gas. [1]
[Do NOT accept: town gas is poisonous]
(2) dialing the telephone will trigger off a spark (or electric spark) which may ignite the town gas (or may cause an explosion). [1]

CE90_05c(ii)

(1) Sulphur dioxide gas is released by burning fuels containing sulphur. [1]

(2) as a gas: (any one) [1]
- toxic (or poisonous) nature
- choking smell
- harmful to human respiratory system
- harmful to plants
- yellowing of leaves

when dissolved in water (any one) [1]
- forms acid rain
- is corrosive to building (or metals)
- makes soil acidic

CE91_02a

(i) First, use a pipette to draw 25.0cm^3 of vinegar to a 250.0cm^3 volumetric flask. [2]
Then fill up to the mark with distilled water. [1]

(ii) Use phenolphthalein as indicator. [1]
At end point, the colour changes from colourless to red. [1]

(iii)

Titration /Burette reading	1	2	3	4
Final reading (cm^3)	25.50	25.70	26.20	25.90
Initial reading (cm^3)	0.00	1.00	1.30	1.10
Volume of NaOH used	25.50 – 0.00 = 25.50	25.70 – 1.00 = 24.70	26.20 – 1.30 = 24.90	25.90 – 1.10 = 24.80

1st trial would not be counted since the value is largely different from others.
Reasonable average volume of NaOH used = (24.70 + 24.90 + 24.80) / 3
= 24.80 cm^3 [1]

(iv) $NaOH + CH_3COOH \longrightarrow CH_3COONa + H_2O$ [1]

(v) $NaOH + CH_3COOH \longrightarrow CH_3COONa + H_2O$

mole of CH_3COOH = mole of $NaOH = 0.10 \times \frac{24.80}{1000} = 0.00248$ [1]

$[CH_3COOH]_{diluted} = \frac{0.00248}{\frac{25}{1000}} = 0.0992 \text{ mol dm}^{-3}$ [1]

$[CH_3COOH]_{undiluted} = 0.0992 \times \frac{250}{25} = 0.992 \text{ mol dm}^{-3}$ [1]

(vi) Given: better buy = lower price per gram of CH_3COOH

mass of CH_3COOH in Brand A $= 50 \times \frac{250}{1000} = 12.5$ g

mole of CH_3COOH in Brand B $= 0.992 \times \frac{500}{1000} = 0.496$

mass of CH_3COOH in Brand B $= 0.496 \times 60 = 29.76$ g

For Brand A, \$ of $CH_3COOH = \frac{3.00}{12.5} = \$0.24$ [1]

For Brand B, \$ of $CH_3COOH = \frac{6.00}{29.76} = \$0.20$ [1]

Brand B is better buy. [1]

CE91_03a

(i) It is because petroleum comes from dead sea organisms million years ago. [1]

(ii) Different petroleum fractions have different boiling points. [1]

(iii) (1) heavy oil [1]
(2) cracking [1]

(iv) (1) (I) $CH_2{=}CH{-}CH_2$ [1]
(II) $CH_3{-}CH_2{-}CH_3$ [1]
(2) (I) $C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$ [1]
(II) Propene gives a more sooty flame because propene has higher mass percentage of carbon. [1]
(3) (I) Burning of propane gives a gas (CO_2) [1]
which can turn lime water milky. [1]
(II) Burning of propane gives a liquid (H_2O)
which can turn dry cobalt(II) chloride paper from blue to pink. [1]

(4) either one of the following tests: [2]

Test	Observation	
	Propene	Propane
Adding bromine water or bromine in CCl_4 (Do not accept $Br_2(g)$)	Colour changes from brown to colourless	Does not decolourize
Adding acidified $KMnO_4$	Colour change from purple to colourless	Does not decolourize

CE92_01c

(i) $2C_8H_{18} + 25O_2 \longrightarrow 16CO_2 + 18H_2O$ [1]

OR, $C_8H_{18} + 25/2\ O_2 \longrightarrow 8CO_2 + 9H_2O$

The reaction is highly exothermic, the gas produced expand rapidly, so the motor is pushed rapidly. [2]

(ii) Carbon dust and carbon monoxide are produced. [1]

OR, Incomplete combustion occurs.

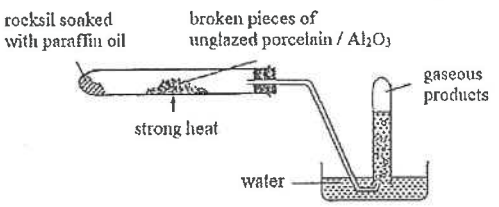
(iii) (1) (II) To increase efficiency of fuel combustion. [1]

(2) It is because leaded petrol burns and releases lead compounds which can damage human nervous system. [1] [1]

CE93_01c

(i) Cracking is the process of breaking down large hydrocarbon molecules into many small hydrocarbon molecules under the action of heat (and catalyst) in the absence of air. [1]

(ii) [3]



2 marks for showing cracking

1 mark for showing collection of gas over water

(iii) (1) The boiling tube may be cracked / broken by cold water flowing in. [1]

(2) Remove the delivery tube from water first, then stop heating. [1]

(iv) No, this can only conclude that the gaseous products contain C=C bond alkene or unsaturated hydrocarbons. [2]

CE93_01d

(i) Burning of fuel because [1]

it is an exothermic reaction that provide energy to move the cars. [1]

(ii) (1) Incomplete combustion of fuel [1]

because will produce air pollutant like carbon and carbon monoxide. [1]

(2) Install catalytic converters in cars. [1]

CE93_03b

(iii) (1) The fuel used in incineration contains sulphur. [1]

(2) Carbon dust. It will sick and mark harms to human respiratory system. [2]

Carbon monoxide. It is a toxic gas. [2]

CE94_05b

(iii) (1) $C_7H_{16} + 11O_2 \longrightarrow 7CO_2 + 8H_2O$ [1]

(iv) The high temperature inside car engine will make nitrogen gas (N_2) to react with oxygen gas (O_2) to form oxide of nitrogen. [2]

CE05_02d

Nitrogen [1]

It cannot burn in air (the others can burn in air). [1]

CE95_08a

(i) (1) sulphur dioxide / SO_2 [1]

(2) attacks respiratory system / produces acid rain / cause smog / toxic [1]

(3) installation of scrubbers (pass fumes through alkalis) / use fuel of low sulphur content. [1]

(ii) Any one of the following groups of answer: [4]

- Part (1) carbon monoxide / CO
  Part (2) incomplete combustion (of fuel)
  Part (3) poisonous / toxic
  Part (4) ensure that there is sufficient supply of air during combustion of fuel
  OR, installation of catalytic converter
- Part (1) particulates / carbon particles
  Part (2) incomplete combustion (of fuel)
  Part (3) cause smog / carcinogenic
  Part (4) ensure that there is sufficient supply of air during combustion of fuel
  OR, installation of catalytic converter
  OR, installation of electrostatic precipitator
- Part (1) nitrogen oxide / NO_x
  Part (2) combination of N_2 and O_2 at high temperature
  Part (3) poisonous / toxic / produces acid rain / photochemical smog
  Part (4) installation of scrubber
  OR, installation of catalytic converter

- Part (1) unburnt hydrocarbons
  Part (2) incomplete combustion (of fuel)
  Part (3) cause smog / carcinogenic
  Part (4) ensure that there is sufficient supply of air during combustion of fuel
  OR, installation of catalytic converter

(iii) water type fire extinguisher [1]

CE96_01a(3)

Explain:

Turning on the exhaust fan may produce a spark [1]

which may cause an explosion / the ignition of the town gas / cause a fire [1]

Proper treatment:

Turn off the gas supply / open windows to let out the town gas [1]

OR, inform the Town gas company (police / fire service) via an outside telephone.

