

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2021

CHEMISTRY PAPER 1

8:30 am – 11:00 am (2 hours 30 minutes)

This paper must be answered in English

GENERAL INSTRUCTIONS

1. There are **TWO** sections, A and B, in this Paper. You are advised to finish Section A in about 45 minutes.
2. Section A consists of multiple-choice questions in this question paper, while Section B contains conventional questions printed separately in Question-Answer Book B.
3. Answers to Section A should be marked on the Multiple-choice Answer Sheet while answers to Section B should be written in the spaces provided in Question-Answer Book B. **The Answer Sheet for Section A and the Question-Answer Book for Section B will be collected separately at the end of the examination.**
4. A Periodic Table is printed on page 20 of Question-Answer Book B. Atomic numbers and relative atomic masses of elements can be obtained from the Periodic Table.

INSTRUCTIONS FOR SECTION A (MULTIPLE-CHOICE QUESTIONS)

1. Read carefully the instructions on the Answer Sheet. After the announcement of the start of the examination, you should first stick a barcode label and insert the information required in the spaces provided. No extra time will be given for sticking on the barcode label after the 'Time is up' announcement.
2. When told to open this book, you should check that all the questions are there. Look for the words '**END OF SECTION A**' after the last question.
3. All questions carry equal marks.
4. **ANSWER ALL QUESTIONS.** You are advised to use an HB pencil to mark all the answers on the Answer Sheet, so that wrong marks can be completely erased with a clean rubber. You must mark the answers clearly; otherwise you will lose marks if the answers cannot be captured.
5. You should mark only **ONE** answer for each question. If you mark more than one answer, you will receive **NO MARKS** for that question.
6. No marks will be deducted for wrong answers.

This section consists of two parts. There are 24 questions in PART I and 12 questions in PART II.

Choose the best answer for each question.

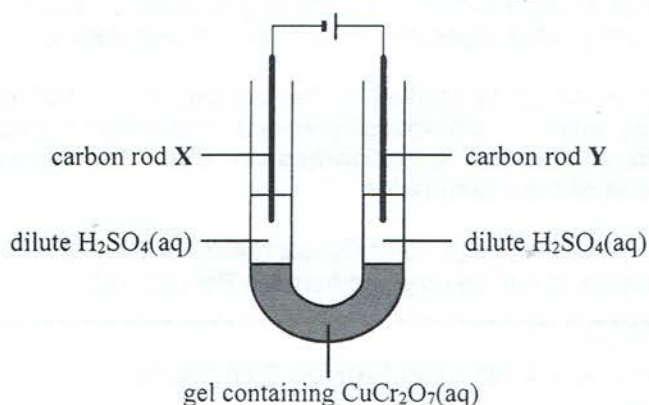
Candidates may refer to the Periodic Table printed on page 20 of Question-Answer Book B.

PART I

1. The melting point of a chemical species is $146\text{ }^{\circ}\text{C}$. It is soluble in water and the solution formed does not conduct electricity. Which of the following structures would this chemical species have ?

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

2. Consider the following experimental set-up :



Which of the following statements is correct when an electric current passes through the circuit ?

- A. Blue colour is observed in the dilute $\text{H}_2\text{SO}_4(\text{aq})$ around Y.
 - B. Gas bubbles are observed in the dilute $\text{H}_2\text{SO}_4(\text{aq})$ around Y.
 - C. Orange colour is observed in the dilute $\text{H}_2\text{SO}_4(\text{aq})$ around X.
 - D. Electrons flow from X to Y through the external circuit.
3. Which of the following statements is INCORRECT ?
- A. Cracking of heavy oil can give ethene.
 - B. Electrolysis of sea water can give chlorine.
 - C. Strong heating of limestone can give oxygen.
 - D. Fractional distillation of liquefied air can give nitrogen.
4. M, Q and R are three different metals. When their oxides are separately heated, only the oxide of M gives a metallic lustre. When their carbonates are separately heated with a Bunsen burner, only the carbonate of R gives no observable changes. Which of the following shows the increasing order of reactivity of the metals ?
- A. $\text{R} < \text{Q} < \text{M}$
 - B. $\text{R} < \text{M} < \text{Q}$
 - C. $\text{M} < \text{R} < \text{Q}$
 - D. $\text{M} < \text{Q} < \text{R}$

5. 15.0 cm³ of 0.20 M Ba(NO₃)₂(aq) is added to 25.0 cm³ of 0.10 M Na₂SO₄(aq). After the reaction is completed, which of the following ions has the highest concentration in the mixture ?
- SO₄²⁻(aq)
 - NO₃⁻(aq)
 - Ba²⁺(aq)
 - Na⁺(aq)

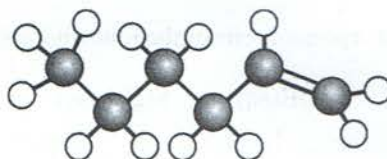
6. Refer to the information in the table below :

| Solution | Contents | pH |
|----------|--|-----|
| X | 50 cm ³ of 0.001M HCl(aq) | 3.0 |
| Y | 25 cm ³ of 0.001M H ₂ SO ₄ (aq) | 2.7 |
| Z | 50 cm ³ of 0.1M CH ₃ COOH(aq) | 2.9 |

Which of the following statements is correct ?

