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. $Al(OH)_3$

Provided by dse.life

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.

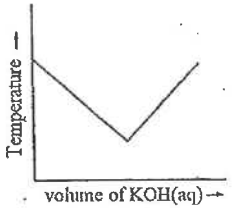
CE90_46

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.



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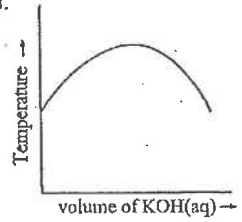

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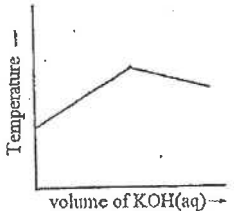

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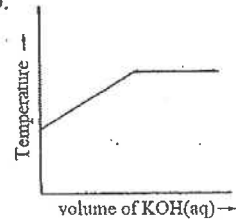


CE91_16

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

Provided by dse.life

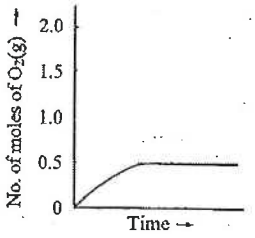
CE91_28

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.



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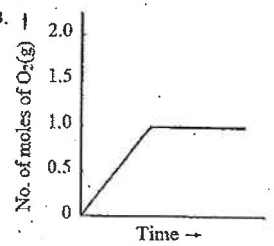
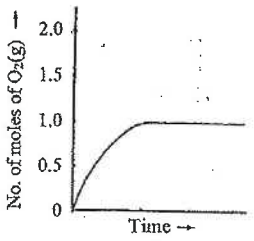
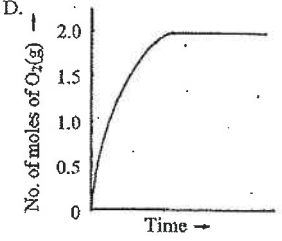


C.



D.



CE91_47

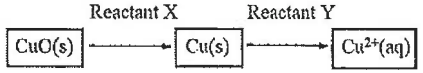
1st statement	2nd statement
Distilled water is a poor conductor of electricity.	Distilled water contains an equal number of $H^+(aq)$ ions and $OH^-(aq)$ ions.

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.

Provided by dse.life

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

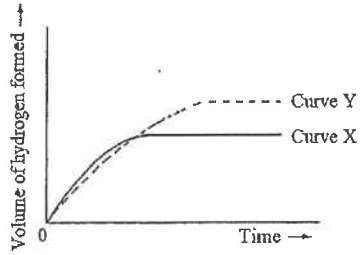
The following experiment results were obtained when 2 M HCl was allowed to react separately with 2 M NaOH and 2 M KOH:

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

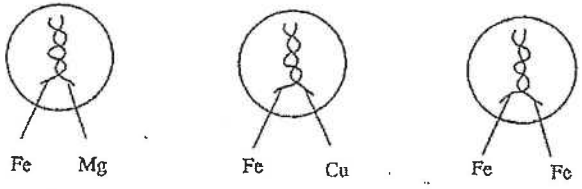
The following substances were burnt in oxygen and the products were mixed with water. Which of these substances would produce a resulting solution with the highest pH value?

A. calcium
B. iron
C. sulphur
D. carbon

Provided by dse.life

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.

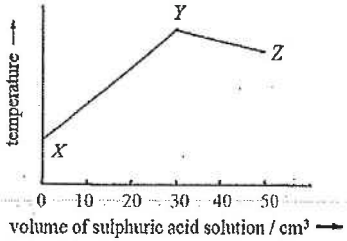
CE93_27

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

Provided by dse.life

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.

$$2FeSO_4 \cdot 7H_2O(x) \longrightarrow Fe_2O_3(y) + SO_3(z) + SO_2(g) + 14H_2O(l)$$

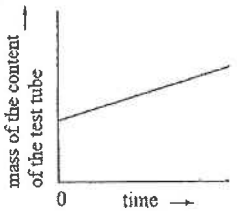
Which of the following combinations is correct?

	x	y	z
A.	aq	s	g
B.	aq	s	l
C.	s	aq	s
D.	s	s	g

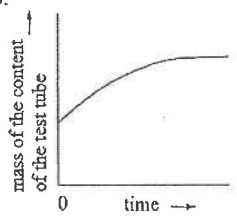
CE95_27

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?

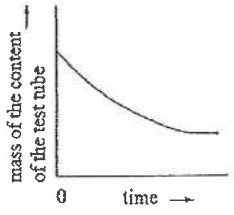
A.



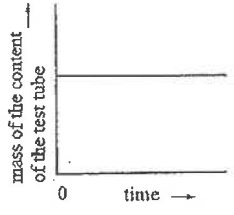
B.



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

Provided by dse.life

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?

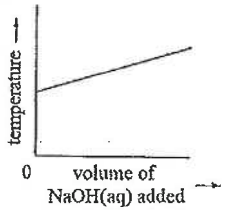
A. ammonium nitrate
B. calcium hydroxide
C. citric acid
D. potassium hydroxide

CE96_10

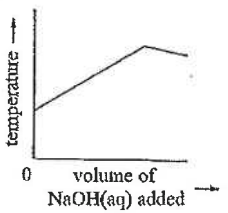
A student added 16 cm^3 of 2M sodium hydroxide solution, in 2 cm^3 portions, to 10 cm^3 of 2M nitric acid. He measured the temperature of the mixture immediately after each addition of the sodium hydroxide solution.

Which of the following graphs represents the relationship between the temperature of the mixture and the volume of sodium hydroxide solution added?

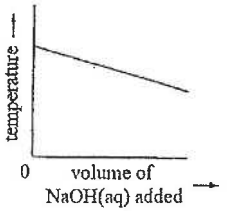
A.



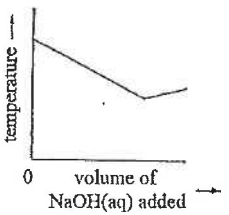
B.



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

Provided by dse.life

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

Provided by dse.life

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

Provided by dse.life

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

Provided by dse.life

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

Provided by dse.life

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

Provided by dse.life

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. $w = x < y = z$

Provided by dse.life

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

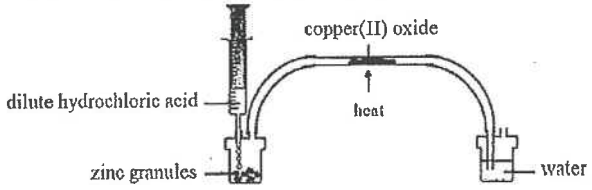
CE09_14

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

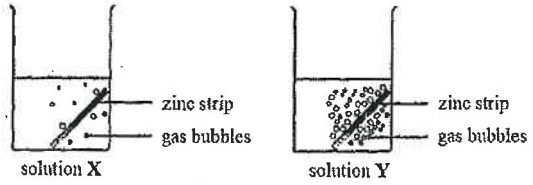
What is the concentration of acid A in solution X?

A. 0.2 M
B. 0.16 M
C. 0.01 M
D. 0.008 M

Provided by dse.life

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)

Provided by dse.life

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

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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. $CaO(s)$

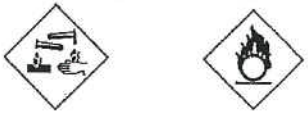
ASL12(I)_03

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)

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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?

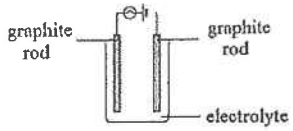
(1) formation of a dirty green precipitate
(2) formation of a brown precipitate
(3) evolution of a gas with a pungent odor

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)

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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

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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

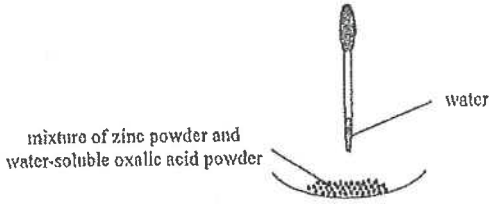
DSE16_06

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

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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

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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

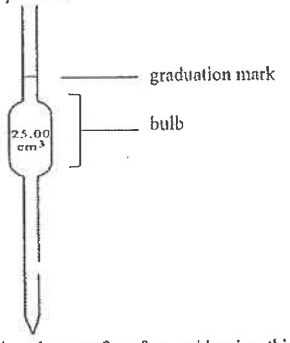
Which of the following chemicals can be used to distinguish concentrated hydrochloric acid from concentrated nitric acid?

(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

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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.

