

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2025

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. Which of the following combinations represents the numbers of subatomic particles of an anion ?

	Number of protons	Number of neutrons	Number of electrons
A.	7	7	10
B.	10	10	10
C.	19	20	18
D.	26	30	23

2. A white solid X gives a brick-red flame in a flame test. When X(s) is added to dilute hydrochloric acid, a colourless gas is given out. Which of the following compounds may X be ?

- A. calcium sulphate
- B. potassium sulphate
- C. calcium carbonate
- D. potassium carbonate

3. Which of the following statements is INCORRECT ?

- A. Calcium carbonate solid can be obtained from passing carbon dioxide gas into limewater.
- B. Calcium hydroxide solid can be obtained directly from strong heating of marble.
- C. Hydrogen gas can be obtained directly from electrolysis of sea water.
- D. Nitrogen gas can be obtained from fractional distillation of liquefied air.

4. Which of the following processes would give a colourless gas and a colourless solution ?

- A. adding lead granules to hot water
- B. adding zinc foils to concentrated nitric acid
- C. adding copper powder to concentrated sulphuric acid
- D. adding magnesium ribbons to dilute hydrochloric acid

5. Silver can be extracted from silver sulphide. If the percentage yield of this extraction in an experiment is 85%, what would the mass of silver sulphide be needed to obtain 15.0 g of silver ?

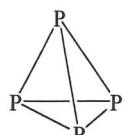
(Relative atomic masses : S = 32.1, Ag = 107.9)

- A. 14.6 g
- B. 17.2 g
- C. 20.3 g
- D. 34.5 g

6. Which of the following methods is NOT suitable for preparing zinc sulphate crystals in a school laboratory ?

- A. adding excess zinc solid to copper(II) sulphate solution
- B. adding excess zinc chloride solid to copper(II) sulphate solution
- C. adding excess zinc oxide solid to dilute sulphuric acid
- D. adding excess zinc carbonate solid to dilute sulphuric acid

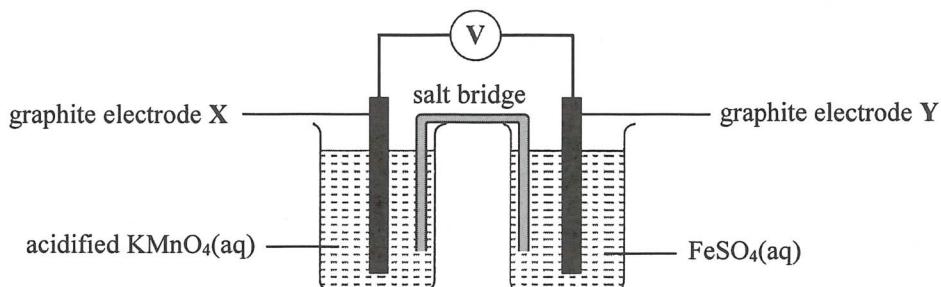
7. The structure of a molecule of white phosphorus is shown below :



Which of the following statements about white phosphorus is correct ?

- A. White phosphorus does not conduct electricity.
- B. The relative molecular mass of white phosphorus is 31.0.
- C. The attraction between the molecules of white phosphorus is covalent bond.
- D. There is no lone pair of electrons on each phosphorus atom in a molecule of white phosphorus.

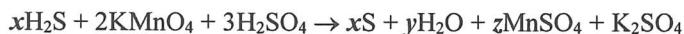
8. The diagram below shows the set-up of an experiment :



Which of the following statements concerning the above experiment is correct ?

- A. Electrode X is the cathode.
- B. Saturated $\text{Ca}(\text{NO}_3)_2\text{(aq)}$ is suitable to be used in preparing the above salt bridge.
- C. Electrons flow from electrode X to electrode Y through the external circuit.
- D. The half equation for the change that occurs at electrode Y is $\text{Fe}^{2+}\text{(aq)} + 2\text{e}^- \rightarrow \text{Fe(s)}$.

9. Refer to the following chemical equation :



Which of the following combinations is correct ?

- | | x | y |
|----|-----|-----|
| A. | 3 | 6 |
| B. | 5 | 8 |
| C. | 5 | 10 |
| D. | 7 | 10 |

10. Which of the following gases is NOT a mixture ?

- A. town gas
- B. natural gas
- C. butane gas
- D. refinery gas

11. What is the systematic name of $(\text{CH}_3)_2\text{CHCH}_2\text{C}(\text{OH})(\text{CH}_3)\text{CH}_2\text{CH}=\text{CHCH}_3$?