- X has a higher pH than Z because HCl is a stronger acid than CH₃COOH.
 - Y has a lower pH than X because the volume of H₂SO₄(aq) is smaller than that of HCl(aq).
 - Y has a lower pH than X because H₂SO₄ is a strong dibasic acid but HCl is a strong monobasic acid.
 - Y has a lower pH than Z because the concentration of H₂SO₄(aq) is lower than that of CH₃COOH(aq).
7. The oxidation number of Pb in Pb₁₀(VO₄)₆F₂ is +2. What is the oxidation number of V ?
- 3
 - +2
 - +4
 - +5

8. Consider two compounds with their structures shown below :



● carbon atom
○ hydrogen atom

Which of the following statements is correct ?

- Both of them are flammable.
- They have different empirical formulae.
- They belong to the same homologous series.
- Both of them can decolourise bromine solution in the dark.

9. Gases discharged from coal-fired power plants contain SO_2 . SO_2 is also regarded as an air pollutant. What is the most suitable way to remove the SO_2 before discharging these gases into the atmosphere?

- A. Pass these gases through calcium oxide.
- B. Pass these gases through concentrated sulphuric acid.
- C. Cool these gases to liquefy SO_2 for subsequent removal.
- D. Pass these gases through an organic solvent such as hexane.

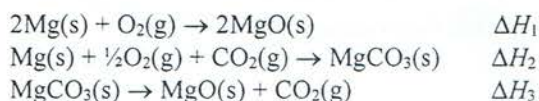
10. Which of the following processes involves the breaking of hydrogen bonds?

- A. $\text{H}_2(\text{l}) \rightarrow \text{H}_2(\text{g})$
- B. $\text{HBr}(\text{l}) \rightarrow \text{HBr}(\text{g})$
- C. $\text{CH}_3\text{OH}(\text{l}) \rightarrow \text{CH}_3\text{OH}(\text{g})$
- D. $\text{CH}_3\text{CHO}(\text{l}) \rightarrow \text{CH}_3\text{CHO}(\text{g})$

11. The monosubstitution of methane with chlorine under diffuse sunlight involves several steps. Which of the following steps initiates the reaction?

- A. $\text{Cl}_2 \rightarrow 2 \text{Cl} \cdot$
- B. $\text{CH}_4 \rightarrow \text{CH}_3 \cdot + \text{H} \cdot$
- C. $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{HCl}$
- D. $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{H} \cdot + \text{Cl} \cdot$

12. Given that:



What is ΔH_3 ?

- A. $\Delta H_1 - \Delta H_2$
- B. $\Delta H_2 - \Delta H_1$
- C. $\Delta H_2 - \frac{1}{2}\Delta H_1$
- D. $\frac{1}{2}\Delta H_1 - \Delta H_2$

13. W, X, Y and Z, each represents one of the following solutions:



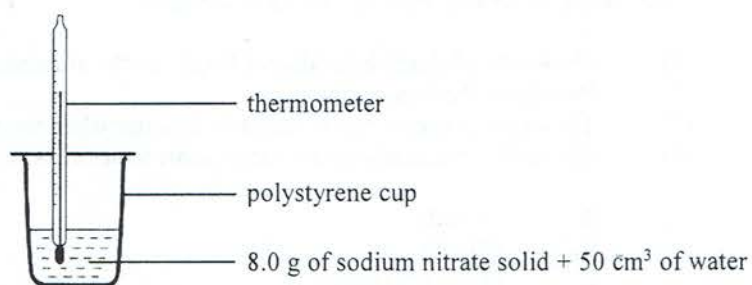
Given that:

- 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. $\text{HCl}(\text{aq})$
- B. $\text{NaOH}(\text{aq})$
- C. $\text{MgCl}_2(\text{aq})$
- D. $\text{Na}_2\text{CO}_3(\text{aq})$

14. Based on the experimental set-up in the diagram below, after 8.0 g of sodium nitrate solid is completely dissolved in 50 cm³ of water, the temperature drops by 6 °C.



Which of the following would give a drop of temperature by 3 °C under the same experimental conditions ?

- A. After 2.0 g of sodium nitrate solid is completely dissolved in 25 cm³ of water.
B. After 4.0 g of sodium nitrate solid is completely dissolved in 100 cm³ of water.
C. After 16.0 g of sodium nitrate solid is completely dissolved in 100 cm³ of water.
D. After 24.0 g of sodium nitrate solid is completely dissolved in 75 cm³ of water.
15. When 7.89 g of carbon monoxide gas burns completely, 80 kJ of heat is released. Under those experimental conditions, the enthalpy change of formation of carbon dioxide gas is -394 kJ mol^{-1} . What is the enthalpy change of formation of carbon monoxide gas under the same experimental conditions ?
- (Relative atomic masses : C = 12.0, O = 16.0)
- A. -678 kJ mol^{-1}
B. -474 kJ mol^{-1}
C. -314 kJ mol^{-1}
D. -110 kJ mol^{-1}
16. A sample of sulphuric acid was completely neutralised by 25.0 cm³ of 0.200 M potassium hydroxide solution. The salt solution obtained was then made up to 100.0 cm³ 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

17. What is the systematic name of $\text{CH}_2\text{BrCHBrCH}_2\text{CH}_2\text{I}$?

- A. 1-iodo-3,4-dibromobutane
B. 4-iodo-1,2-dibromobutane
C. 1,2-dibromo-4-iodobutane
D. 3,4-dibromo-1-iodobutane

18. Both aluminium and iron form oxides on their surfaces when they are exposed in air. The oxide of aluminium can prevent the aluminium from further corrosion, but the oxide of iron cannot prevent the iron from further corrosion. What is / are the reason(s) ?