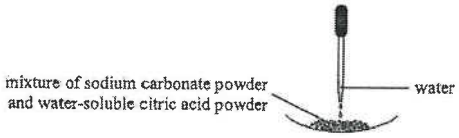
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3) only

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

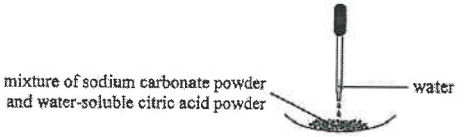
11. A reaction occurs when water is dropped into the mixture in the set-up below. A colourless gas is given out.



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.

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.

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. $Na_2CO_3(aq)$

Provided by dse.life

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 :

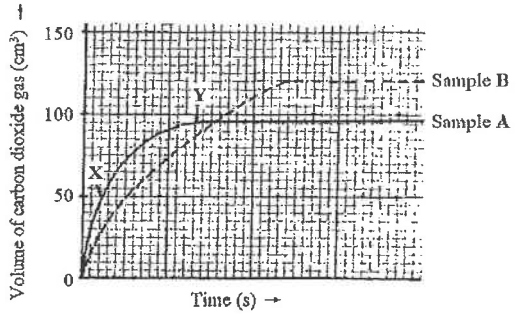
1st statement	2nd statement
Iron(II) hydroxide is a base.	Iron(II) hydroxide is insoluble in water.

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)

Provided by dse.life

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.)

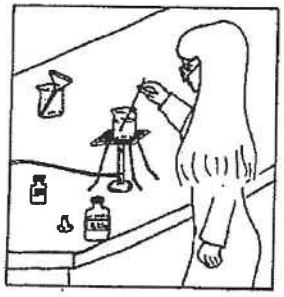
(v) Calculate the molarity of ethanoic acid in Brand B.

(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?

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(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.

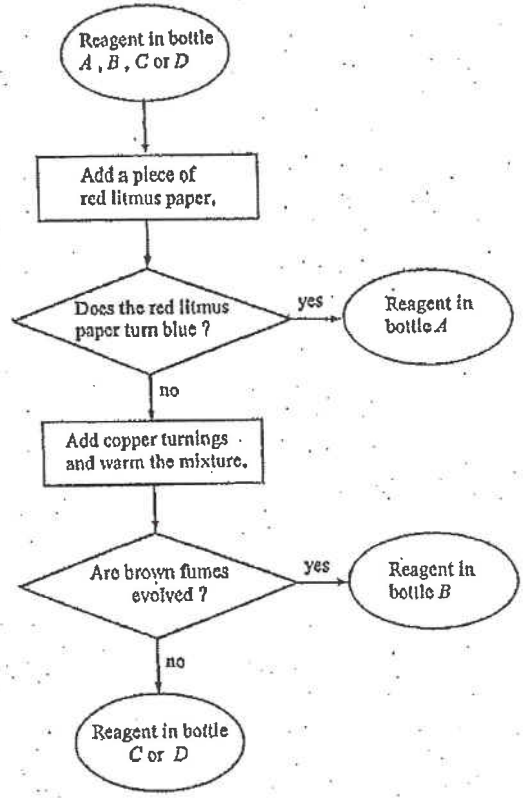
(5 marks)

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)

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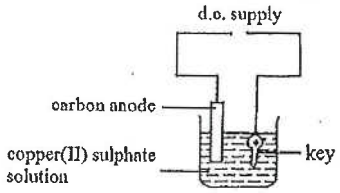
CE96_09b

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)

Provided by dse.life

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.

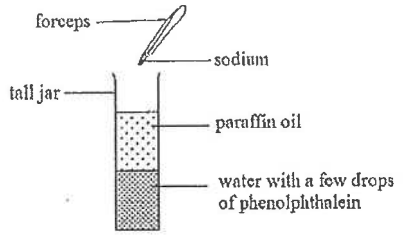
(b) Adding sodium hydroxide solution to iron(II) sulphate solution.

(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)

Provided by dse.life

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)

Provided by dse.life

CE05_10

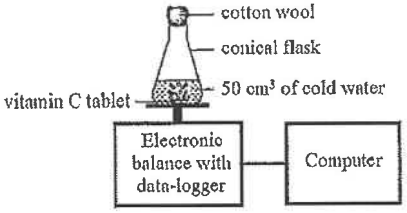
The information below was found on the label of a brand of effervescent vitamin C tablets:

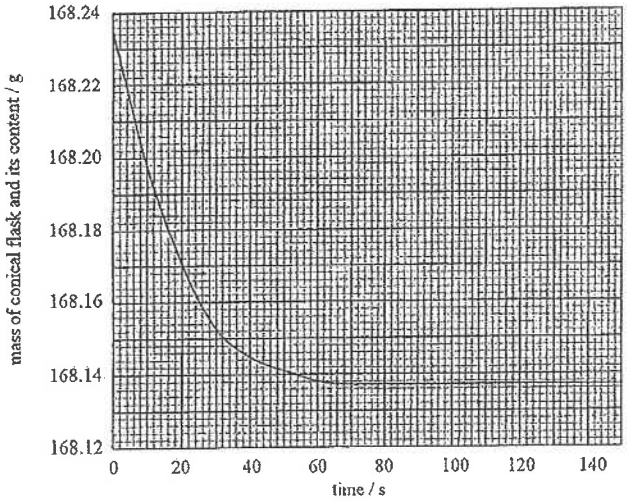
Each tablet contains 1000 mg of vitamin C. Other ingredients: sodium hydrogencarbonate, citric acid, sugar and colourant

(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.

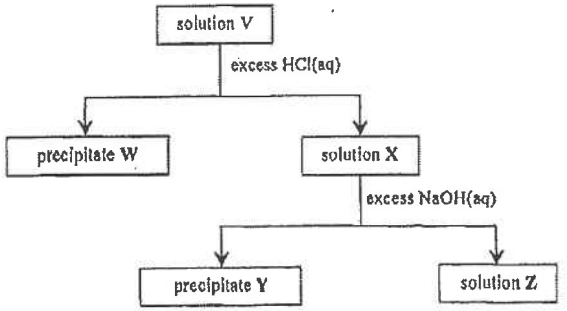
(6 marks)

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)

Provided by dse.life

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?

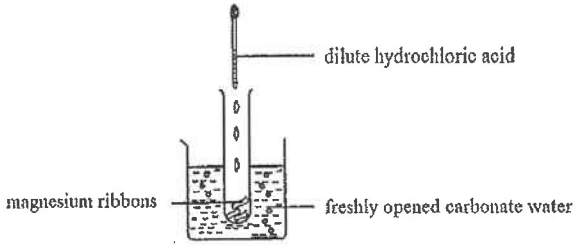
(ii) Comment whether it is appropriate to prepare a standard solution of sodium hydroxide by the following procedure:
'Weigh a sample of solid sodium hydroxide, dissolve it some distilled water and make up to a known volume of solution.'

(2 marks)

Provided by dse.life

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)

Provided by dse.life

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.

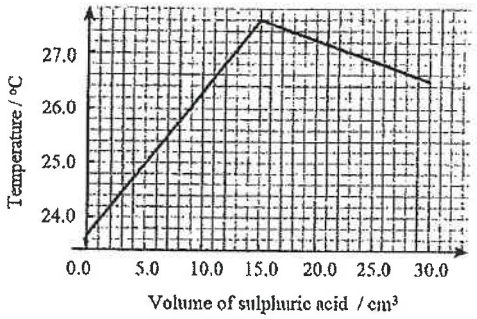
(1 mark)

(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)

Provided by dse.life

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.

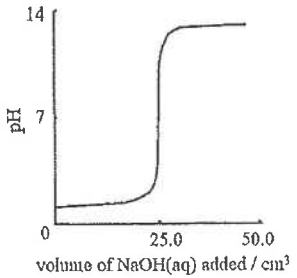
(1 mark)

(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)

Provided by dse.life

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)

Provided by dse.life

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)

Provided by dse.life

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)

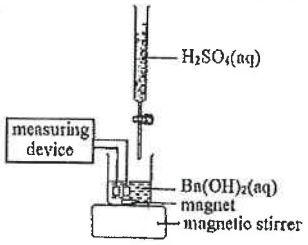
(c) Assuming that the experimental error is negligible, suggest ONE reason why the relative atomic mass of magnesium calculated in (b) is different from that found in the Periodic Table.

(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

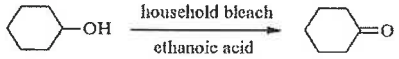
State the expected observation(s) in each of the following experiments, and write the chemical equation(s) of the reaction(s) involved.