CE96_02

(a) mass of 1 mole of $X = 1 \times 60 = 60$ g

mass of C in $X = 60 \times \frac{60}{100} = 36$ g

no. of mole of $C = \frac{36}{12} = 3$ [1]

The general formula of alkanol is $C_nH_{2n+1}OH$ [1]

Thus, molecular formula of X is C_3H_7OH (C_3H_8O). [1]

(b) Any ONE of the following [1]

propan-1-ol

propan-2-ol

CE96_03

(a) Petroleum and coal were formed from the remains (dead/decayed bodies) of living organisms (animals and plants) that lived millions (thousands) of years ago. [1]

(b) Any TWO of the following: [2]

- The reserve of fossil fuels is limited / may be used up / is non-renewable energy source.
- The price of fossil fuel is controlled by countries which have large reserve of these fuels.
- For economic and political reasons, countries which do not have reserve of fossil fuels have to develop other energy sources.
- Burning of fossil fuels produces a lot of air pollutants.
- Burning of fossil fuels can cause global warming / greenhouse effect.

(c) Advantage: (any one) [1]

- In the long run, nuclear power is cheaper.
- Can produce a large quantity of energy
- Production of nuclear power produces less air pollutants / nuclear power is a clean energy source

Disadvantage: (any one) [1]

- Leakage of radioactive source is disastrous (harmful / cancer causing)
- Difficult to treat the waste.
- Setting up the plant is expensive.

(d) Solar energy / hydroelectric power / geothermal energy / tidal power / wind power / power from biomass. [1]

CE97_05

Chemical knowledge:

Environmental problems caused by oil spillage: [4]

- Oil is less dense than water and is insoluble in water, the oil layer can block the oxygen supply to marine life and cause death of marine life.
- Oil is flammable, it may cause huge fire which is hard to put out.
- Oil wasted ashore may spoil the beaches, the decomposition of oil is low and the effect is long lasting. Oil clogs the feather of sea birds and prevent them from flying or swimming, so the sea birds may die of cold or pneumonia (肺炎).
- Oil layer blocks the sunlight from penetration into sea water and hinders the photosynthesis of aquatic plants.
- Oil is toxic / poisonous to marine life.
- If detergent is used to clean up the split oil, the detergent remained in the sea may cause harm to marine life.

Treatment of oil spillage: [1]

- Treat oil with detergent which can emulsify the oil which break down oil into droplets.
- Use floating barrier or boom to prevent the spread of oil.
- Use micro-organism to break down the oil.

Presentation [3]

CE97_09a

(i) $CH_3–CH_2–CH_2–CH_3$ [1]

(ii) (1) $2C_4H_{10} + 13O_2 \longrightarrow 8CO_2 + 10H_2O$ [1]

(2) Carbon dioxide can turn lime water milky. [1]

Water can turn anhydrous copper(II) sulphate from white to blue. [1]

OR, Water can turn anhydrous cobalt(II) chloride (paper) from blue to pink.

(3) [1]

mole of butane in the can $= \frac{250}{58} = 4.31$

$2C_4H_{10} + 13O_2 \longrightarrow 8CO_2 + 10H_2O$

mole ratio $C_4H_{10} : CO_2 = 1 : 4$

mole of $CO_2 = 4.31 \times 4 = 17.24$ [1]

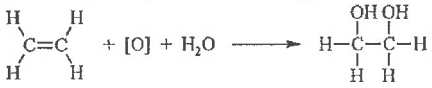
volume of CO_2 produced $= 17.24 \times 24 = 413.8\ dm^3$ [1]

(Accept answers from 412 to 414 dm^3 ; deduct 1 mark for wrong / no unit)

(iii) **Incomplete combustion of butane may occur which produces carbon monoxide (CO) which is toxic.** [2]

CE98_02

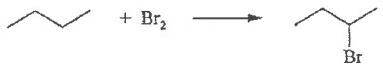
(a) potassium permanganate solution changes from purple to colourless. [1]



[1]

OR, $CH_2{=}CH_2 + [O] + H_2O \longrightarrow CH_2(OH)CH_2(OH)$

(b) Brown colour of bromine changes to colorless. [1]



OR, $CH_3CH_2CH_2CH_3 + Br_2 \longrightarrow CH_3CH_2CHBrCH_3 + HBr$ [1]

CE99_03

(a) incomplete combustion [1]

(b) (1) $2NO + O_2 \longrightarrow 2NO_2$ [1]

$2NO_2 + H_2O \longrightarrow HNO_3 + HNO_2$ [1]

(2) damage buildings / statues, [1]

OR, increase the rate of corrosion of metals / decrease crop yield / harmful to aquatic life

(c) Irritates the respiratory system / causes lung cancer. [1]

(d) Unburnt hydrocarbons / alkanes / sulphur dioxide [1]

(do not accept carbon dioxide / lead compounds / dark smoke)

(e) Catalytic converter [1]

CE99_09b

(i) Breaking down of large hydrocarbon (molecules) to small hydrocarbon (molecules) by heat and with help of a catalyst. [1]

(ii) Treat compounds with bromine in 1,1,1-trichloroethane / bromine water. [1]

Y can cause the bromine solution to change from brown to colourless rapidly. [1]

OR, Treat compounds with acidified $KMnO_4$

Only Y can cause the acidified $KMnO_4$ solution to change from purple to colourless.

(iii) General formula of alkene is C_nH_{2n}

$12n + 2n = 42, \quad n = 3$ [1]

Y is C_3H_6 [1]

CE00_08a

(i) Vapour of alkanes with **low relative molecular mass condenses at lower temperature.** [2]

OR, Vapour of alkanes with high relative molecular mass condenses at higher temperature.

(ii) (1) Petrol is mainly used as fuel for motor cars. [1]

The rapid growth in the number of motor cars makes the demand for petrol much greater than that for kerosene. [1]

(2) Thermal cracking: heating (kerosene) under pressure in the absence of air. [1]

OR, catalytic cracking: heating (kerosene) in the presence of a catalyst in the absence of air at a much lower pressure.

(iii) (1) Any ONE of the following: [1]

It is easier to transport / store naphtha.

Using naphtha produces less air pollutants.

(2) To alert consumers of the leakage of town gas which contains carbon monoxide **which is toxic** / hydrogen which is explosive. [2]

(iv) Lubricating oil [1]

CE00_08b

(i) Burning gasohol produces a smaller amount of carbon monoxide / less unburnt hydrocarbons / gasohol burns completely / produces less soot (dark smoke). [1]

(ii) Catalytic hydration of ethene. [1]

$CH_2{=}CH_2 + H_2O \longrightarrow CH_3CH_2OH$ [1]

(iii) Fermentation of carbohydrates. [1]

(iv) Open-ended question:

Fermentation because it can save petroleum / the price of production of ethanol is low in agricultural countries. [1]

OR, Catalytic hydration because ethanol can be produced at a faster rate.

CE00_09b

(i) Burning fossil fuels (wood) / respiration. [1]

(ii) Photosynthesis / dissolving carbon dioxide in seas (oceans). [1]

(iii) (1) Carbon dioxide absorbs (infra-red) **radiation from the earth surface and traps the energy.** [2]

(2) The atmosphere is maintained in a temperature range suitable for plant and animal growth. [1]

(3) Any ONE of the following: [1]

- melting of ice in the polar caps which may cause flooding of the low-lying areas
- change in rainfall pattern
- weather disrupt ecosystem worldwide

CE01_01

(a) saturated hydrocarbon / alkane [1]

(b) (i) vapour [1]

(ii) oxygen (air) and heat / high temperature [2]

(iii) The strong wind causes a lowering of temperature / removal of heat. [1]

(c) The high temperature of molten wax causes water to evaporate rapidly. [1]

The steam produced causes the molten candle wax to splash out. The hot wax may cause burning of skin. [1]

OR, The steam produced causes the wax to form tiny drops of wax which can easily catch fire / can burn violently.