- (1) The oxide of aluminium adheres firmly on the aluminium surface while the oxide of iron adheres loosely on the iron surface.
- (2) The oxide of aluminium is insoluble in water while the oxide of iron is soluble in water.
- (3) The oxide of aluminium has a giant ionic structure while the oxide of iron does not.

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

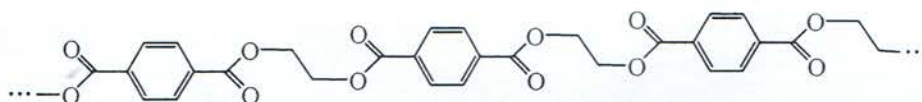
19. The composition by mass of element X in the compound K_2XO_4 is 26.8%. Which of the following statements concerning X is / are correct ?

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

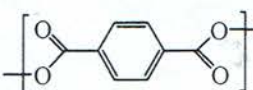
- (1) X is a transition metal.
- (2) X is an element in Group VI of the Periodic Table.
- (3) X is an element in the fourth period of the Periodic Table.


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

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

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

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

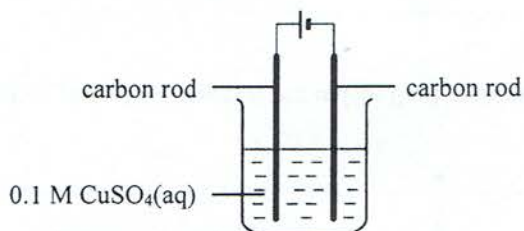
- A. (1) only
- B. (2) only
- C. (1) and (3) only
- D. (2) and (3) only

22. Which of the following statements concerning hydrogen-oxygen fuel cells are correct ?

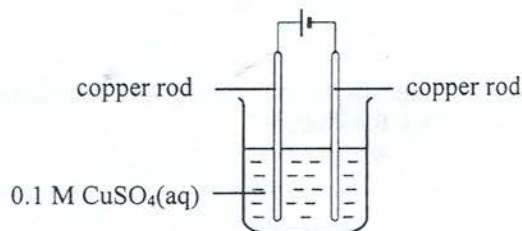
- (1) When used to power vehicles, they are more environmentally friendly than using petrol engine.
- (2) When used in space stations, they can produce drinking water in addition to energy. \times
- (3) When used as a back-up power source in hospitals, they do not produce noise pollution.

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

23. Consider the following two electrolytic cells :



Electrolytic cell 1



Electrolytic cell 2

During electrolysis, which of the following would occur in **Electrolytic cell 1** but not in **Electrolytic cell 2** ?

- (1) Gas bubbles are given out.
- (2) The blue solution becomes paler.
- (3) A reddish brown solid is deposited.

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

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

1st statement

Iron(II) hydroxide is a base.

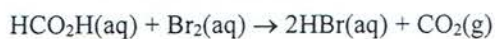
2nd statement

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.

PART II

Direction: Questions 25 and 26 refer to the following experiment on the study of the rate of reaction between $\text{HCO}_2\text{H}(\text{aq})$ and $\text{Br}_2(\text{aq})$ at a certain temperature. It is given that the rate depends on both the concentrations of $\text{HCO}_2\text{H}(\text{aq})$ and $\text{Br}_2(\text{aq})$:



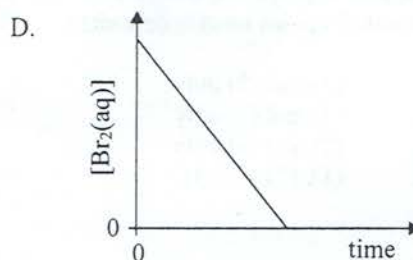
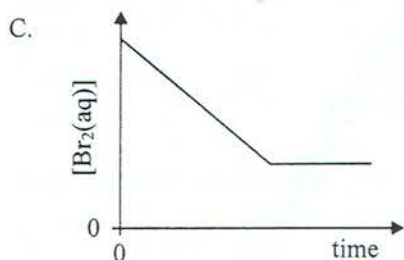
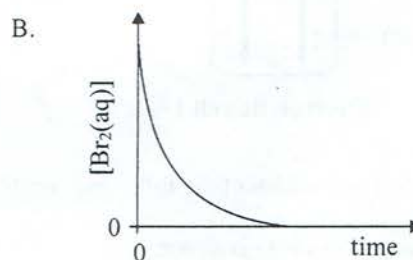
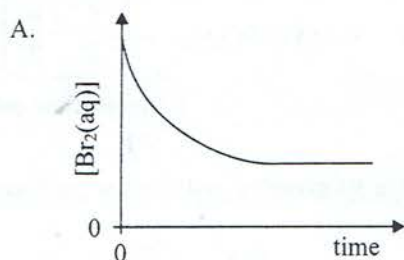
5.0 cm^3 of 0.05 M $\text{HCO}_2\text{H}(\text{aq})$ are separately added to four conical flasks each containing $\text{Br}_2(\text{aq})$ prepared by mixing different volumes of 0.05 M $\text{Br}_2(\text{aq})$ and water as shown in the table below :