(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)

Provided by dse.life

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)

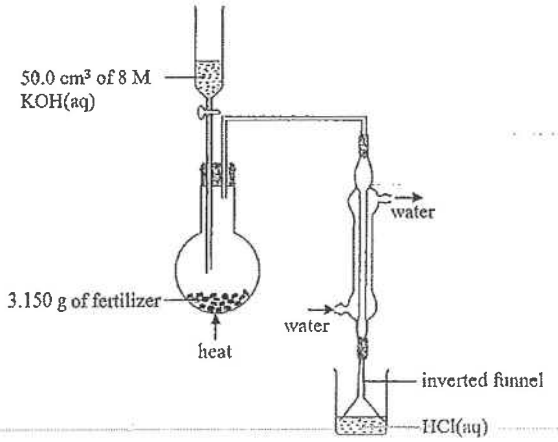
DSE12_06

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:



Provided by dse.life

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)

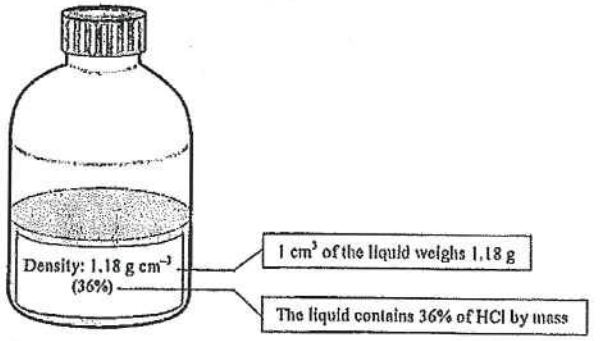
(b) Comment on the following statement:

'*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)

Provided by dse.life

(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

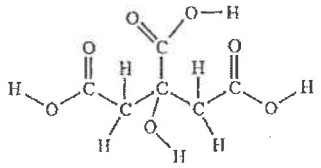
Explain, with the aid of a chemical equation, why $NH_3(aq)$ is regarded as a weak alkali. Suggest how you would show that $NH_3(g)$ is a weaker alkali than NaOH(aq) through an experiment.

(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)

Provided by dse.life

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]

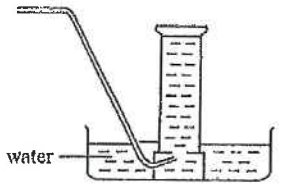
Barium (Ba) is an element in Group II of the Periodic Table. Its chemical properties are similar to those of calcium.

(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:

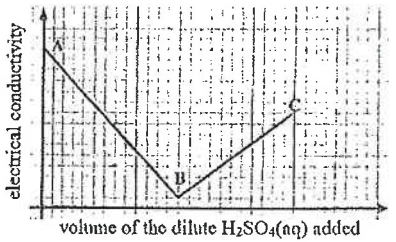
(1 mark)

(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.

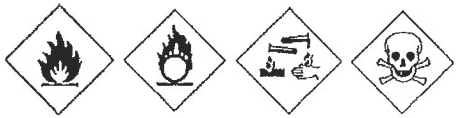
(c) A city stipulates that the concentration of lead ions in drinking water should not exceed 1.0×10^{-8} g cm^{-3}. Express this concentration in mol dm^{-3}.
(Relative atomic mass : Pb = 207.2)

(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)

Provided by dse.life

(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)

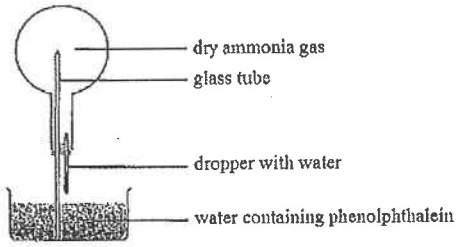
DSE18_02

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)

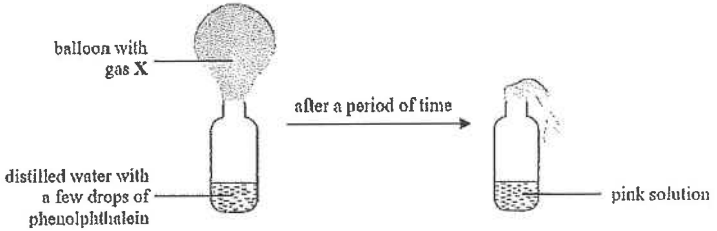
DSE18_08

(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)

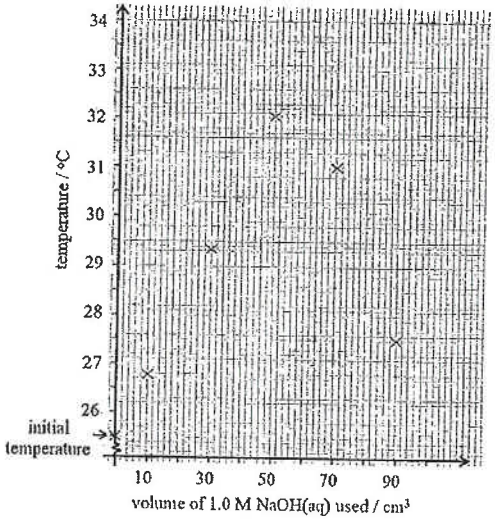
Provided by dse.life

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.

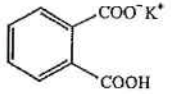
(1 mark)

(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:

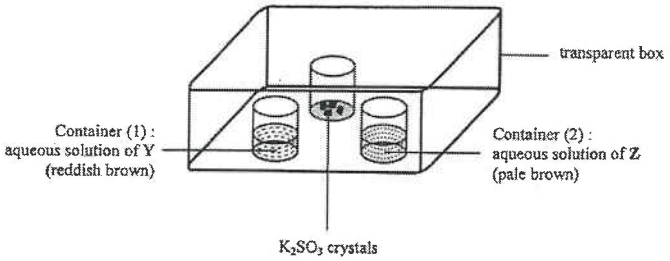
iron powder zinc powder aqueous ammonia distilled water

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.

Provided by dse.life

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)

Provided by dse.life

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)

Provided by dse.life

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.

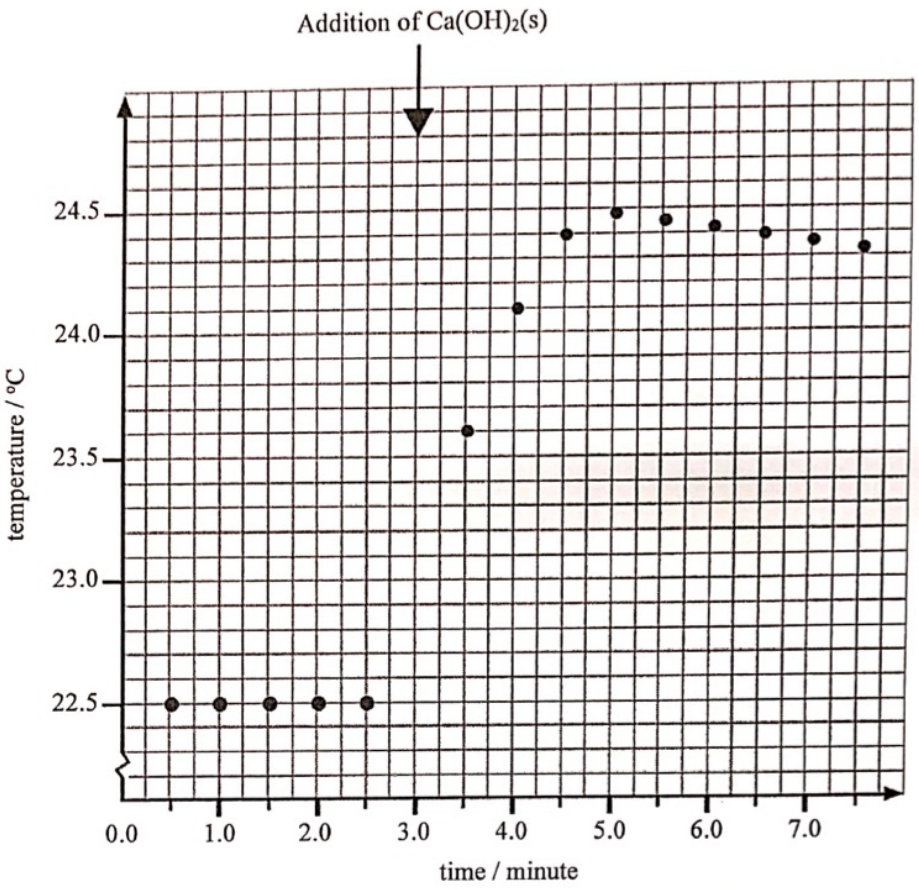
(ii) Suggest an instrument to measure the pH of the solution accurately.

(3 marks)

(d) State one advantage of taking antacids containing $Mg(OH)_2(s)$ over those containing $NaHCO_3(s)$.

Provided by dse.life

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.