- A. 5,7-dimethyloct-2-en-5-ol
- B. 2,4-dimethyloct-6-en-4-ol
- C. 7,7-dimethylhept-2-en-5-ol
- D. 1,1-dimethylhept-5-en-3-ol

12. Refer to the following two solutions :



Which of the following statements is correct ?

- A. X has a higher pH than Y.
- B. Both X and Y have the same electrical conductivity.
- C. The reaction of X with excess Mg(s) releases the same amount of heat as the reaction of Y with excess Mg(s).
- D. Complete neutralisation of X and complete neutralisation of Y require the same volume of 0.5 M NaOH(aq).

13. An organic compound W contains hydrogen, carbon and oxygen only. 30.00 g of W burns completely in excess oxygen to give 33.75 g of water and 41.25 g of carbon dioxide. Which of the following compounds may W be ?

(Relative atomic masses : H = 1.0, C = 12.0, O = 16.0)

- A. HCOOH
- B. CH₂=CHCOOH
- C. CH₃OH
- D. CH₂(OH)CH₂OH

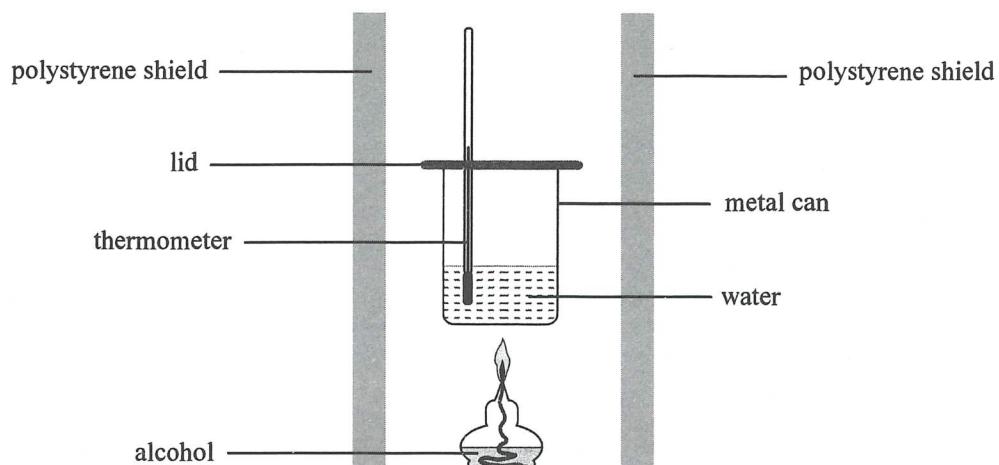
14. In the species below, the underlined atom is the central atom. In which of them does the central atom have a non-octet electronic arrangement ?

- A. OF₂
- B. SCl₄
- C. PCl₃
- D. HCHO

15. Which of the following CANNOT prevent the corrosion of an iron-made object ?

- A. immersing it in vinegar
- B. immersing it in oil
- C. connecting it to a piece of zinc metal
- D. connecting it to the negative pole of a chemical cell

Directions : Questions 16 and 17 refer to the following experimental set-up, which is used to determine the enthalpy changes of combustion of different alcohols under certain conditions.



In an experiment, a fixed mass of water contained in a metal can is heated by burning methanol and ethanol separately. The experimental data obtained are as follows :

Alcohol	Mass of alcohol used / g	The greatest temperature rise / °C
methanol	1.930	22.6
ethanol	1.740	27.1

The enthalpy change of combustion of methanol is found to be -715 kJ mol^{-1} .

16. Which of the following is the enthalpy change of combustion of ethanol determined under the same experimental conditions ?

(Relative molecular masses : methanol = 32.0, ethanol = 46.0)

- A. $-1367 \text{ kJ mol}^{-1}$
- B. $-1157 \text{ kJ mol}^{-1}$
- C. $-1028 \text{ kJ mol}^{-1}$
- D. -857 kJ mol^{-1}

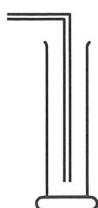
17. The above experiment is repeated with some changes in the experimental set-up, the enthalpy change of combustion of methanol found is -690 kJ mol^{-1} instead of -715 kJ mol^{-1} . Which of the following changes may lead to this result ?