| Conical flask | Volume of 0.05 M $\text{Br}_2(\text{aq})$ / cm^3 | Volume of water / cm^3 |
|---------------|---|---------------------------------|
| A | 1.0 | 4.0 |
| B | 2.0 | 3.0 |
| C | 3.0 | 2.0 |
| D | 4.0 | 1.0 |

25. In which of the above conical flasks does the reaction have the fastest initial rate ?

- A. **A**
- B. **B**
- C. **C**
- D. **D**

26. Which of the following graphs best represents the variation of $[\text{Br}_2(\text{aq})]$ in the reaction mixture of conical flask **B** with time ?



27. Copper(II) oxide can catalyse the decomposition of hydrogen peroxide to form oxygen and water. In an experiment, hydrogen peroxide solution is shaken with copper(II) oxide in a test tube. What would be observed in the test tube after the completion of the reaction ?

- A. a pale blue liquid
- B. a blue solid and a colourless liquid
- C. a black solid and a colourless liquid
- D. a reddish brown solid and a colourless liquid

28. Which of the following statements correctly describes the property of an amphoteric oxide ?

- A. It can react as an acid or as a base.
- B. It can react with water to form an acid and an alkali.
- C. It can be simultaneously oxidised and reduced in a reaction.
- D. It can react with water to form an oxidising agent and a reducing agent.

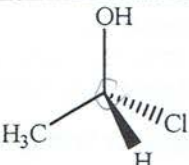
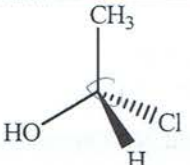
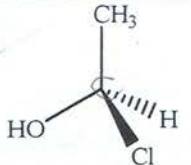
29. Consider the following reaction :



What is Y ?

- A. $\text{HOOCCH}_2\text{COCH}_2\text{CH}_2\text{OH}$
- B. $\text{HOOCCH}_2\text{CH}(\text{OH})\text{CH}_2\text{CHO}$
- C. $\text{HOOCCH}_2\text{CH}(\text{OH})\text{CH}_2\text{CH}_2\text{OH}$
- D. $\text{HOCH}_2\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{CH}_2\text{OH}$

30. Consider the information shown in the table below :

| Structure of the molecules of the liquid in | | |
|--|--|--|
| bottle A | bottle B | bottle C |
|  |  |  |

Which of the following liquids have identical boiling point ?

- A. liquids in bottle A and bottle B only
- B. liquids in bottle A and bottle C only
- C. liquids in bottle B and bottle C only
- D. liquids in bottle A, bottle B and bottle C

31. Consider the following reaction under certain conditions :

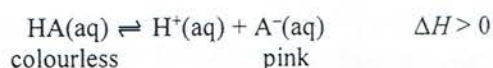


The reaction quotient is 2.0 mol dm^{-3} at a certain moment. Which of the following statements is / are correct ?

- (1) The reaction quotient is larger than 2.0 mol dm^{-3} after a period of time.
- (2) The backward reaction is faster than the forward reaction at that moment.
- (3) The concentration of $\text{X}_2(\text{g})$ must be equal to the concentration of $\text{X}_3(\text{g})$ at that moment.

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

32. Consider the following equilibrium system :



Which of the following statements is / are correct ?

- (1) Adding $\text{Na}_2\text{CO}_3(\text{s})$ would make its colour become paler.
- (2) Increasing the temperature would make its colour become darker.
- (3) Adding a few drops of concentrated $\text{HCl}(\text{aq})$ would increase the concentration of $\text{A}^{\text{-}}(\text{aq})$.

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

33. Which of the following statements concerning the elements in the third period of the Periodic Table going from Na to Cl is / are correct ?

- (1) The bond type of the elements changes from metallic bonding to covalent bonding.
- (2) The oxide of the elements changes from acidic to basic.
- (3) The electrical conductivity of the elements keeps decreasing.

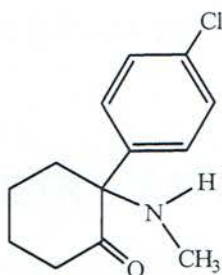
- A. (1) only
- B. (2) only
- C. (1) and (3) only
- D. (2) and (3) only

34. Which of the following mixtures would NOT separate into two liquid layers after heating under reflux for a period of time ?

- (1) $\text{HCOOCH}_2\text{CH}_3(\text{l})$ and excess $\text{NaOH}(\text{aq})$
- (2) $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}(\text{l})$ and excess concentrated $\text{NaOH}(\text{aq})$
- (3) $\text{CH}_3\text{CH}_2\text{CHO}(\text{l})$ and excess acidified $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$

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

35. The diagram below shows the structure of a compound.



Which of the following statements concerning the compound are correct ?