CE01_07b

(i) Remains of sea animals and plants (e.g. planktons) that lived millions of years ago. [1]

(ii) The carbon content of alkanes in diesel is higher than that in LPG. [1]

It is more difficult for diesel to undergo complete combustion. [1]

So, burning diesel produces more particulates / carbon monoxide / unburnt hydrocarbons. [1]

(iii) Any one of following: [1]

- not enough LPG refill centers
- investment to buy LPG taxis
- not enough service centers

(accept reasonable answers)

CE02_08a

(i) Mass of sulphur in 1.0 kg of coal $= 1000 \times 1.5\% = 15$ g

$S + O_2 \longrightarrow SO_2$

mole of SO_2 released = mole of sulphur used $= \frac{15}{32} = 0.469$ [1]

Volume of SO_2 released $= 0.469 \times 24 = 11.26$ dm^3 (Accept 11 and 11.3 dm^3) [2]

(ii) Acid rain / high incidence of respiratory illnesses / corrosion of buildings. [1]

(iii) Installation of scrubbers / installation of desulphurization system / use of coal of lower sulphur content. [1]

(iv) (1) High incidence of respiratory illnesses / causing cancer / darkening of building walls / reduce visibility / smog. [1]

(2) Installation of electrostatic precipitator. [1]

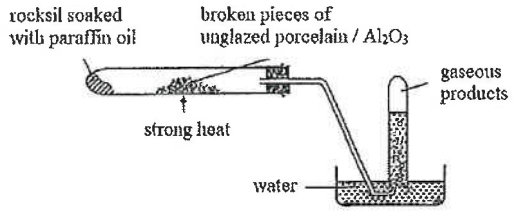
CE03_07b

(i) breaking down of large molecules into smaller ones. [1]

(ii) Cracking can help to produce extra petrol which is used as fuel for motor vehicles. [2]

OR, Cracking produces unsaturated hydrocarbons (e.g. alkene) which can be converted to other useful organic compounds.

(iii) [3]



(1 mark for the set-up used for cracking octane; 1 mark for collection of gaseous product; 1 mark for the labels of an appropriate catalyst and heat.)

(iv) (1) $C_8H_{18} \longrightarrow C_4H_{10} + C_4H_8$ [1]

(2) Treat compounds with Br_2 in CH_3CCl_3. [1]

The unsaturated hydrocarbon readily turns Br_2 in CH_3CCl_3 from brown to colourless. [1]

CE03_09c

(i) sewage sludge [1]

(ii) $CH_4 + O_2 \longrightarrow CO_2 + H_2O$ [1]

(iii) Save fossil fuels. [1]

(iv) Possible answers: (any one) [1]

- Methane produced in biogas plants cannot meet the huge demand of domestic fuel.
- Investment in the construction of biogas plant may be great.
- Biogas plants release air pollutants.
- Difficult to collect large amount of organic wastes.

CE04_03

(a) Dissolve iodine in ethanol/ alcohol. [1]

(b) (1) I_2 is reduced by $SO_3^{2-}(aq)$ to colourless $I^-(aq)$. [2]

(2) I_2 dissolves in 1,1,1-trichloroethane. [1]

(1) is better than (2).

In (2), the stain will be spread by 1,1,1-trichloroethane/ the stain will remain on the coat when 1,1,1-trochloroethane vaporizes. [1]

OR, 1,1,1-trichloroethane is toxic/ harmful.

CE04_04

Chemical knowledge (6 marks)

Formation of acid rain:

Burning of coal in power stations gives sulphur dioxide [1]

OR, Roasting of sulphur-containing ores gives sulphur dioxide

OR, Burning of diesel in diesel engines gives sulphur dioxide

Sulphur dioxide dissolves in rain water to give sulphurous acid. [1]

Combination of N_2 and O_2 at high temperatures, e.g. in car engines or power stations gives NO_x / NO / NO_2. [1]

NO_2 is finally formed which, when dissolves in rain water, gives HNO_2 / HNO_3. [1]

OR, Burning of chlorine-containing plastic wastes gives HCl(g)

OR, HCl(g) dissolves in rain water to give HCl(aq)

Possible ways to reduce the formation of acid rain:

For sulphur dioxide:

Use low-sulphur coal / natural gas / wind power (etc) instead of high-sulphur coal [1]

OR, installation of scrubbers / flue gas desulphurization system.

For NO_x:

Installation of catalytic converters in car exhaust systems. [1]

OR, Installation of low nitrogen oxide burner / scrubbers in power stations

For HCl:

Installation of scrubbers in exhaust system of incinerators / treat plastic wastes by landfilling

(Accept other possible ways for the removal of SO_2, NO_x and HCl.)

Effective communication [3]

CE05_05

(a) Any TWO of the following pairs: [4]

- Both pentane and octane can be represented by a same general formula.
  The general formula for pentane and octane is C_nH_{2n+2} / Adjacent members differ by one $-CH_2$.
- There are gradual changes in physical properties among the members of a homologous series.
  The boiling point / melting point / viscosity / density of octane is higher than that of pentane.
- Members of the same homologous series have similar chemical properties.
  Both pentane and octane can undergo substitution reaction with Br_2 / Cl_2.

(b) Octane, it has a higher percentage of carbon by mass. Its chance to undergo incomplete combustion to give carbon is higher. [2]

(c) Any TWO of the following: [2]

$CH_3CH_2CH_2CH_2CH_3$

$(CH_3)_2CHCH_2CH_3$

$(CH_3)_4C$

CE06_01b

(i) Pressure builds up in the set-up when the mixture is heated. It is dangerous to conduct an experiment using a closed system. An explosion is liable to occur. [1]

Modification: add a receiver adaptor between the condenser and the round-bottomed flask. [1]

(ii) No. The boiling point of hex-1-ene and hexane are very close together. They cannot be separated by simple distillation. [1]

(iii) Treat the hydrocarbons with bromine in 1,1,1-trichloroethane. Hex-1-ene will turn the solution from brown to colourless immediately. In the case of hexane, the colour of the Br_2 solution fades slowly. [1] [1]

CE06_06

(a) The number of motor vehicles increases rapidly. Large quantities of petrol / diesel are burnt to produce CO_2. [1]

The rapid growth in population leads to deforestation, which can provide more land for housing. [1]

(b) Increase in the number of rice paddies / cattle. The remains / manure decay to give methane. [1]

(c) (i) Greenhouse gases can trap heat which is reradiated from the Earth, and keep the atmosphere warm for life to sustain on Earth. [1]

(ii) Increase in temperature of the atmosphere can cause melting of polar ice caps / flooding / change in rainfall pattern etc. [1]

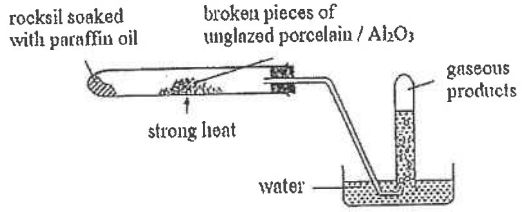
(iii) (I) Any ONE of the following: [1]

- Use alternative energy sources to generate electricity, e.g. nuclear energy, wind energy, solar energy, HEP etc.
- Use H_2 as fuel (fuel cell) in cars
- Plant more trees

(II) Natural gas / marsh gas / methane from biomass can be used as a fuel. [1]

CE07_02

(a)



Cracking set-up [1]

Gas collection set-up [1]

Labelling of paraffin oil and porcelain/porous pot/pumice stones/aluminium oxide/etc. [1]

(b) (i) The products of cracking contained unsaturated (hydrocarbons) / alkenes / C=C / ethane / reasonable name of alkene, which decolourized the bromine water immediately by addition reaction. [2]

(ii) The products of cracking also contained saturated (hydrocarbons) / alkanes / methane / reasonable name or molecular formula of alkane, which decolourized the bromine water slowly by substitution reaction. [2]

CE07_07

(a) concentrated sodium hydroxide solution [1]
solid / powder left [1]

(b) (i) methanol and hexane [1]

(ii) methanol burns with a blue flame while hexane burns with a yellow flame / hexane burns with a more sooty flame than methanol
carbon content in hexane is higher than that in methanol [1]

(iii) Add distilled water / conc. sodium hydroxide solution separately to methanol and hexane. [1]
Methanol is miscible with distilled water / conc. sodium hydroxide solution while hexane is not.
OR, Just mix them together. Two layers observed. Upper layer is hexane while lower layer is methanol.
OR, Carry out boiling point test. The one with higher boiling point is hexane.

CE08_07

(a) A: fractional distillation [1]
B: cracking [1]

(b) (i) Diesel oil has a higher viscosity because the intermolecular forces between the molecules are larger than those in petrol. [1]

(ii) Petrol is a cleaner fuel because
it burns more completely [1]
OR, has shorter carbon chains
OR, has lower carbon to hydrogen ratio
OR, has lower carbon contents than diesel oil.