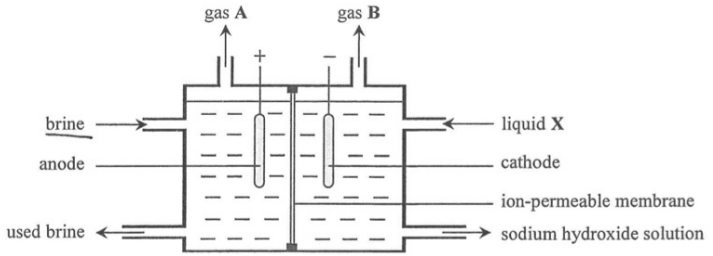
(2 marks)

(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)

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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

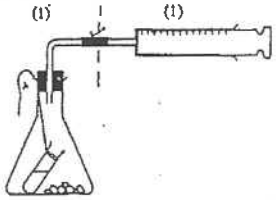
DSE2020:

4_A 11_D 16_C 17_B 18_A

Provided by dse.life

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]

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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

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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]

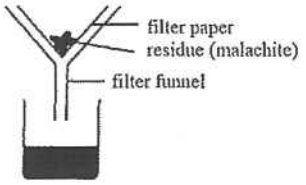
(b) pH : 1M sulphuric acid < 1M hydrochloric acid < 1M ethanoic acid [1]
Ethanoic acid is a weak acid, it undergoes incomplete ionization. It has the highest pH. [1]
Both hydrochloric acid and sulphuric acid are strong acids. It undergoes complete ionization. It has lower pH than ethanoic acid. [1]
Sulphuric 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]

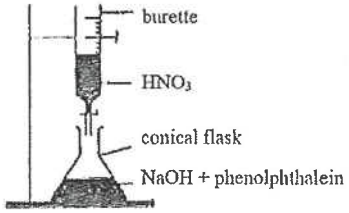


(iv) [1]
mole of H_2SO_4 used $= 2 \times \frac{50}{1000} = 0.1$
Since $CuCO_3$ is in excess,
mole of $CuSO_4 \cdot 5H_2O$ = mole of H_2SO_4 used = 0.1 [1]
Theoretical mass of $CuSO_4 \cdot 5H_2O = 0.1 \times 249.6 = 24.96$ g
Formula mass of $CuSO_4 \cdot 5H_2O = 63.5 + 32.1 + 16\times4 + 5(1.0\times2 + 16.0) = 249.6$ [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]

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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.

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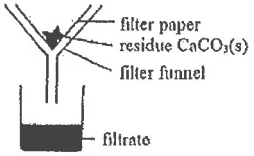
(ii) Diagram: [2]



(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]

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(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]

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(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]

Provided by dse.life

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]

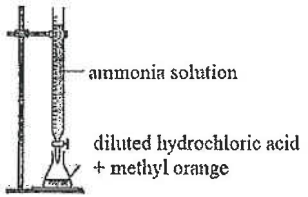
The salt should be sodium sulphate. [1]

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]

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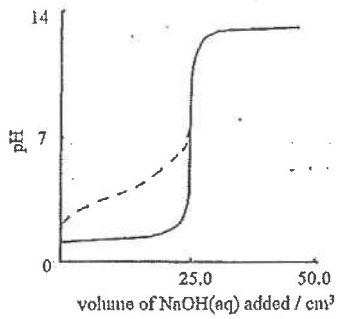
AL99(I)_04

(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]

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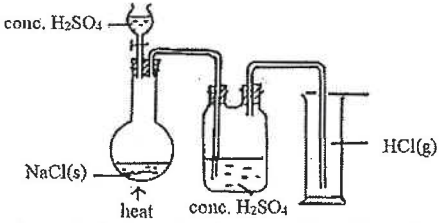
AL01(I)_07

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)

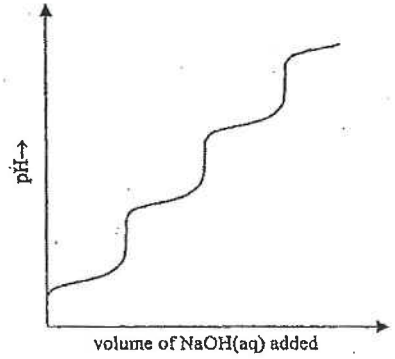
(a) $H_3PO_4(aq) \rightleftharpoons H_2PO_4^-(aq) + H^+(aq)$ [1]

$H_2PO_4^-(aq) \rightleftharpoons HPO_4^{2-}(aq) + H^+(aq)$ [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.

Provided by dse.life

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]

Provided by dse.life

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

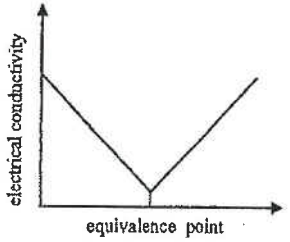
Relative atomic mass = $0.420 \div 0.0161 = 26.05$ [1]

(c) Some of the Mg has been oxidized to MgO [1]

ASL10(I)_09

(a) Electrical conductivity / pH [1]

(b)

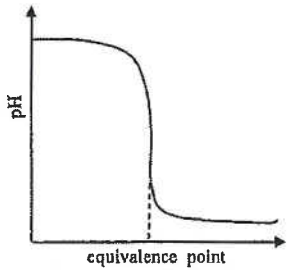


[1]

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.]

Provided by dse.life

(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]

Provided by dse.life

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]

Provided by dse.life

(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)

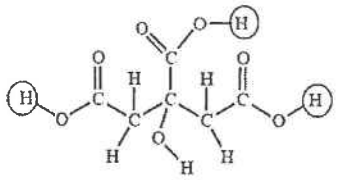
enthalpy change of neutralization – same amount / known amount of NH_3(aq) and NaOH(aq) [1]

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]

Provided by dse.life

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}

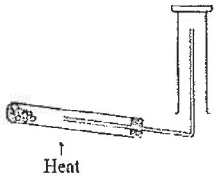
DSE18_02

(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]

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(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]

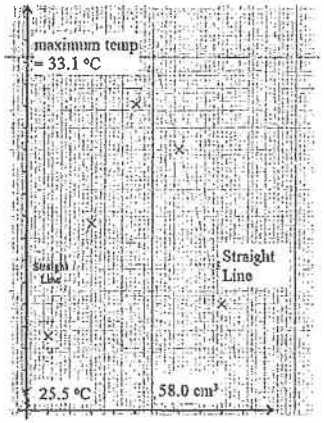
(State symbols not required) (Ignore incorrect state symbols) (Accept single arrow)

$OH^-(aq)$ 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.

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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

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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)

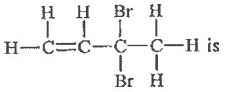
A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

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

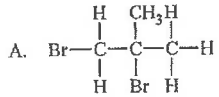
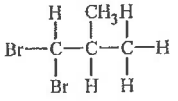
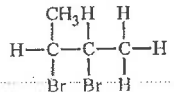
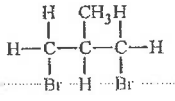
Equal moles of chlorine and methane are allowed to react in diffused sunlight. Which of the following statements concerning the reaction is/are correct?

(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. 

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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.

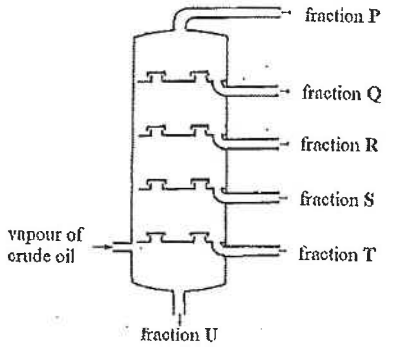
CE94_21

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

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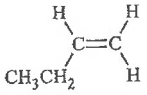
CE94_41

A compound has the following structure:



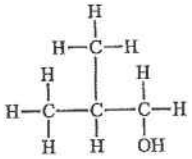
Which of the following statements about this compound are correct?

(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

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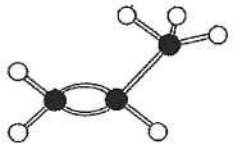
CE97_18

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.

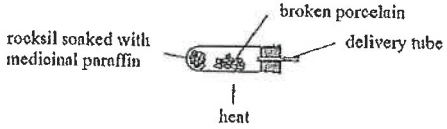
CE97_19

Which of the following compounds CANNOT be produced directly from ethene?

A. carbon dioxide
B. ethanol
C. ethyl ethanoate
D. 1,2-dibromoethane

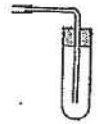
CE97_23

Direction: Q.23 and Q.24 refer to the following experiment:

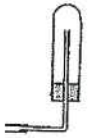


Which of the following set-ups should be connected to the delivery tube to collect the gaseous products formed?

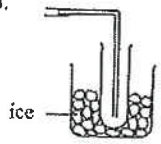
A.



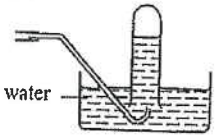
C.