- (1) It has an amide group.
(2) Its structure has only one chiral carbon.
(3) It can be converted to an alcohol by using an appropriate reducing agent.
- A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)
36. Consider the following statements and choose the best answer :
- | 1st statement | 2nd statement |
|---|--|
| Methyl ethanoate and ethyl methanoate have similar chemical properties. | Methyl ethanoate and ethyl methanoate are isomers. |
- 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.

END OF SECTION A

CHEMISTRY PAPER 1
SECTION B: Question-Answer Book B

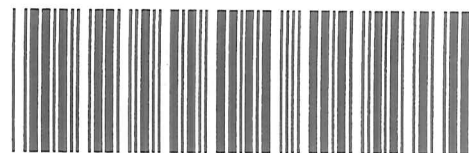
This paper must be answered in English

INSTRUCTIONS FOR SECTION B

- (1) After the announcement of the start of the examination, you should first write your Candidate Number in the space provided on Page 1 and stick barcode labels in the spaces provided on Pages 1, 3, 5, 7 and 9.
- (2) Refer to the general instructions on the cover of the Question Paper for Section A.
- (3) This section consists of TWO parts, Parts I and II.
- (4) Answer ALL questions in both Parts I and II. Write your answers in the spaces provided in this Question-Answer Book. Do not write in the margins. Answers written in the margins will not be marked.
- (5) An asterisk (*) has been put next to the questions where one mark will be awarded for effective communication.
- (6) Supplementary answer sheets will be provided on request. Write your candidate number, mark the question number box and stick a barcode label on each sheet, and fasten them with string INSIDE this Question-Answer Book.
- (7) No extra time will be given to candidates for sticking on the barcode labels or filling in the question number boxes after the 'Time is up' announcement.

Please stick the barcode label here.

Candidate Number

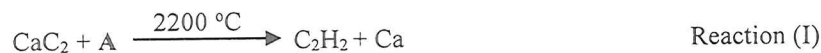


* A 1 4 0 E 0 1 B *

PART I

Answer ALL questions. Write your answers in the spaces provided.

1. 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 :



- (a) Draw the electron diagram for a C_2H_2 molecule, showing ELECTRONS IN THE OUTERMOST SHELLS only.

(1 mark)

- (b) Write a chemical equation for the complete combustion of acetylene.

(1 mark)

- (c) Refer to Reaction (I) :

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

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

(2 marks)

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

(1 mark)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Please stick the barcode label here.

2. In the boxes (a) to (g) of the table below, fill in the information relating to the electrolysis of each electrolyte.

| Electrolyte | Electrode | Observation at the electrode | Product at the electrode | Half equation OR Justification for the change occurred at the electrode |
|---------------------------------------|------------------|------------------------------|--------------------------|---|
| Molten PbBr_2 | Graphite anode | (a) Observation: | | |
| | Graphite cathode | | | (b) Half equation: |
| Very dilute ZnCl_2 solution | Platinum anode | | | (c) Half equation: |
| | Platinum cathode | | (d) Product: | |
| Concentrated CuSO_4 solution | Copper anode | | (e) Product: | |
| | Copper cathode | (f) Observation: | | (g) Justification: |

(7 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

3. Silicon occurs naturally in three isotopes with the abundance of each isotope shown in the table below :

| Isotope | Abundance / % |
|------------------|---------------|
| ^{28}Si | 92.20 |
| ^{29}Si | x |
| ^{30}Si | y |

- (a) What is meant by the term 'isotope' ?

(1 mark)

- (b) Calculate x .
(Relative atomic mass : Si = 28.1)

(2 marks)

- (c) Silicon dioxide is an oxide of silicon.
(i) Explain why silicon dioxide has a high melting point.

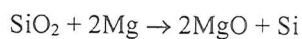
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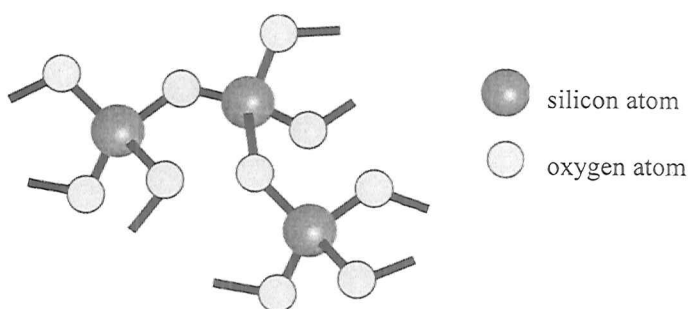
3. (c) (ii) Under certain conditions, 1.0 g of SiO_2 is allowed to react with 1.0 g of Mg. The equation for the reaction is shown below :



Calculate the theoretical mass of Si that can be formed.
(Relative atomic masses : O = 16.0, Mg = 24.3, Si = 28.1)

(4 marks)

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



What is this mineral ?

(1 mark)

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4. The chemical equation for a possible cracking reaction of decane ($C_{10}H_{22}$) is shown below :



(a) State the systematic name of X.