(c) (i) To increase the amount of petrol for meeting the demands. [1]
OR, To increase the amount of smaller molecules for meeting the demands.
OR, To produce alkenes which are used to make other compounds.

(ii) (1)

	$CH_3CH_2CH=CH_2$	but-1-ene
OR	$CH_3CH=CHCH_3$	but-2-ene
OR	$CH_3C(CH_3)=CH_2$	2-methylpropene / methylpropene

[2]

(2)

Test	Observation	
	$C_{20}H_{42}$	D
Bromine solution	Brown / orange / yellow to colourless slowly / under light	Brown / orange / yellow to colourless immediately / quickly / in the dark
Acidified $KMnO_4$ solution	No observable changes	Purple to colourless
$KMnO_4$ solution	No observable changes	Brown precipitate
Burning	More dark smokes	Less dark smokes

[2]

CE11_01a

Enough oxygen is provided when air hole is fully open. [1]
Complete combustion of methane has occurred. [1]
$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$ [1]

CE11_06

(a) (i) Butane [1]

(ii) LPG burns more completely. [1]
OR, LPG gives less sooty flame on burning.

(b) (i) Any 2 points, 1 mark for each point. [2]
- Reduce the amount of nitrogen oxides in the exhaust.
- Reduce the amount of unburnt hydrocarbons in the exhaust.
- Reduce the amount of carbon monoxide in the exhaust.
- Reduce the amount of soot.
- Reduce the amount of suspended particulates in the exhaust.

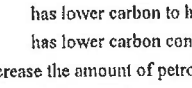
(ii) Nitrogen gas (N_2) or water (H_2O) or carbon dioxide (CO_2) [1]

(c) Burning of ultra low sulphur diesel (ULSD) gives less sulphur dioxide. [1]
Sulphur dioxide causes acid rain / is harmful to human respiratory system. [1]

Part 2: (d) addition polymers

CE90_01a(iv)

(1) polypropene [1]

 [1]

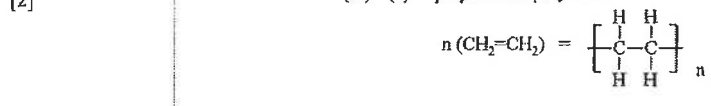
(2) household articles:
bowls / buckets / cups [1]

CE91_02b

(i) Thermoplastic are easily melt and catch fire because electricity produces heat. [1]

(ii) Polystyrene. [1]
The gas is a good insulator of heat, so as the plastic. [1]

(iii) (1) polyethene / polythene [1]

 [1]

CE92_04a

(i) (1)  [1]

(2) polypropene / polystyrene [1]

(3) In A, X will melt [1]
because X is heated in a limited supply of air. [1]
OR, because X is a thermoplastic.
In B, X will burn [1]
because there is much air supplied for burning. [1]

(ii) $\text{mole ratio of C : H} = \frac{4.62}{12} : \frac{5.00 - 4.62}{1} = 0.385 : 0.38 = 1 : 1$ [2]

n(CH) = 104, hence n = 8
Molecular formula of monomer of X is C_8H_8. [1]

CE93_02a

(i) Plastics are **chemically unreactive** and **cheap**. [2]

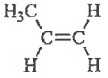
CE95_06a(iv)

(1) It is inert / does not react with HCl / the bottle is not easily broken / flexible / light in weight / can be molded easily. [1]

(2) polyethene / polythene / polypropene / polystyrene / polyvinyl chloride etc. [1]

CE96_07b

(i) fractional distillation of crude oil [1]

(ii) (1)  [1]

(2) Step 1: (catalytic) cracking of heavy oil [1]
Step 2: fractional distillation of the mixture to obtain propene [1]

(iii) Step 1: monomer A (propene) is polymerized to give polypropene [1]
Step 2: polypropene is injection moulded to give the polypropene bottle [1]

(iv) Polypropene is non-biodegradable. [1]
OR, Burning of polypropene waste may produce toxic gas / air pollutants.

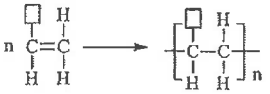
(v) (1) Separating polypropene from other plastic wastes [1]
OR, cleaning the polypropene wastes
(2) Urea-methanal [1]

CE97_01c

Polystyrene [1]
Feeding bottles are usually sterilized by heating in boiling water. Polyethene has a low melting point. It softens at the temperature of boiling water. [1]
Urea-methanal. It cannot be moulded into the shape of a bottle / it is not transparent. [1]

CE97_07b

(i) compound IV [1]

 [1]

CE98_07b

(i) $n\ H_2C{=}CH_2 \longrightarrow \text{-}[CH_2\text{-}CHCl]\text{-}_n$ [1]

(ii) (1) Any one: [1]
- rain coats
- bottles
- garment
- surface of sofa
- hose
- cable sheathing
- foot wear
- tiles curtains

(2) Any one: [1]
- pipes
- bottles
- record

(3) No. PVC is a thermoplastic, it melts upon heating. [1]

(iii) (1) Acid rain / damage to the respiratory system. [1]

(2) Washing the flue gas with alkali / water. [1]
OR, pass the gas through scrubber.

(3) $\text{mole of HCl produced} = \text{mole of PVC repeating units} = \frac{1000000}{62.5}$ [1]

$= 16000$ [1]

$\text{volume of HCl produced} = 16000 \times 24 = 384000\ \text{dm}^3$ [1]

CE99_01

(a) (i) Any one: [1]
- Polyvinyl chloride is more corrosive resistant than iron
- It can be more easily shaped
- It is chemically inert

(ii) Any one: [1]
- Iron is stronger
- Iron has higher tensile strength than PVC

(b) (i) Perspex is not easily broken / lighter. [1]

(ii) Glass cannot be easily scratched / has better light transmission property. [1]

(c) (i) Any one: [1]

- It is waterproof
- Polyethene is more durable
- It has higher tensile strength

(ii) Any one: [1]

- Paper is biodegradable
- It causes less pollution problems when disposed of
- It can be made from renewable materials
- It is air permeable

CE99_09b

(i) Breaking down of large hydrocarbon (molecules) to small hydrocarbon (molecules) by heat with the help of a catalyst. [1]

(ii) Treat compounds with bromine in 1,1,1-trichloroethane / bromine water. [1]

Y can cause the bromine solution to change from brown to colourless rapidly. [1]

OR, Treat compounds with acidified $KMnO_4$.

Only Y can cause the acidified $KMnO_4$ solution to change from purple to colourless.

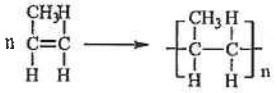
(iii) General formula of alkene is C_nH_{2n}

$12n + 2n = 42$ [1]

$n = 3$

Y is C_3H_6 [1]

(iv) (1) [1]



(2) Apply heat to Z until it softens / melts. [1]

Compress (inject) molten Z to the shape of a cup in a mould and allow it to cool. [1]

(v) **Advantage:**

to reduce the consumption of non-renewable energy source or fossil fuels. [1]

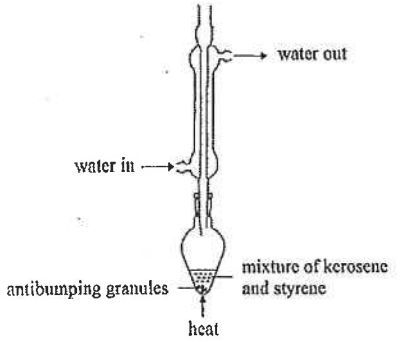
Disadvantage:

burning plastic wastes produces air pollutants / toxic gases. [1]

OR, the cost to remove the pollutants produced by burning plastic wastes is high.

CE00_07b

(i) [2]



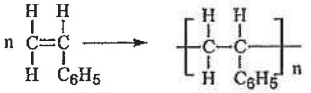
(ii) **Add anti-bumping granules to prevent bumping and ensure smooth heating.** [2]

OR, A small flame / an electric heating mantle / an oil (water) bath should be used because kerosene is flammable.