- (1) having more water in the metal can
- (2) removal of all the polystyrene shields
- (3) having greater distance between the metal can and the flame

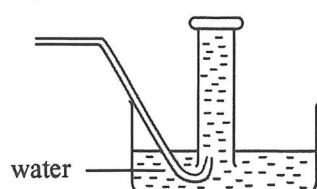
- A. (1) and (2) only
- B. (1) and (3) only
- C. (2) and (3) only
- D. (1), (2) and (3)

18. Which of the following set-ups can be used to collect $\text{H}_2(\text{g})$?

(1)



(2)



(3)



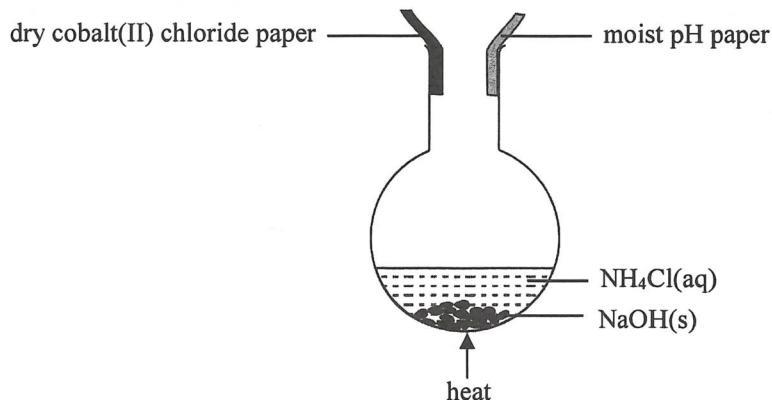
- A. (1) only
- B. (2) only
- C. (1) and (3) only
- D. (2) and (3) only

19. When metal X is added to copper(II) nitrate solution, a blue solid is formed as one of the products. Which of the following metals may X be ?

- (1) zinc
- (2) calcium
- (3) sodium

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

20. Refer to the diagram below :



Which of the following statements is / are correct ?

- (1) A colourless gas with a characteristic pungent smell is given out.
- (2) The dry cobalt(II) chloride paper turns blue.
- (3) The moist pH paper turns blue.

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

21. Which of the following reactions involve oxidation ?

- (1) $\text{CH}_3\text{CH}=\text{CHCH}_3 + \text{H}_2 \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
- (2) $3\text{Br}_2 + 6\text{NaOH} \rightarrow 5\text{NaBr} + \text{NaBrO}_3 + 3\text{H}_2\text{O}$
- (3) $2\text{Al} + 2\text{NaOH} + 6\text{H}_2\text{O} \rightarrow 2\text{NaAl(OH)}_4 + 3\text{H}_2$

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

22. Which of the following measures can reduce the emission of air pollutants from combustion of fossil fuels ?

- (1) installing scrubbers in coal-fired power plants
- (2) installing catalytic converters in petrol-driven cars
- (3) installing electrostatic precipitators in coal-fired power plants

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

23. There are two gas jars, one containing $\text{CO}_2(\text{g})$ and the other containing $\text{SO}_2(\text{g})$. Which of the following can be used to distinguish between these two gases ?

- (1) adding bromine water
- (2) adding sodium hydroxide solution
- (3) adding concentrated nitric acid

- 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

Hydrogen iodide has a higher boiling point than hydrogen bromide.

2nd statement

The van der Waals' forces between hydrogen iodide molecules are stronger than those between hydrogen bromide molecules.

- A. Both statements are true and the 2nd statement is a correct explanation of the 1st statement.
- B. Both statements are true and 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

25. Under room conditions, the initial rate of the reaction between excess zinc granules and 100 cm^3 of 1.0 M HCl(aq) is measured as r . Using the same amount of zinc granules under room conditions, with which of the following would the zinc granules react to give the same initial rate r ?

- A. 50 cm^3 of 2.0 M HCl(aq)
- B. 200 cm^3 of 1.0 M HCl(aq)
- C. 100 cm^3 of 1.0 M H_2SO_4 (aq)
- D. 100 cm^3 of 1.0 M CH_3COOH (aq)

26. Refer to the following equilibrium system in a closed container of a certain volume at temperature T :



Which of the following changes would increase the number of moles of NO(g) at equilibrium in the system ?