(1 mark)

(b) Suggest a chemical test to show how X and butane can be distinguished.

(2 marks)

(c) X can form a polymer Z.

(i) Suggest why X can form a polymer.

(ii) Draw the repeating unit of Z.

(2 marks)

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4. (d) Compound Y is a structural isomer of butane.

(i) Draw one possible structure of Y.

(ii) Which of decane, butane and Y would have the highest boiling point ? Explain your answer.

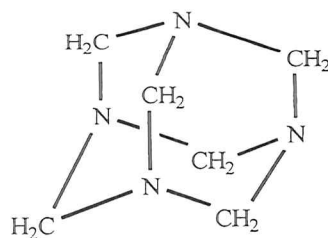
(3 marks)

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5. Hexamine ($C_6H_{12}N_4$) is the main component of a portable solid fuel. It is a solid under room conditions and its structure is shown below :



- (a) Suggest why the combustion of hexamine is exothermic in terms of the breaking and forming of covalent bonds.

(2 marks)

- (b) It is given that :

| Compound | Standard enthalpy change of formation / kJ mol^{-1} |
|-------------------|--|
| $C_6H_{12}N_4(s)$ | +123 |
| $CO_2(g)$ | -394 |
| $H_2O(l)$ | -286 |
| $NO_2(g)$ | +33 |

- (i) Write a thermochemical equation for the standard enthalpy change of formation of hexamine.

- (ii) Hexamine combusts as shown by the equation below :



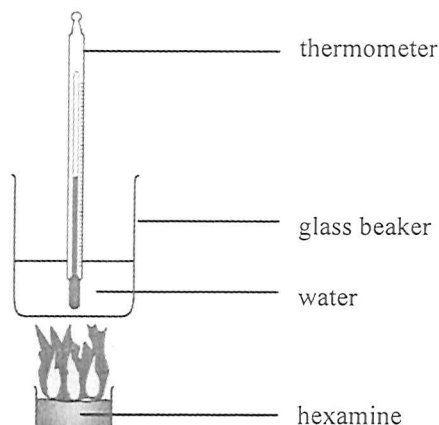
Calculate the standard enthalpy change of combustion of hexamine.

(3 marks)

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5. (c) The following diagram shows an experimental set-up for determining the enthalpy change of combustion of hexamine under certain experimental conditions.



The data obtained are shown below :

| | |
|-----------------------------------|--|
| Mass of hexamine combusted : | 2.40 g |
| Mass of water : | 600.0 g |
| Initial temperature of water : | 23.5 °C |
| Final temperature of water : | 47.5 °C |
| Molar mass of hexamine : | 140.0 g |
| Specific heat capacity of water : | 4.20 J g ⁻¹ K ⁻¹ |

Assuming that the heat capacity of the glass beaker is negligible, calculate the enthalpy change of combustion of hexamine under these experimental conditions.

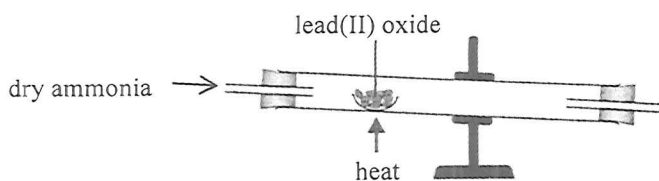
(3 marks)

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



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

- (i) The reaction tube is placed in a downward slanted position.
- (ii) The experiment is performed in a fume cupboard.

(2 marks)

- (b) Write a chemical equation for the reaction.

(1 mark)

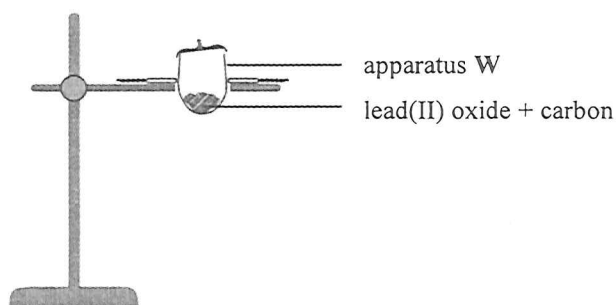
- (c) Explain which of the reagents is a reducing agent in the reaction.

(1 mark)

- (d) Lead can also be obtained from lead(II) oxide using carbon.

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

- (ii) The diagram below shows an incomplete set-up for performing the reaction :



- (1) Add suitable drawing (with label) to the diagram for completing the set-up.
- (2) Name apparatus W.

(3 marks)

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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 cm³.

Step (2) : 25.0 cm³ 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).

(2 marks)

(b) State the colour change at the end point of the titration.

(1 mark)

(c) Calculate a reasonable average for the volume of the hydrochloric acid used in the titrations.

(1 mark)

(d) Calculate the concentration of hydrochloric acid (in g dm⁻³) in the sample.
(Relative atomic masses : H = 1.0, Cl = 35.5)

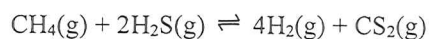
(3 marks)

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PART II

Answer ALL questions. Write your answers in the spaces provided.