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

Provided by dse.life

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.

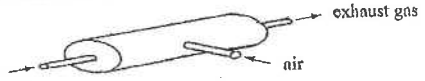
Test
(1) Treating X with sodium hydrogencarbonate solution.
(2) Treating X with a solution of bromine in 1,1,1-trichloroethane
(3) Heating X with acidified potassium dichromate solution.

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

Provided by dse.life

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

Provided by dse.life

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

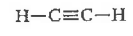
(3) the treatment of car exhaust in a catalytic converter

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.

Provided by dse.life

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	$C_nH_{2n+1}CO_2H$

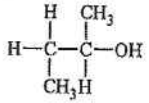
CE03_10

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

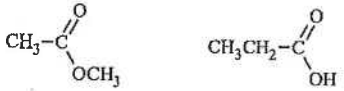
Which of the following statements concerning the manufacture of town gas in Hong Kong is/are correct?

(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

Provided by dse.life

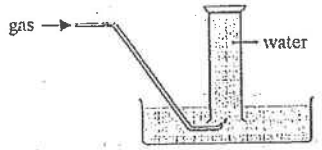
CE04_28

Ethene can be prepared by heating ethanol with excess concentrated sulphuric acid. The reaction involved can be represented by the equation:

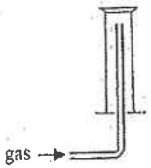
$$CH_3CH_2OH \xrightarrow{\text{conc. } H_2SO_4} CH_2{=}CH_2 + H_2O$$

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)

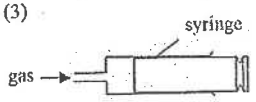
(1)



(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

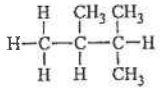
1st statement	2nd statement
Both but-1-ene and but-2-ene can decolourize a solution of bromine in 1,1,1-trichloroethane.	Both but-1-ene and but-2-ene have the same molecular formula.

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. $C_2H_6O_2$

Provided by dse.life

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

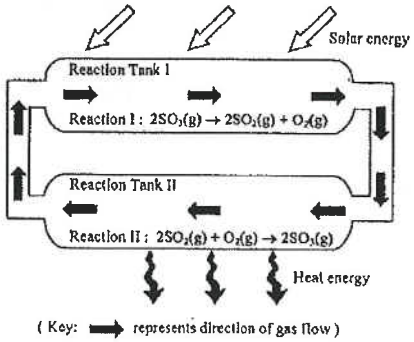
Which of the following statements concerning the system are correct?

(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.

Provided by dse.life

CE06_12

Consider the following information:

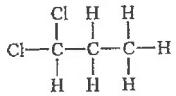
Compound	Relative molecular mass
CH_3CH_2OH	46
$CH_3CH_2OCH_3$	60
$CH_3CH_2CO_2CH_3$	88
$C_6H_{12}O_6$	180

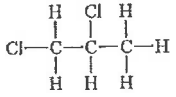
When 1 g of each of these compounds undergoes complete combustion, which one will produce the greatest number of moles of carbon dioxide?

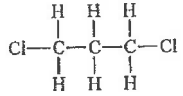
A. CH_3CH_2OH
B. $CH_3CH_2OCH_3$
C. $CH_3CH_2CO_2CH_3$
D. $C_6H_{12}O_6$

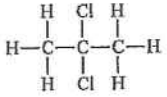
CE06_16

Which of the following compounds is formed from the reaction of propene with chlorine?

A. 

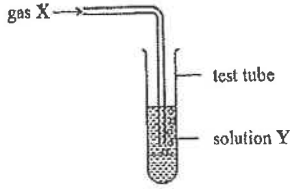
B. 

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)

Provided by dse.life

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

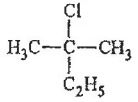
CE07_04

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)

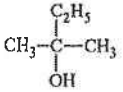
A. 50 cm^3
B. 75 cm^3
C. 100 cm^3
D. 150 cm^3

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

Provided by dse.life

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.

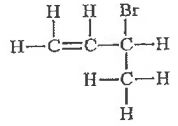
CE09_03

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?

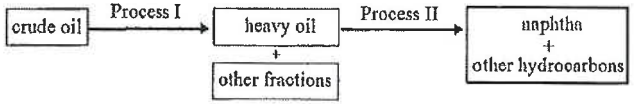
(1) using liquefied petroleum gas as fuel for motor vehicles
(2) installing catalytic converter for motor vehicles
(3) installing electrostatic precipitators for motor vehicles

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

Provided by dse.life

CE10_02

Consider the industrial processes as shown below:

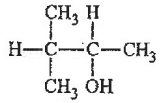


Which of the following combinations is correct?

	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)

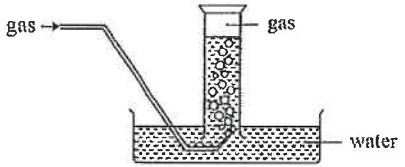
CE10_29

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

Provided by dse.life

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

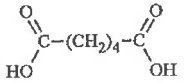
CE91_27

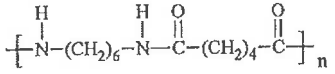
A sample of polymer gives acid fumes on strong heating. The polymer is probably

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

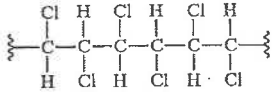
Which of the following polymers is/are NOT suitable for making a container for boiling water?

(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.

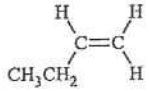
CE94_20

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?

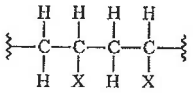
(1) It can decolourize bromine water.
(2) It can be polymerized.
(3) It can burn in air.

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

Provided by dse.life

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

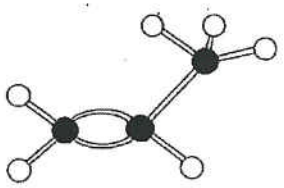
CE96_05

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.

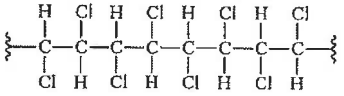
CE99_28

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:



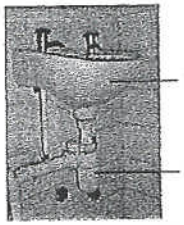
Which of the following statements concerning X are correct?

(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)

Provided by dse.life

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

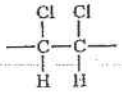
Which of the following compounds is a monomer of polyvinyl chloride (polychloroethene)?

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

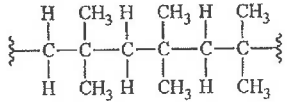
1st statement	2nd statement
Polyethene is used for making the handle of frying pans.	The shape of the polyethene handle remains unchanged during the frying process.

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

Provided by dse.life

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

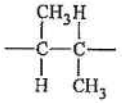
Which of the following items can be made from polystyrene?

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.

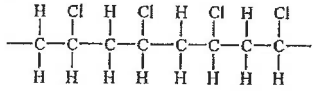
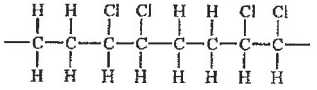
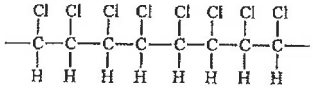
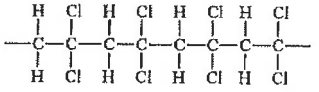
(2) It can form a polymer with  as the repeating unit.

(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.

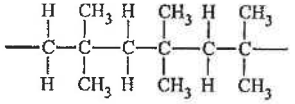
DSE11SP_01

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

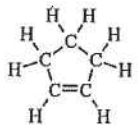
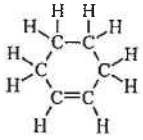
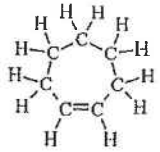
DSE11SP_09

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}

Provided by dse.life

DSE12PP_11

The equation below represents the cracking of a hydrocarbon:

$$C_{22}H_{46} \longrightarrow C_{14}H_{30} + 2X$$

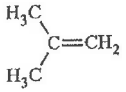
What is the chemical formula of compound X?

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=$CHCH_2OH$

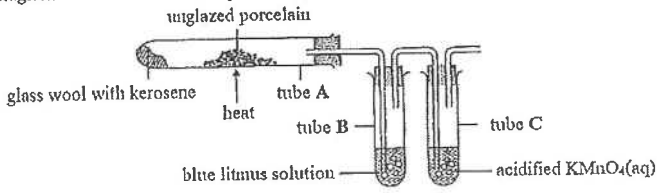
The systemic name of X is

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.

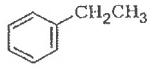
(3) There is NO color change in the solution in tube C.

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)

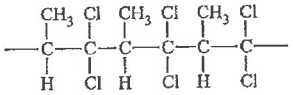
DSE12_24

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?