OR, Heat the mixture in a fume cupboard because styrene vapour is irritant.

(iii) (1) carbon-carbon double bond / C=C [1]

(2) [1]



(iv) (1) To improve the heat insulating properties of the material. [1]

(2) Open-ended question:

Agree: [1]

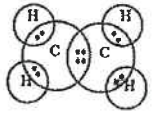
- landfilling causes less air pollution problems

OR, Disagree:

- degradation of polystyrene wastes takes a long time
- a lot of landfilling sites are needed
- incineration can produce energy

CE01_07a

(i) [1]



(ii) addition [1]

(iii) durable / water repelling / chemically inert / high tensile strength [1]

(iv) any one of answer:

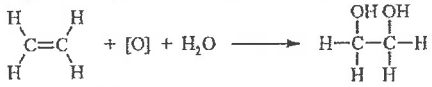
	Answer 1	Answer 2	Answer 3	
(1)	incineration	landfilling	recycling	[1]
(2) Advantage	can reduce the volume of solid waste *OR,* converts plastic wastes into energy	does not cause much air pollution *OR,* produces methane which is a fuel	saves petroleum which is a non-renewable energy source *OR,* reduces the volume of solid waste	[1]
Disadvantage	release toxic gases (CO / dioxins)	a lot of landfill sites are required *OR,* causes underground water pollution	difficult to separate from other wastes *OR,* energy consuming	[1]

CE02_05

Chemical knowledge (total 6 marks)

- Members of a homologous series can be represented by the same general formula of alkenes: C_nH_{2n} [1]
- Successive members of a homologous series differ in their structure by one CH_2 unit [1]
- Formulae: ethene (C_2H_4), propene (C_3H_6) etc.
- Members of a homologous series have the same functional group
- Functional group of alkenes: C=C
- Structures of alkenes: ethene ($CH_2=CH_2$) ; propene ($CH_3CH=CH_2$)
- Their physical properties change gradually from one member to the next [1]
- The melting point / boiling point of alkene increase with increase in relative molecular mass [1]
- Members of a homologous series have similar chemical properties [1]
- One example of the reactions of alkenes which is characteristics of unsaturated hydrocarbons [1]

e.g. $CH_2=CH_2 + Cl_2 \longrightarrow CH_2Cl\text{–}CH_2Cl$



Effective communication [3]

CE03_05

Chemical ways of treating plastic wastes:

(any three of the following; in each case, 1 mark for advantage and 1 mark for disadvantage)

- Incineration
  - Advantage: Operation cost is low. Volume of solid waste can be greatly reduced, energy can be recycled, reduce land wastage, etc. [1]
  - Disadvantage: Incineration produces toxic gases, the cost of operating a controlled incineration plant is high, etc. [1]
- Recycling
  - Advantage: Save materials, plastic wastes can be converted to useful products. [1]
  - Disadvantage: The cost of operating a recycling plant is high, separation of the different types of plastics in the waste is costly, low quality plastics are produced by melting and re-moulding plastic wastes, etc. [1]
- Landfilling
  - Advantage: Does not cause much air pollution, a lot of plastic waste can be treated in a short period of time, etc. [1]
  - Disadvantage: land wastage, it takes a long time for plastic wastes to degrade, may cause pollution of underground water, slow release of toxins from landfill sites, etc. [1]
- Pyrolysis
  - Advantage: Save materials, useful products (e.g. methane, ethane) can be obtained, etc.
  - Disadvantage: Requires a lot of energy.

Effective communication [3]

CE04_06c

(i) In the presence of air, plastic wastes will be oxidized / burn / give CO_2 and H_2O. [1]

(ii) Fractional distillation of the liquefied pyrolysis products. [1]

(iii) Methane: fuel/steam cracking to give CO or H_2 / production of CH_2Cl_2 ($CHCl_3$ and CCl_4) [1]
Ethene: making starting materials for polymers (PE or PVC) / manufacture of ethanol (or ethane-1,2-diol) [1]
(accept other correct answers)

(iv) (1) Incineration / landfilling / recycling [1]

(2) Advantage of pyrolysis (any one)
- useful products can be obtained [1]
- cause less air pollution problems
- save materials
- not necessary to separate the plastic wastes

Advantage of incineration (any one)
- low operation cost [1]
- reduce solid waste volume / reduce land wastage
- not necessary to separate the plastic wastes

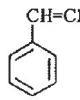
OR, Advantage of landfilling (any one)

- low operation cost
- causes less air pollution problems
- not necessary to separate the plastic wastes

OR, Advantage of recycling (any one)

- low operation cost
- save materials
- causes less air pollution problems
- reduce land wastage

CE05_06

(a) (i)  or $H_2C{=}CHC_6H_5$ [1]

(ii) PS is a mixture of polymeric molecules of different chain lengths. [1]

(b) (i) Condenser [1]

(ii) Electric heating mantle / oil bath / sand bath should be used because kerosene is flammable. [2]

OR, Heat the mixture in a flame cupboard because styrene vapour is irritant.

(iii) Addition polymerization [1]

(c) (i) Electricity leakage can be prevented. [1]

(ii) Plastic does not corrode easily. [1]

(iii) Low density [1]

CE06_11

(a) Thermoplastics are made up of molecules with long carbon chains. The attraction between the polymers is weak van der Waals' forces. At elevated temperatures, the molecules can move relative to each other (translational motion). [1]

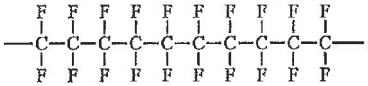
In thermosetting plastics, there are cross-links between the polymer molecules. There is little motion between the chains. [1]

Thermosetting plastics do not melt upon heating / cannot be reshaped at high temperature. But, thermoplastics soften upon heating / can be moulded at high temperatures. [1]

(b) (i) $n\ H_2C{=}CH_2 \longrightarrow -\left[CH_2{-}CH_2\right]_n-$ [1]

(ii) PE contains only C – H and C – C bonds. These bonds are strong / unreactive / not readily attacked by chemicals. [1]

CE07_08

(a) (i)  [1]

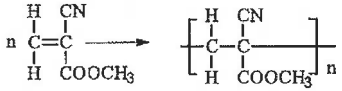
(ii) Repeating unit:

 [1]

Monomer: $CF_2{=}CF_2$ / tetrafluroethene [1]

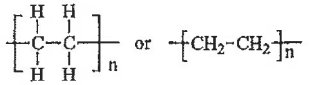
CE08_08

(a) Addition polymerization [1]

(b)  [1]

CE09_04

(a) Corrosive [1]

(b) (i)  [1]

(ii) Polyethene lining is inert / does not react with acid. [1]

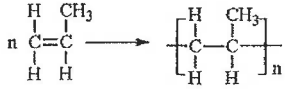
It can prevent acid from reacting with the steel storage tank. [1]

(c) mass of HCl = $57000000 \times 38\% = 21660000$ g

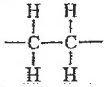
mole of HCl = $\dfrac{21660000}{1+35.5} = 593424.7 = 593400$ [1]

$[HCl] = \dfrac{593400}{50000} = 11.87$ M (Accept 11.86 – 11.90) [1]

CE10_12

(f)  [1]

CE11_07

(a)  [1]

(b) Addition polymerization [1]

(c) Prevent wetting the paper layer. [1]

(d) The box has an aluminium layer. [1]
Aluminium can react with oxygen so as to prevent the beverage from spoiling. [1]

(e) (i)  [1]

(ii) Monomer of PVC [1]
OR, short chain molecule of PVC
OR, plasticiser

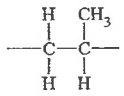
AL99(I)_06b

(i) CO: incomplete combustion of petrol. [1]
NO: combination of N_2 and O_2 at high temperature. [½]
$N_2 + O_2 \longrightarrow 2NO$
NO_2: air oxidation of NO [½]
$2NO + O_2 \longrightarrow 2NO_2$

(ii) In the catalytic converter, **Rh catalyzes the reaction** [½]
$2NO + 2CO \longrightarrow N_2 + 2CO_2$ [½]
Air is introduced to the converter and acts as an oxidizing agent. [½]
Pt/Pd catalyzes the reactions
$2CO + O_2 \longrightarrow 2CO_2$ [½]
$C_7H_{16} + 11O_2 \longrightarrow 7CO_2 + 8H_2O$ [½]
(Accept any equation showing the oxidation of alkane with 5 to 10 carbon atoms.)