9. An experiment was performed for a reversible reaction involving $\text{CH}_4(\text{g})$, $\text{H}_2\text{S}(\text{g})$, $\text{H}_2(\text{g})$ and $\text{CS}_2(\text{g})$ in a closed container of a fixed volume of 2.0 dm^3 at a constant temperature. The equation for the reaction is shown below :



- (a) Write an expression for the equilibrium constant K_c for the reaction.

(1 mark)

- (b) The number of moles of each species at different times at that temperature are given in the table below :

| | $\text{CH}_4(\text{g})$ | $\text{H}_2\text{S}(\text{g})$ | $\text{H}_2(\text{g})$ | $\text{CS}_2(\text{g})$ |
|--------------------------------|-------------------------|--------------------------------|------------------------|-------------------------|
| Initial number of moles | 0.04 | 0.08 | 0.08 | 0.04 |
| Number of moles at equilibrium | | 0.11 | 0.02 | 0.025 |

- (i) Fill in the number of moles at equilibrium for $\text{CH}_4(\text{g})$ in the above table.
(ii) Calculate the equilibrium constant K_c for the reaction at that temperature.

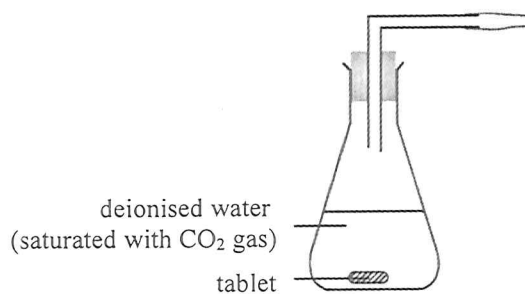
- (iii) If the volume of the closed container changes to 3.0 dm^3 while all other experimental conditions remain unchanged, explain whether K_c would increase, decrease or remain unchanged.

(4 marks)

Answers written in the margins will not be marked.

10. A tablet contains solid sodium hydrogencarbonate and solid citric acid (water soluble). An experiment was performed under room conditions to study the rate of formation of CO_2 gas when the tablet was placed in deionised water.

(a) The diagram below shows an incomplete set-up for the experiment :



- (i) Explain why the deionised water used should be saturated with CO_2 gas before the start of the experiment.
- (ii) Add suitable drawing (with label) to the above diagram to show how the volume of the CO_2 gas formed can be measured.

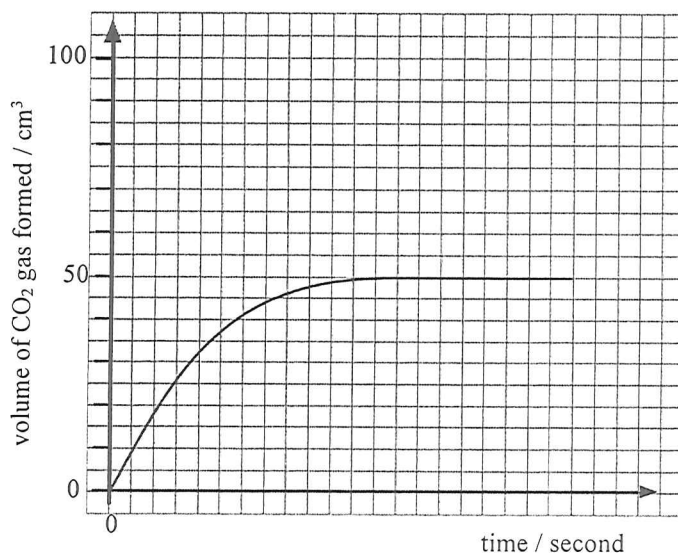
(2 marks)

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10. (b) (i) The graph below shows the variation of the volume of CO_2 gas formed with time for the experiment :



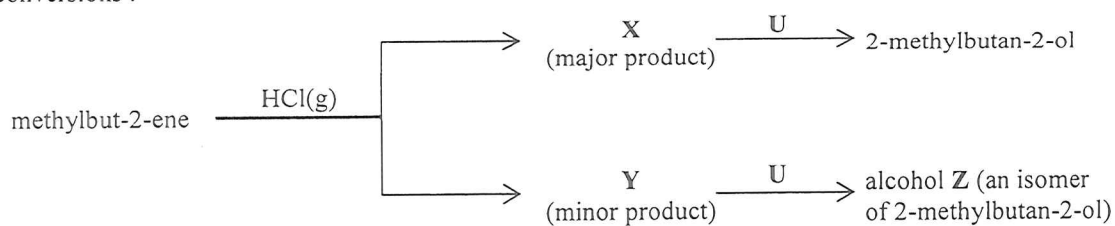
Assuming that citric acid was in excess and no other substances reacted with sodium hydrogencarbonate, calculate the mass of sodium hydrogencarbonate in the tablet.
(Molar masses : sodium hydrogencarbonate = 84.0 g, citric acid = 192.0 g;
Molar volume of gas at room conditions = 24 dm^3)

- (ii) Sketch another curve (using dotted line) on the above graph to show the expected experimental result if the tablet is ground into a powder, with all other experimental conditions remaining unchanged.

(3 marks)

Answers written in the margins will not be marked.

11. Methylbut-2-ene reacts with HCl(g) to give **X** as the major product as predicted from Markovnikov's rule. During the reaction, another product **Y** (minor product) can also be formed. Refer to the following organic conversions :



- (a) State the Markovnikov's rule.