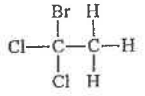


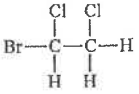
A. 1,1-dicloro-2-methylethene B. 1,1-dichloropropene

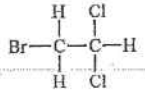
C. 1,2-dichloropropene D. 3,3-dichloropropene

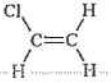
DSE14_08

Which of the following compounds would be formed when bromoethene reacts with chlorine in a suitable organic solvent?

A. 

B. 

C. 

D. 

Provided by dse.life

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

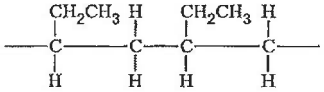
What are the advantages of using natural gas over using coal as a fuel in power stations?

(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

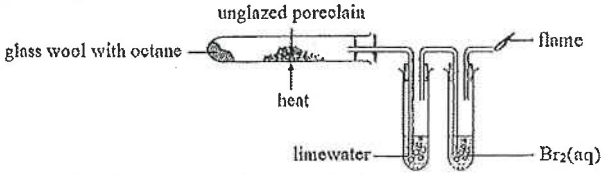
Which of the following are renewable energy sources?

(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

Provided by dse.life

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?

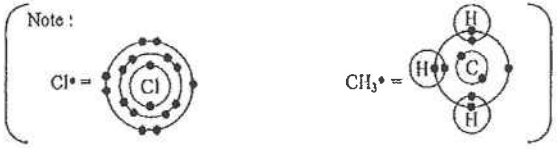
A. CH_2O
B. $C_2H_6O_2$
C. $C_4H_8O_2$
D. $C_4H_{10}O_2$

DSE18_13

The reaction below involves several steps.

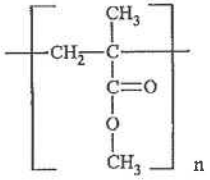
$$CH_4(g) + Cl_2(g) \xrightarrow{\text{sunlight}} CH_3Cl(g) + HCl(g)$$

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.

Provided by dse.life

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)

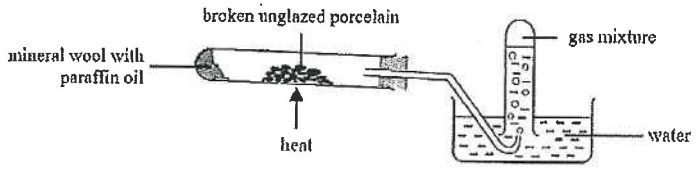
(2)

(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:

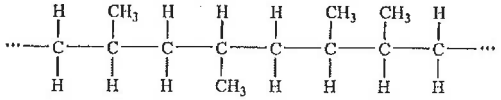


Which of the following statements is INCORRECT ?

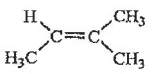
A. The broken unglazed porcelain acts as a catalyst.
B. Fractional distillation is performed in the set-up.
C. The gas mixture turns acidified potassium permanganate solution from purple to colorless.
D. When no more gas can be collected, the delivery tube should be taken out of the water before removing the heat source.

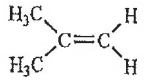
DSE19_10

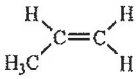
A part of the structure of a polymer is shown below :

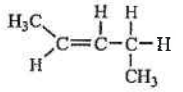


Which of the following can be a monomer of this polymer?

A. 

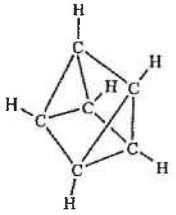
B. 

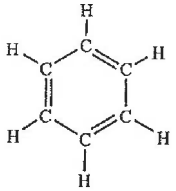
C. 

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

Provided by dse.life

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

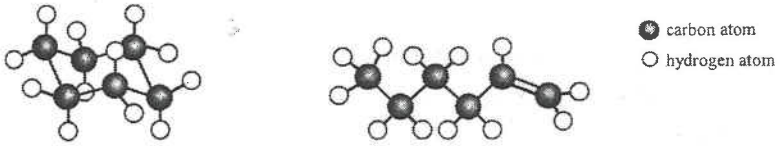
24. Consider the following statements and choose the best answer :

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. $CH_4 + Cl_2 \rightarrow CH_3Cl + H\bullet + Cl\bullet$

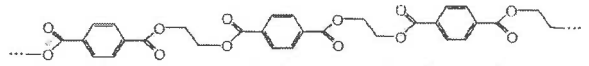
DSE21_17

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

Provided by dse.life

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.

Provided by dse.life

(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)

Provided by dse.life

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

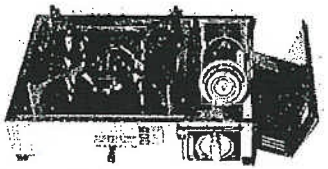
In March 1989, the oil tanker *Exxon Valdez* was wrecked off the coast of Alaska and split a large amount of crude oil into the sea. The oil spillage caused serious environmental problems.

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)

Provided by dse.life

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.

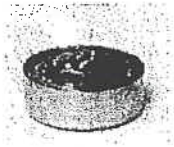
(2) State the importance of the greenhouse gases in the atmosphere to living things on earth.

(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)

Provided by dse.life

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.

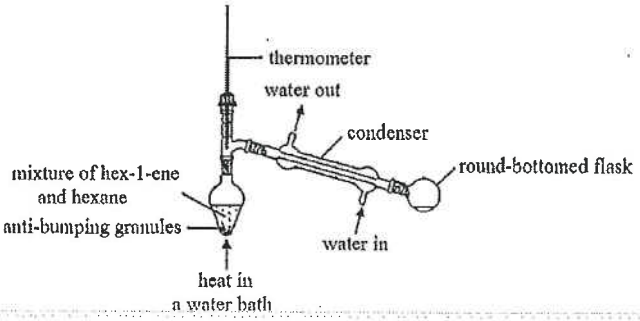
(2 marks)

(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.)



Provided by dse.life

(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)

Provided by dse.life

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.

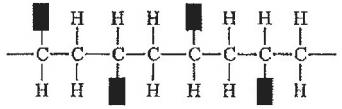
(ii) The foam lunch box is made from a plastic containing a trapped gas. Name the plastic that is commonly used and state the purpose of trapping a gas within the plastic.

(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:

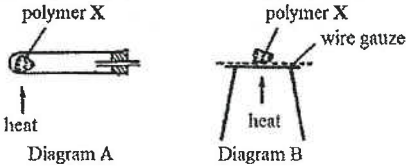


Diagram A | Diagram B

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.

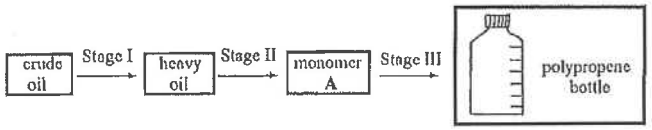
(2) Name ONE plastic material suitable for making the bottle for the toilet cleaner.

(2 marks)

Provided by dse.life

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.

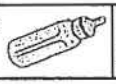
(1) What preliminary treatment of the polypropene wastes is required before recycling?

(2) Name ONE plastic which cannot be recycled by melting and remoulding.

(9 marks)

CE97_01

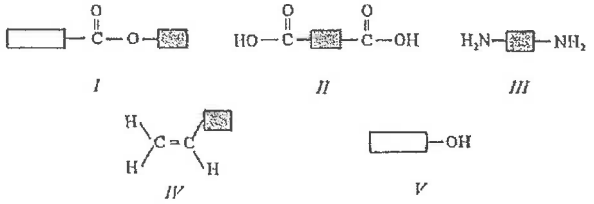
For each of the tasks listed in the table below, decide which substance on the right is the best to use to accomplish the task. Explain your answer in each case.

(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)

Provided by dse.life

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.

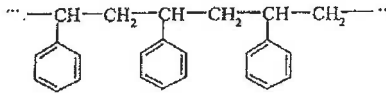
(iv) (1) Suggest another method which is commonly used for treating plastic wastes.

(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:

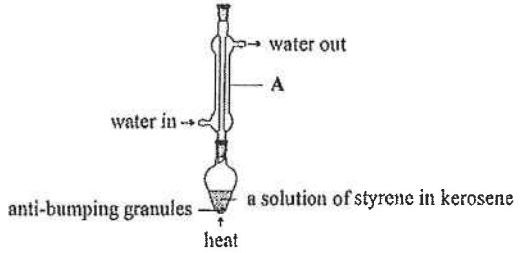


(i) Draw the structure of styrene, the monomer of polystyrene.

(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)

Provided by dse.life

(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.

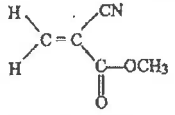
Repeating Unit:

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.