(iii) Lead / lead compounds can poison the catalysts Pt / Pd [1]

ASL99(I)_07

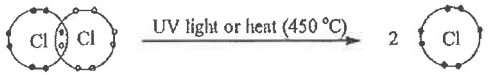
(a)  [1]

(b) (i) Polymer is a mixture of polymer chain with different hydrocarbon length. [1]

(ii) $$\text{Average number of repeating unit} = \frac{\text{molecular mass of poly(propene)}}{\text{formula mass of repeating unit}}$$
$$= \frac{4.2 \times 10^5}{(12 \times 3 + 6)} = 10000$$ [1]

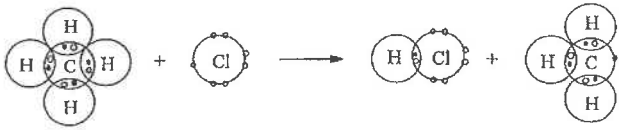
ASL99(II)_09 (modified)

(a) Chain initiation



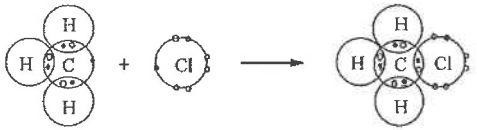
[1]

Chain propagation



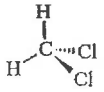
[1]

Chain termination



[1]

(b) (i) **Dichloromethane is polar. As C–Cl bond is polar** and CH_2Cl_2 is an **asymmetrical molecule.** [1]
Bond polarity (bond dipole moment) of C–Cl cannot cancel out each other. [1]



[1]

(ii) As other products such as CH_3Cl or CCl_4 are also formed, which further decrease the reaction yield of dichloromethane. [1]

ASL99(II)_10 (modified)

(a) $2CO(g) + O_2(g) \longrightarrow 2CO_2(g)$ [1]
$2NO(g) + 2CO(g) \longrightarrow N_2(g) + 2CO_2(g)$ [1]
$4C_xH_y(g) + (2x + y)O_2(g) \longrightarrow 2xCO_2(g) + 2yH_2O(l)$ [1]
Catalyst converters can convert carbon monoxide and nitrogen oxides to nitrogen gas and carbon dioxide, and hydrocarbons to carbon dioxide and water. [1]

(b) (i) Carbon dioxide can intensify the greenhouse effect. [1]
As the high concentration of carbon dioxide in the atmosphere can trap the infra-red radiation on the Earth. [1]

(ii) Replace the fossil fuel by alternative fuel such as hydrogen gas. [1]
(Accept other reasonable answer)

(c) (i) Presence of nitrogen dioxide [1]

(ii) Cause respiratory disease [1]

ASL01(I)_06

(a) **Cracking** of naphtha gives a mixture of hydrocarbons which include propene. [1]
Fractional distillation of the gaseous products can separate propene from other hydrocarbons. [1]
Polymerization of propene at elevated temperatures. [1]

(b) The molecular size of repeating unit of PVC is larger than that of PP. Under the same length of the polymer chain, there is a stronger van der Waals' force between PVC polymer chains than that in PP. [1] [1]

(c) (i) The intermolecular attraction between polymer chains weakens if there are plasticizer molecules between the polymer chains, increasing the distance between two polymer chains. [1]
(ii) The plasticizer molecules decompose under the prolonged sunlight radiaton, and PVC restores its rigidity. [1]

(d) Buring PVC wastes will produce toxic Cl_2 gas / acidic HCl gas and others chlorinated compounds such as dioxin. [1]

ASL02(II)_10

(a) At high temperature, $N_2(g)$ and $O_2(g)$ in the air combine to form NO(g) [½]
$N_2(g) + O_2(g) \longrightarrow 2NO(g)$ [½]
Burning sulphur impurities in the coat produces sulphur dioxide. [½]
$S(s) + O_2(g) \longrightarrow SO_2(g)$ [½]

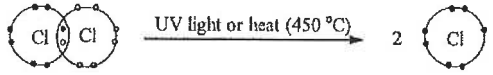
(b) (i) A catalyst can speed up the reaction by providing an alternative pathway with lower activation energy. [1]
(ii) $6NO(g) + 4NH_3(g) \longrightarrow 5N_2(g) + 6H_2O(l)$ [1]

(c) $2SO_2(g) + 2CuO(s) + O_2(g) \longrightarrow 2CuSO_4(s)$ [1]

(d) (i) $2CuSO_4(s) + CH_4(g) \longrightarrow 2SO_2(g) + CO_2(g) + 2Cu(s) + 2H_2O(l)$ [1]
(ii) Heating Cu in the air [1]

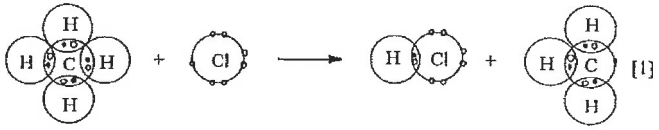
ASL03(II)_08 (modified)

(a) (i) Under sunlight or under ultra-violet radiation [1]
Use a mixture of CH_4 and Cl_2 in a mole ratio of 1 : 1 [1]
(ii) Chain initiation



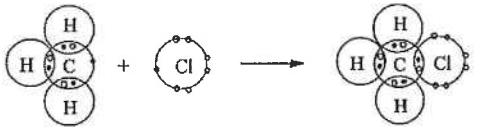
[1]

Chain propagation



[1]

Chain termination



[1]

(b) CH_2CH_2, $CHCl_3$ and CCl_4 [1]

AL04(II)_06a

(i) (I) At high temperature, $N_2(g)$ reacts with $O_2(g)$ to give NO(g). [1]
$N_2(g) + O_2(g) \longrightarrow 2NO(g)$ [½]
$2NO(g) + O_2(g) \longrightarrow 2NO_2(g)$ [½]
(II) Acid rain / photochemical smog [1]

(ii) $2CO(g) + O_2(g) \longrightarrow 2CO_2(g)$ [1]
OR, $2CO(g) + 2NO(g) \longrightarrow 2CO_2(g) + N_2(g)$

$$C_nH_{2n+2}(g) + \frac{3n+1}{2}O_2(g) \longrightarrow nCO_2(g) + (n+1)H_2O(g)$$ [1]

n is an integer

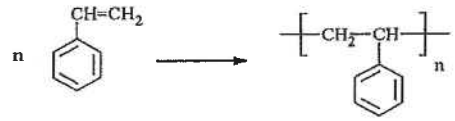
(iii) (I) Carbon [1]
(II) Nitrogen dioxide oxidizes C in PM to $CO_2(g)$ / gaseous products. [1]
$C(s) + NO_2(g) \longrightarrow CO_2(g) + NO(g)$ [1]
$C(s) + 2NO(g) \longrightarrow CO_2(g) + N_2(g)$

(iv) SO_2 (or other sulphur compound) would poison the catalyst. [1]

ASL04(II)_12

(a) (i) The C–Cl bonds and C–H bonds in PVC are polar. The rigidity of PVC is due to the strong van der Waals' force (dipole-dipole attraction) which occurs between slightly negative chlorine atoms on one polyme chain and the slightly positive hydrogen atoms on an adjacent chain. [1] [1]
(ii) The intermolecular attraction between the polymer chains weakens if there are plasticizer molecules between the polymer chains. [1]

(b) (i)



[1]

(ii) Hydrocarbons [1]
(iii) **Air is good insulator. Trapping of air in expanded PS would enhance the heat insulating properties.** [1]

ASL05(II)_11

(a) (i) Incomplete combustion of fuel / petrol / diesel [1]

(ii) At high temperature / the temperature of the car engine, $N_2(g)$ and $O_2(g)$ combine to form NO(g) [1]

$N_2(g) + O_2(g) \longrightarrow 2NO(g)$

The NO(g) formed in then oxidized to $NO_2(g)$ [1]