- A. decreasing the temperature of the system
- B. decreasing the volume of the container at temperature T
- C. adding a small amount of $\text{SO}_3(\text{g})$ to the equilibrium mixture
- D. removing a small amount of $\text{SO}_2(\text{g})$ from the equilibrium mixture

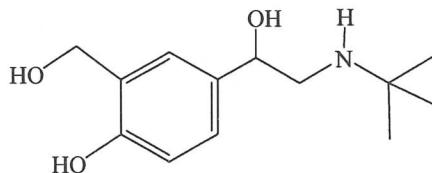
27. Refer to the following reversible reaction under certain conditions :



The reaction quotient is $4.5 \text{ mol}^{-1} \text{ dm}^3$ at time t . Which of the following statements concerning this reversible reaction at time t is correct ?

- A. The reaction has attained equilibrium.
- B. The rate of the forward reaction is greater than the rate of the backward reaction.
- C. The concentration of $\text{Y}_2(\text{g})$ is 4.5 times the concentration of $\text{Y}(\text{g})$.
- D. The concentration of $\text{Y}(\text{g})$ starts to increase.

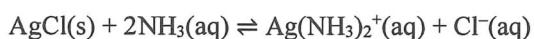
28. Salbutamol is a medicine for asthma. Its structure is shown below :



Which of the following statements concerning salbutamol is INCORRECT ?

- A. It is a polar molecule.
- B. It reacts with PCl_3 .
- C. It has optical activity.
- D. Its molecular formula is $\text{C}_{13}\text{H}_{18}\text{NO}_3$.

29. Refer to the following equilibrium system :

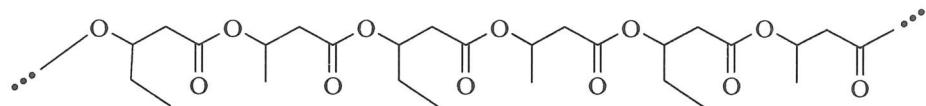


It is given that, at 25 °C, $K_c = \frac{[\text{Ag}(\text{NH}_3)_2^+\text{(aq)}]_{\text{eqm}} [\text{Cl}^-\text{(aq)}]_{\text{eqm}}}{[\text{NH}_3\text{(aq)}]^2_{\text{eqm}}} = 3.60 \times 10^{-3}$.

A certain amount of $\text{NH}_3\text{(aq)}$ and AgCl(s) are initially mixed. When the system attains chemical equilibrium at 25 °C, the concentration of $\text{NH}_3\text{(aq)}$ in the mixture is $8.93 \times 10^{-2} \text{ mol dm}^{-3}$. What is the concentration of $\text{Cl}^-\text{(aq)}$ ions in the equilibrium mixture ?

- A. $2.87 \times 10^{-5} \text{ mol dm}^{-3}$
- B. $3.21 \times 10^{-4} \text{ mol dm}^{-3}$
- C. $5.36 \times 10^{-3} \text{ mol dm}^{-3}$
- D. $1.79 \times 10^{-2} \text{ mol dm}^{-3}$

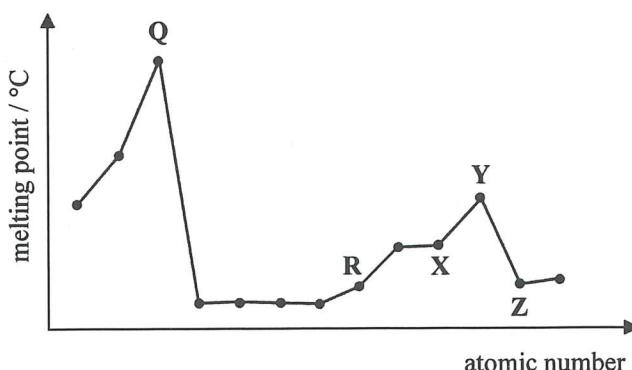
30. The structure of a portion of a polymer is shown below :



Which of the following pairs of compounds would be the monomers of this polymer ?