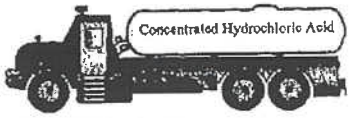
(1 mark)

(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)

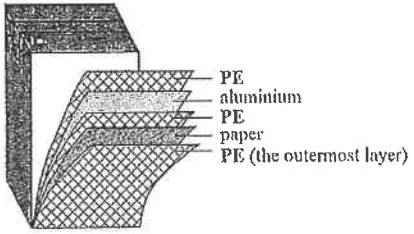
CE10_12f

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)

Provided by dse.life

(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)

Provided by dse.life

(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)

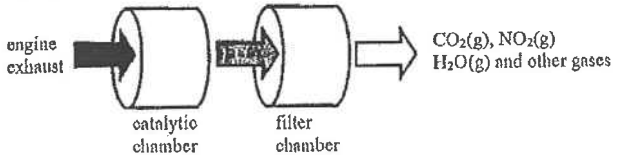
(b) Apart from CH_3Cl, what other organic products will be formed when CH_4 reacts with Cl_2?

(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.

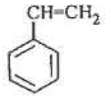
(i) Explain, in terms of intermolecular forces, why PVC is rigid.

(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)

Provided by dse.life

(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

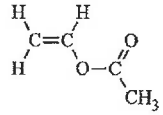
(b) (i) With reference to the properties of the materials involved, explain why

(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)

Provided by dse.life

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)

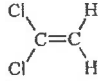
DSE14_03 [Similar to DSE11SP_02]

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)

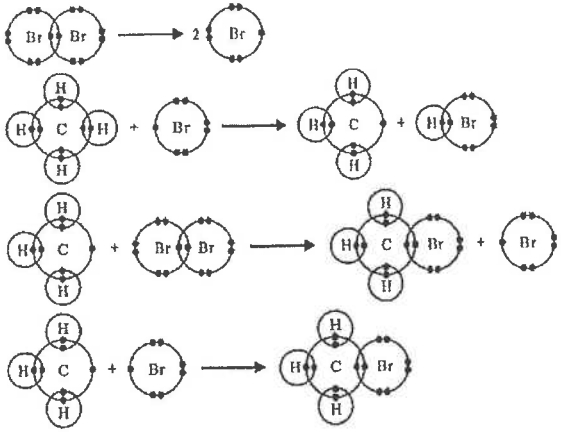
(b) Motor cars powered by petrol emit air pollutants such as nitrogen monoxide and carbon monoxide. Installing a certain device in motor cars can convert these two oxides to less harmful substances.

(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)

Provided by dse.life

(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	

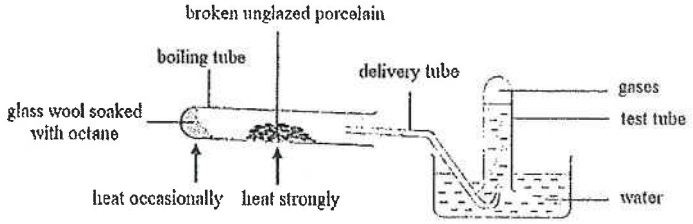
(2 marks)

(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)

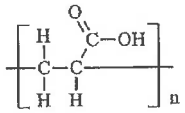
(d) When no more gas can be collected, what should be done to end the experiment for safety consideration? Explain your answer.

(2 marks)

Provided by dse.life

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)

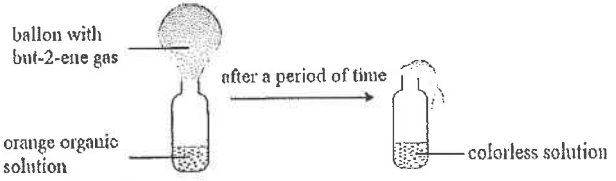
DSE18_09

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)

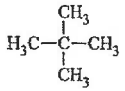
(ii) With the help of a chemical equation, explain the color change in the solution.

(2 marks)

Provided by dse.life

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.

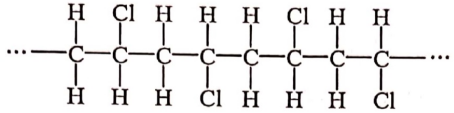
(c) **X** can form a polymer **Z**.

(i) Suggest why **X** can form a polymer.

(ii) Draw the repeating unit of **Z**.

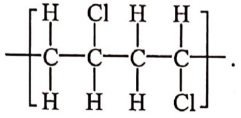
Provided by dse.life

8. The structure of a portion of a polymer is shown below :



Which of the following statements concerning the polymer is correct ?

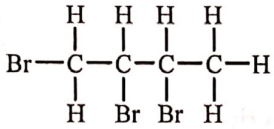
A. It can be used as a substitute for glass.

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 :

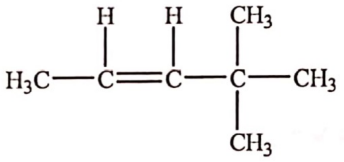


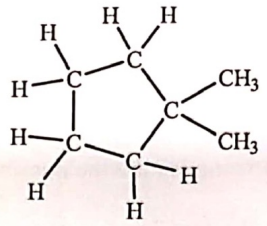
Which of the following is / are the possible structure(s) of **X** ?

(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 :



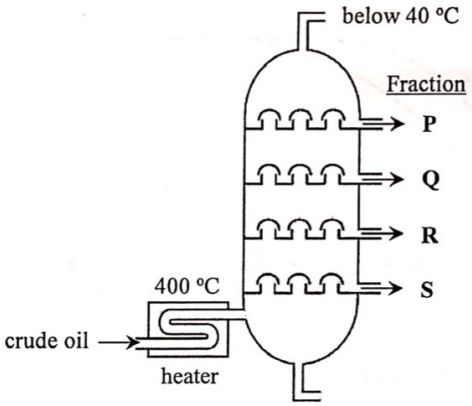


Which of the following statements is / are correct ?

(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)

Provided by dse.life

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 :

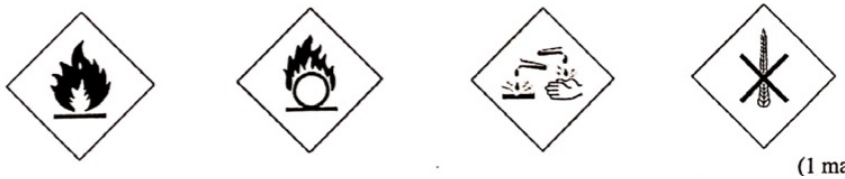
[ ] + [ ] $\rightarrow CH_3Cl$

(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)

Provided by dse.life

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

Provided by dse.life

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]

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(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.

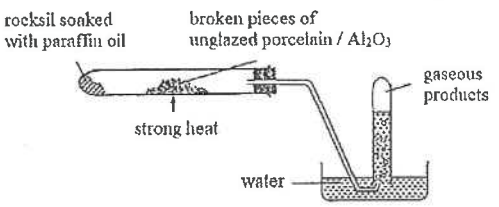
(iii) (1) (II) To increase efficiency of fuel combustion. [1]

(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

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- 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 $C_4H_{10} : CO_2 = 1 : 4$

Provided by dse.life

mole of $CO_2 = 4.31 \times 4 = 17.24$ [1]

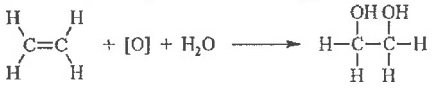
volume of CO_2 produced $= 17.24 \times 24 = 413.8\ dm^3$ [1]

(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

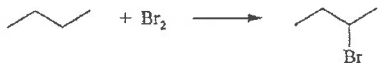
(a) potassium permanganate solution changes from purple to colourless. [1]



[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

Provided by dse.life

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]

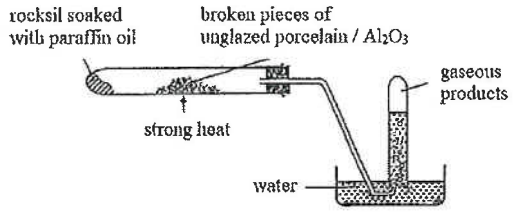
CE03_07b

(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]

Provided by dse.life

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]

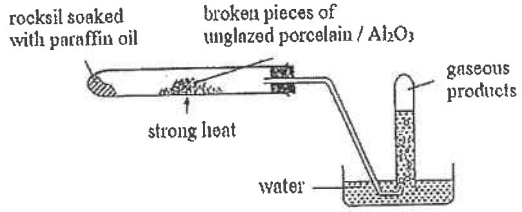
(iii) (I) Any ONE of the following: [1]

- 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]

Provided by dse.life

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.