$2NO(g) + O_2(g) \longrightarrow 2NO_2(g)$

(b) (i) Photochemical smog / acid rain [1]

(ii) Carcinogen / causing respiratory illnesses [1]

(c) The catalyst (Pt / Rd) in the catalytic converter speeds up the reaction of NO(g) with CO(g) to give $CO_2(g)$ and $N_2(g)$ which are les harmful. [1]

$2NO(g) + 2CO(g) \longrightarrow N_2(g) + 2CO_2(g)$ [1]

(d) Yes

The HCs in diesel contains a much higher percentage of carbon. Incomplete combustion will give a greater amount of particulates. [1]

ASL08(I)_09 (modified)

(a) $CH_2{=}CHCONH_2$ [1]

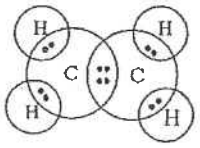
(b) Add Br_2/H_2O or Br_2/CCl_4 [1]

The presence of propenamide cause the reddish brown reagent to turn colorless. [1]

(c) $Br_2 + CH_2{=}CHCONH_2 \longrightarrow CH_2BrCHBrCONH_2$ [1]

DSE11SP_02

(a)



[1]

(b) Addition polymerization [1]

(c) Durable / water repelling /chemically inert / high tensile strength [1]

(d) (i) Incineration [1]

(ii) Advantage: can reduce the volume of solid waste / converts plastic waste into energy. [1]

Disadvantage: releases toxic gas (CO / dioxin) / CO_2 which is a greenhouse gas / particulates which cause respiratory diseases (darkening of building) / cost to remove air pollutant from flue gas is high. [1]

(i) Landfilling [1]

(ii) Advantage: does not cause much air pollution / produces methane which is a fuel. [1]

Disadvantage: a lot of landfill sites are required / causes underground water pollution. [1]

(i) Recycling [1]

(ii) Advantage: saves petroleum which is a non-renewable energy source / reduces the volume of solid waste / does not cause much air pollution / can help to conserve plastic materials. [1]

Disadvantage: difficult to separate PE from other wastes / recycling is energy consuming. [1]

DSE12PP_05

(a) Mole ratio of $C : H = \frac{81.8}{12} : \frac{18.2}{1} = 6.82 : 18.2 = 3 : 8$ [1]

Alkane has the general formula C_nH_{2n+2} [1]

∴ **X is propane / C_3H_8** [1]

(b) **Fractional distillation** of the petroleum gaseous fraction. [1]

OR, Cracking of naphtha / heavy oil (or any appropriate petroleum fraction) followed by **fractional distillation** of the products.

(c) (i) X : C_3H_8 easily undergoes complete combustion to give CO_2 and H_2O. The products pose little harm to the environment. [1]

(ii) Kerosene : kerosene undergoes incomplete combustion to give a luminous flame. The flame can be more easily seen. [1]

DSE12PP_07

(b) (i) (1) PP is a poor conductor of heat. Using PP container to hold CaO(s) will protect hands for skin burns. [1]

PP can withstand the high temperature caused by the reaction of CaO(s) with $H_2O(l)$.

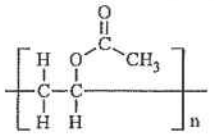
DSE12_02

(a) (i) Cracking / Catalytic cracking / Thermal cracking [1]

(ii) This process can produce small molecules / alkene / ethene / petrol / hydrocarbons of lower molecular mass from large hydrocarbons to meet the industrial demand / to make useful materials / to make useful fuels. [1]

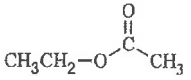
OR, This process can produce more small molecules / alkenes / ethene / petrol / hydrocarbons of lower molecular masses from large hydrocarbons.

(b)



[1]

(c) (i)



[1]

(ii) Bromine test – ethenyl ethanoate can decolorize orange / brown / yellow bromine / Br_2 solution immediately while ethyl ethanoate cannot. [1]
(NOT Accept Br). [1]
(Require to mention the reaction of Br_2 with ethenyl ethanoate is much faster than ethyl ethanoate)

OR, Treating with acidified potassium permanganate solution - ethenyl ethanoate can decolorize purple acidified potassium permanganate solution while ethyl ethanoate cannot.

(Also accept treating with potassium permanganate solution (without acidification) with the correct descriptions of observations – change from purple to brown (precipitate)).

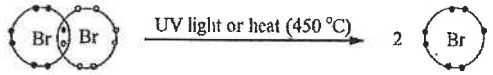
DSE12_10

Any THREE [3]

- Install catalytic converters in car
- Use unleaded petrol
- Replace diesel with LPG for vehicles / Use LPG for vehicles/mini-bus/bus/taxi
- Install scrubbers in power plant
- Using Ultra Low Sulphur Diesel / Use low sulphur coal in power plant / use low Sulphur fuels.
- Use electrostatic precipitator
- Remove dust by mechanical filtering

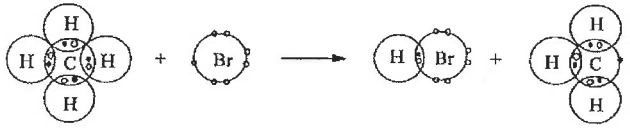
DSE12_15

Chain initiation



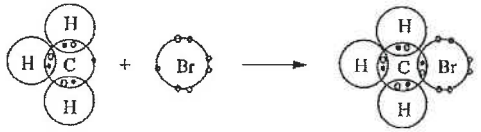
[1]

Chain propagation



[1]

Chain termination



[1]

DSE13_06

- **Cracking** of naphtha gives a mixture of hydrocarbons which include propene. [1]
- **Fractional distillation** of the gaseous products can separate propene from other hydrocarbons. [1]
- **Polymerization of propene at elevated temperatures / >45 °C / high pressure / >5 atm / in the presence of a suitable catalyst / Zieg;er-Natta catalyst** gives polypropene (Polymerization + any 1 condition). [1]
  (Polymerization of propene can be described in the form of a chemical equation.)
- Communication [1]

DSE13_10

(c) (i) Accept both 'agree' and 'disagree' answers. Award 1 mark for a sound argument. [1]
Agree: The hydrogen can be **obtained from renewable source (with one proper example)** (E.g. electrolysis of water using the electricity generated from hydropower / reforming of CH_4 obtained from animal manure.)
Disagree: The hydrogen gas used is produced from fossil fuel such as steam reforming of nature gas.
Disagree: (Electrical) energy is consumed in the production of hydrogen (from water).
(NOT Accept the answer is yes, because the hydrogen can be obtained from the electrolysis of water, and so the fuel cells do not consume fossil fuel.)

(ii) Agree: Only water is produced from the hydrogen-oxygen fuel cells [1]
OR, No CO_2 / SO_2 / NO_x / CO / unburnt hydrocarbon in the exhaust.

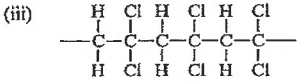
DSE14_03

(a) Add Br_2(aq) or Br_2(organic solvent) / acidified $KMnO_4$(aq) / neutral or alkaline $KMnO_4$(aq). [1]
Reddish brown or brown or orange Br_2(aq) decolorized or becomes colorless (paler). [1]
OR, Purple $KMnO_4$(aq) decolorized or becomes colorless (paler)
OR, Purple $KMnO_4$(aq) becomes brown.
NOT accepted : yellow Br_2(aq), Br_2, Bromine, Br_2(g), Br_2(l).....

(b) (i) 1,1-dichloroethene [1]

(ii) Addition (polymerization) [1]
NOT accept : additional polymerization

(iii) [1]



(c) 'Saran' is more heat resistant / has a higher melting point / is less soluble in oil [1]
Because the **polar attraction** (force) between 'Saran' polymer chains **is stronger** than that between PE [1]
OR, the molecular size of Saran are layer, hence it has a larger dispersion forces or van del Waals' force or intermolecular forces than in PE.