(1 mark)

- (b) Draw the structure of **X**.

(1 mark)

- (c) **X** reacts with **U** to give 2-methylbutan-2-ol. What is **U** ?

(1 mark)

- (d) (i) **Y** has one chiral centre. Draw a three-dimensional diagram for the structure of an enantiomer of **Y**.

Answers written in the margins will not be marked.

11. (d) (ii) Y is optically active. What is meant by the term 'optically active' ?

(2 marks)

(e) Y reacts with U to give alcohol Z. Suggest a chemical test to show how Z and 2-methylbutan-2-ol can be distinguished.

(2 marks)

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12. (a) Silicon dioxide is an acidic oxide. However, the pH of a mixture of silicon dioxide and distilled water is 7.

(i) Suggest why silicon dioxide is classified as an acidic oxide.

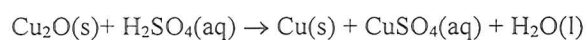
(ii) Explain why the pH of the mixture is 7.

(2 marks)

(b) Phosphorus(V) oxide is an acidic oxide. With the aid of a chemical equation, explain why the pH of a mixture of phosphorus(V) oxide and distilled water is smaller than 7.

(2 marks)

(c) Refer to the following reaction :



State how this reaction can demonstrate that copper exhibits TWO characteristics of transition metals.

(2 marks)

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PERIODIC TABLE 周期表

GROUP 族

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|----------------|----------------|-----------------------------|----------------|----------------|----------------|----------------|------------------|------------------|------------------|------------------|------------------|-----------------|-----------------|------------------|------------------|-----------------|------------------|------------------|------------------|-----------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|-----------------|------------------|------------------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|------------------|-------------------|-------------------|-------------------|---------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|----------------------|-------------------|-------------------|------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| | | atomic number 原子序 | | | | | | | | | | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | relative atomic mass 相對原子質量 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | XIII | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 Li 6.9 | 4 Be 9.0 | 5 B 10.8 | 6 C 12.0 | 7 N 14.0 | 8 O 16.0 | 9 F 19.0 | 10 Ne 20.2 | 11 Na 23.0 | 12 Mg 24.3 | 13 Al 27.0 | 14 Si 28.1 | 15 P 31.0 | 16 S 32.1 | 17 Cl 35.5 | 18 Ar 40.0 | 19 K 39.1 | 20 Ca 40.1 | 21 Sc 45.0 | 22 Ti 47.9 | 23 V 50.9 | 24 Cr 52.0 | 25 Mn 54.9 | 26 Fe 55.8 | 27 Co 58.9 | 28 Ni 58.7 | 29 Cu 63.5 | 30 Zn 65.4 | 31 Ga 69.7 | 32 Ge 72.6 | 33 As 74.9 | 34 Se 79.0 | 35 Br 79.9 | 36 Kr 83.8 | 37 Rb 85.5 | 38 Sr 87.6 | 39 Y 88.9 | 40 Zr 91.2 | 41 Nb 92.9 | 42 Mo 95.9 | 43 Tc (98) | 44 Ru 101.1 | 45 Rh 102.9 | 46 Pd 106.4 | 47 Ag 107.9 | 48 Cd 112.4 | 49 In 114.8 | 50 Sn 118.7 | 51 Sb 121.8 | 52 Te 127.6 | 53 I 126.9 | 54 Xe 131.3 | 55 Cs 132.9 | 56 Ba 137.3 | 57 * La 138.9 | 58 Ce 140.1 | 59 Pr 140.9 | 60 Nd 144.2 | 61 Pm (145) | 62 Sm 150.4 | 63 Eu 152.0 | 64 Gd 157.3 | 65 Tb 158.9 | 66 Dy 162.5 | 67 Ho 164.9 | 68 Er 167.3 | 69 Tm 168.9 | 70 Yb 173.0 | 71 Lu 175.0 | 72 Hf 178.5 | 73 Ta 180.9 | 74 W 183.9 | 75 Re 186.2 | 76 Os 190.2 | 77 Ir 192.2 | 78 Pt 195.1 | 79 Au 197.0 | 80 Hg 200.6 | 81 Tl 204.4 | 82 Pb 207.2 | 83 Bi 209.0 | 84 Po (209) | 85 At (210) | 86 Rn (222) | 87 Fr (223) | 88 Ra (226) | 89 ** Ac (227) | 90 Th 232.0 | 91 Pa (231) | 92 U 238.0 | 93 Np (237) | 94 Pu (244) | 95 Am (243) | 96 Cm (247) | 97 Bk (247) | 98 Cf (251) | 99 Es (252) | 100 Fm (257) | 101 Md (258) | 102 No (259) | 103 Lr (260) | 104 Rf (261) | 105 Db (262) | 106 Sg (263) | 107 Bh (264) | 108 Hs (265) | 109 Mt (266) | 110 Ds (267) | 111 Rg (268) | 112 Cn (269) | 113 Nh (270) | 114 Fl (271) | 115 Mc (272) | 116 Lv (273) | 117 Ts (274) | 118 Og (275) |

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