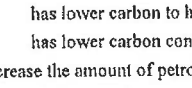
(ii) Nitrogen gas (N_2) or water (H_2O) or carbon dioxide (CO_2) [1]

(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]

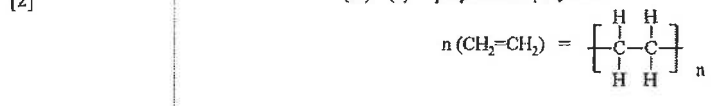
(2) household articles:
bowls / buckets / cups [1]

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]

Provided by dse.life

(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]

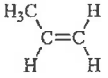
CE95_06a(iv)

(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.

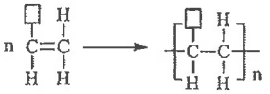
(v) (1) Separating polypropene from other plastic wastes [1]
OR, cleaning the polypropene wastes
(2) Urea-methanal [1]

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]

Provided by dse.life

(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.

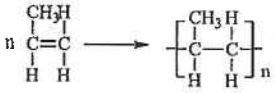
(iii) General formula of alkene is C_nH_{2n}

$12n + 2n = 42$ [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]

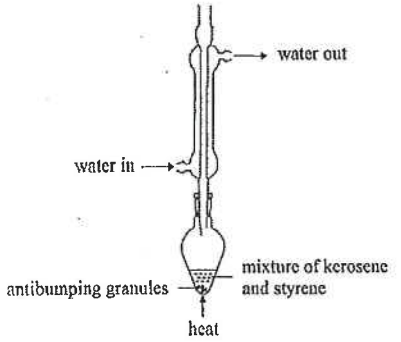
Disadvantage:

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]



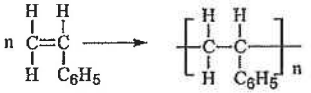
(ii) **Add anti-bumping granules to prevent bumping and ensure smooth heating.** [2]

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]

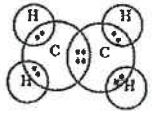
- landfilling causes less air pollution problems

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]

Provided by dse.life

(iv) any one of answer:

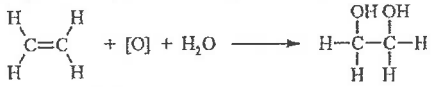
	Answer 1	Answer 2	Answer 3	
(1)	incineration	landfilling	recycling	[1]
(2) Advantage	can reduce the volume of solid waste *OR,* converts plastic wastes into energy	does not cause much air pollution *OR,* produces methane which is a fuel	saves petroleum which is a non-renewable energy source *OR,* reduces 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

Provided by dse.life

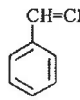
OR, Advantage of landfilling (any one)

- 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]

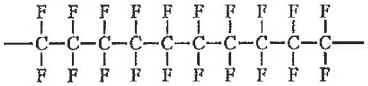
In thermosetting plastics, there are cross-links between the polymer molecules. There is little motion between the chains. [1]

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]

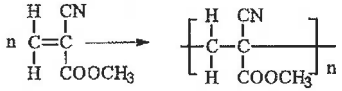
(ii) Repeating unit:

 [1]

Monomer: $CF_2{=}CF_2$ / tetrafluroethene [1]

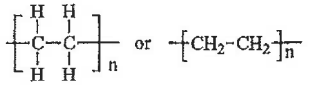
CE08_08

(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]

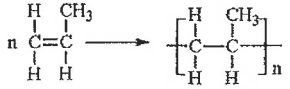
It can prevent acid from reacting with the steel storage tank. [1]

(c) mass of HCl = $57000000 \times 38\% = 21660000$ g

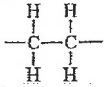
mole of HCl = $\dfrac{21660000}{1+35.5} = 593424.7 = 593400$ [1]

$[HCl] = \dfrac{593400}{50000} = 11.87$ 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]

Provided by dse.life

(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

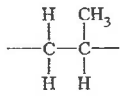
AL99(I)_06b

(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

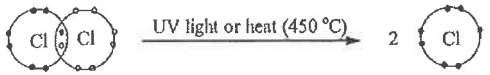
(a)  [1]

(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]

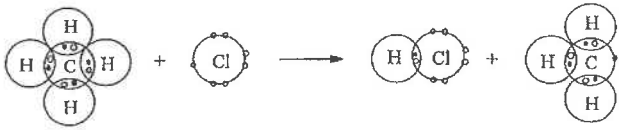
ASL99(II)_09 (modified)

(a) Chain initiation



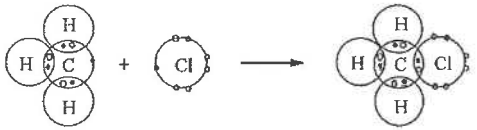
[1]

Chain propagation



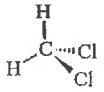
[1]

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]

Provided by dse.life

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]

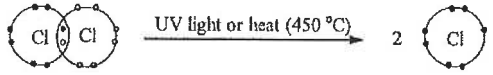
(b) (i) A catalyst can speed up the reaction by providing an alternative pathway with lower activation energy. [1]
(ii) $6NO(g) + 4NH_3(g) \longrightarrow 5N_2(g) + 6H_2O(l)$ [1]

(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]

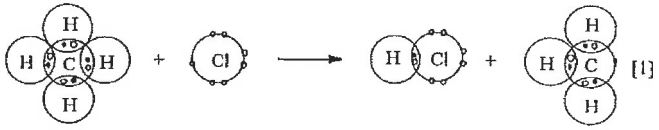
ASL03(II)_08 (modified)

(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



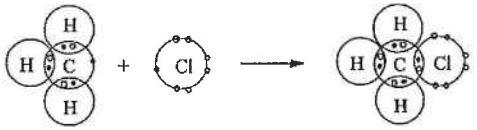
[1]

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

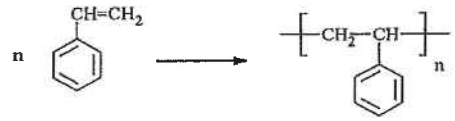
(iii) (I) Carbon [1]
(II) Nitrogen dioxide oxidizes C in PM to $CO_2(g)$ / gaseous products. [1]
$C(s) + NO_2(g) \longrightarrow CO_2(g) + NO(g)$ [1]
$C(s) + 2NO(g) \longrightarrow CO_2(g) + N_2(g)$

(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]

Provided by dse.life

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]

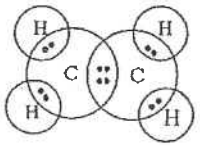
(b) Add Br_2/H_2O or Br_2/CCl_4 [1]

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 $H_2O(l)$.

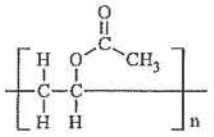
DSE12_02

(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]

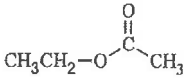
OR, This process can produce more small molecules / alkenes / ethene / petrol / hydrocarbons of lower molecular masses from large hydrocarbons.

(b)



[1]

(c) (i)



[1]

Provided by dse.life

(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)).

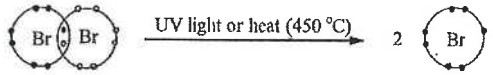
DSE12_10

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

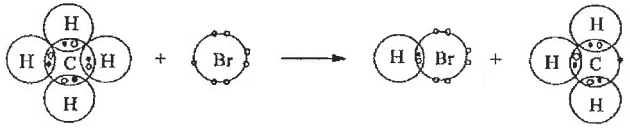
DSE12_15

Chain initiation



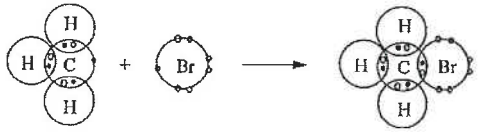
[1]

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.

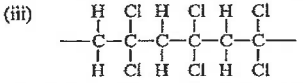
DSE14_03

(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.

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(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

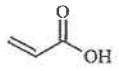
(b) The reaction will be faster when using broken unglazed porcelain instead of a large piece of unglazed porcelain due to larger surface area. [1]

(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]

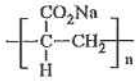
(d) **The delivery tube should be taken out of the water level before removing the heating source, otherwise sucking back will happen / the boiling tube will be cracked.** [1]

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.

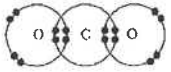
(d)  [1]

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]

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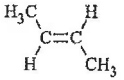
DSE18_04

(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)

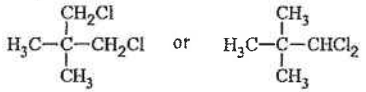
(ii) $CH_3CH=CHCH_3 + Br_2 \longrightarrow CH_3(CHBr)_2CH_3$ [1]
But-2-ene / an alkene reacts with Br_2, and Br_2 is decolorised / all Br_2 is consumed / a colourless product is formed. [1]

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.)

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