(d) Incineration of food wrap made from 'Saran' will produce toxic gases / harmful gases / dioxin / hydrogen chloride / HC/ chorine / Cl_2, while that made from PE will not. [1]

DSE14_06

(a) (i) **Components having different boiling points** can be separated from each other by fractional distillation. [1]
The longer the carbon chain, the higher is the boiling point. [1]
(ii) Cracking of heavy oil / heavy hydrocarbons [1]

(b) (i) Catalytic converter [1]

DSE15_06

(a) Substitution [1]

(b) Light / ultra-violet / UV / heat / radical initiator (e.g. benzoyl peroxide) [1]

(c) Orange / brown color of bromine fades away [1]
Orange / brown color of bromine changes to colorless (slowly)
(bromine color: NOT accept 'yellow')

(d) Br atom **does not have the stable noble gas electronic configuration.** [1]
OR Br atom **does not have the stable octet electronic configuration.**
OR **The electronic configuration of Br atom does not fulfill the octet rule.**

(e) (i) CH_2Br_2 / $CHBr_3$ / CBr_4 [1]
(ii) Use (large) excess amount of CH_4 [1]
OR, Br_2 is the limiting reactant.

DSE15_08

(a) C_nH_{2n+2} [1]

(b) (i) Covalent bond(s) broken C–H and O=O [1]
Covalent bond(s) formed C=O and O–H [1]

(c) - Natural gas burns (more) completely but coal does not. / [1]
Burning coal would produce soot / carbon monoxide but burning natural gas would not.
- Compared with natural gas, coal contains more impurities. / [1]
Burning coal would produce more pollutant, such as SO_2, metal compound dust, NO_2.

DSE16_03

(a) cracking [1]
To produce petrol / to produce alkenes / [1]
to produce smaller hydrocarbons from larger hydrocarbons / to convert heavy oil to petrol

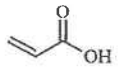
(b) The reaction will be faster when using broken unglazed porcelain instead of a large piece of unglazed porcelain due to larger surface area. [1]

(c) (i) $C_8H_{18} \longrightarrow C_2H_6 + 2CH_3CH{=}CH_2$ [1]
$C_8H_{18} \longrightarrow C_2H_6 + 2C_3H_6$

(ii) (1) Orange / brown Br_2 solution turns to colorless / decolorize [1]
(bromine colour: accept "reddish brown" or "red"; not accept "yellow")
(2) $CH_3CHBrCH_2Br$ [1]

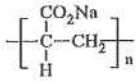
(d) **The delivery tube should be taken out of the water level before removing the heating source, otherwise sucking back will happen / the boiling tube will be cracked.** [1]

DSE16_05

(a)  [1]
Propenoic acid [1]

(b) Addition [1]
(Do not accept "additional")

(c) **B is a mixture of polymer molecules with different lengths.** [1]
OR, Polymer molecules are of different length / carbon chains / n values.

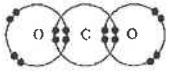
(d)  [1]

DSE17_03

(a) A propene molecule has C=C bond whereas propane molecule has not. [1]
(Not accept: Propene is unsaturated while propane is saturated. / Propene is an alkene while propane is an alkane.)

DSE17_08

(a) $2C_8H_{18} + 25O_2 \longrightarrow 16CO_2 + 18H_2O$ [1]
The stoichiometric coefficients should be whole numbers.

(b)  [1]

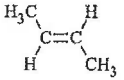
(c) **FOR :** Using carbon capture techniques, the CO_2 produced in power stations can be trapped and stored, thus the emission of carbon dioxide into the atmosphere will be reduced. / Compared with petrol-driven car, power stations have higher energy efficiency, and will reduce CO_2 emissions. / Using renewable energy sources like solar energy to power the electric car will reduce CO_2 emissions. [1]
AGAINST: The electricity used in powering car is mainly produced by burning of fossil fuels, and the CO_2 so produced will still be emitted into the atmosphere. / Producing batteries for electric car will increase CO_2 emissions. [1]

(d) Limited supply of air or oxygen / too large amount of petrol. [1]

(e) (i) Catalytic converter [1]
(ii) Particulates / supended particulate / Sulphur dioxide / PM [1]

DSE18_04

(a) Petroleum is formed when large quantities of dead marine organisms (such as planktons and algae), [1]
that are buried underneath sedimentary rock and subject to intense heat and pressure for a long time. [1]

(b) (i)  [1]

(ii) But-1-ene or methypropene [1]

(c) (i) Pass excess H_2 to ethene in the pressure of Pt / Pd / Ni [1]
OR Catalytic hydrogenation

(ii) Ethene turns Br_2(In CH_3CCl_3) [1]
from brown / orange to colorless, while ethane does not. [1]
(Not accept yellow)
(Accept $KMnO_4/H^+$ - purple to colorless
$KMnO_4$ - purple to brown (precipitate)
$KMnO_4/OH^-$ - purple to brown (precipitate))
(Accept: combustion test; ethene gives more sooty flame, while ethane gives less sooty flame)

DSE18_09

Five knowledge points (1 mark for each point), a maximum of 4 marks: [4]

- Unsaturated compounds / compounds with C=C bonds can undergo addition polymerization.
- No small molecules will be eliminated during addition polymerization.
- High temperature / high pressure / catalyst is used. (Any 2 conditions)
- Structure of monomer: $CF_2=CF_2$
- Structure of the repeating unit: $-CF_2-CF_2-$ OR the polymer: $-[CF_2-CF_2]_n-$

Communication mark [1]
Chemical knowledge = 0 to 2, communication mark = 0
Chemical knowledge = 3 to 4, communication mark = 0 or 1)

DSE19_03

(a) (i) Bromine (in organic solvent) [1]
(Not accept aqueous bromine solution)

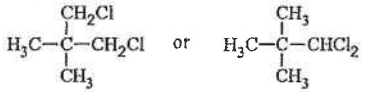
(ii) $CH_3CH=CHCH_3 + Br_2 \longrightarrow CH_3(CHBr)_2CH_3$ [1]
But-2-ene / an alkene reacts with Br_2, and Br_2 is decolorised / all Br_2 is consumed / a colourless product is formed. [1]

DSE19_05

5. (a) Chlorine / Cl_2 [1]
(not accept Cl_2(aq))

(b) Light / hυ / ultra-violet / UV / radical initiator [1]

(c) Substitution (reaction) [1]

(d) (i)  [1]

1,3-dichloro-2,2-dimethylpropane or 1,1-dichloro-2,2-dimethylpropane [1]
(Also accept 1,3-dichlorodimethylpropane or 1,1-dichlorodimethylpropane)
(The structure and the systematic name must be matched.)

(ii) The structure other to the answer in (i) [1]

(iii) structural isomer / position isomer [1]

DSE20_08

8. (Any 5 points from below: 1 mark for each point) 5

- Separation of crude oil gives heavy oil, fuel oil etc. by oil refinery / fractional distillation.
- Cracking of (crude oil) / heavy oil / gas oil / fuel oil / naphtha / etc. gives a mixture of small molecules / mixture with ethene / $CH_2=CH_2$. (Accept: C_2H_4)
(Not accept: lubricating oil / bitumen etc.)
- $C_7H_{16} \rightarrow CH_2=CH_2 + C_5H_{12}$ (Accept: C_2H_4)
(Accept: Hydrocarbons with 5 or more carbon atoms, e.g. C_5H_{12})
(The equation must be balanced) (Ignore state symbols)
- Fractional distillation of the above mixture / small molecules gives ethene / $CH_2=CH_2$.
(Accept: C_2H_4)
- Addition reaction of ethene / $CH_2=CH_2$ and bromine / Br_2 gives 1,2-dibromoethane / $BrCH_2CH_2Br$.
(Not accept: $C_2H_4Br_2$, Br_2(aq)) (Accept: C_2H_4)
- $CH_2=CH_2 + Br_2 \rightarrow BrCH_2CH_2Br$
(Ignore state symbols, need to show carbon carbon double bond)

Note: Candidates have to show the correct process sequence, i.e. fractional distillation, cracking, fractional distillation and addition.

- Communication mark 1
(Chemical knowledge = 0 to 3, communication mark = 0.
Chemical knowledge = 4 to 5, communication mark = 0 or 1.
Incomplete answer or difficult to understand, communication mark = 0.)