- | | | | |
|----|---|-----|--|
| A. | $\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{HO}-\text{C} & -\text{C}-\text{COOH} \\ & \\ \text{CH}_3 & \text{H} \end{array}$ | and | $\begin{array}{c} \text{CH}_3 & \text{H} \\ & \\ \text{HO}-\text{C} & -\text{C}-\text{COOH} \\ & \\ \text{CH}_3 & \text{H} \end{array}$ |
| B. | $\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{HO}-\text{C} & -\text{C}-\text{COOH} \\ & \\ \text{CH}_3 & \text{H} \end{array}$ | and | $\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{HO}-\text{C} & -\text{C}-\text{COOH} \\ & \\ \text{C}_2\text{H}_5 & \text{H} \end{array}$ |
| C. | $\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{HOOC}-\text{C} & -\text{C}-\text{COOH} \\ & \\ \text{CH}_3 & \text{H} \end{array}$ | and | $\begin{array}{c} \text{CH}_3 & \text{H} \\ & \\ \text{HO}-\text{C} & -\text{C}-\text{OH} \\ & \\ \text{C}_2\text{H}_5 & \text{H} \end{array}$ |
| D. | $\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{HOOC}-\text{C} & -\text{C}-\text{COOH} \\ & \\ \text{C}_2\text{H}_5 & \text{H} \end{array}$ | and | $\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{HO}-\text{C} & -\text{C}-\text{OH} \\ & \\ \text{CH}_3 & \text{H} \end{array}$ |

Directions : Questions 31 and 32 refer to the graph below, which shows the variation in the melting points of thirteen consecutive elements in the second and third periods of the Periodic Table. (These elements are arranged in the order of increasing atomic numbers. The letters are NOT the chemical symbols.)



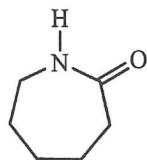
31. Which of the following elements may represent carbon ?

- A. Q
- B. R
- C. X
- D. Y

32. Which of the following statements concerning the oxides of the above elements is / are correct ?

- (1) The oxide of X and the oxide of Z can separately react with dilute NaOH(aq).
 - (2) The oxide of Q and the oxide of Y have giant structures.
 - (3) The oxide of R can conduct electricity in the molten state.
- A. (1) only
 - B. (2) only
 - C. (1) and (3) only
 - D. (2) and (3) only

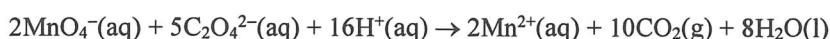
33. The following organic compound is heated with excess NaOH(aq).



Which of the following statements about this reaction is / are correct ?

- (1) $\text{O}=\text{C}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{NH}_2$ is formed.
 - (2) Ammonia is formed.
 - (3) It is a condensation reaction.
- A. (1) only
 - B. (2) only
 - C. (1) and (3) only
 - D. (2) and (3) only

34. Refer to the following reaction :

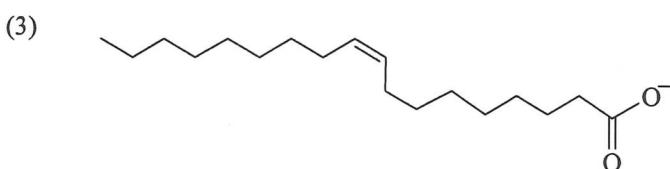
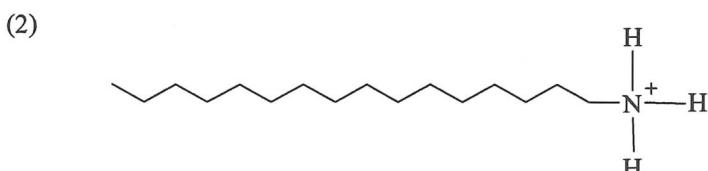
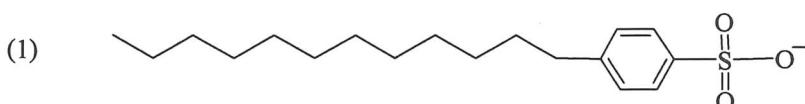


Which of the following can be measured in order to follow the progress of the reaction ?

- (1) mass of $\text{H}_2\text{O}(\text{l})$ formed
- (2) pressure of the reaction system
- (3) colour intensity of the reaction system

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

35. Which of the following species can emulsify an oil-water mixture ?



- 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

At a fixed temperature, an increase in the concentration of a reactant in a reversible reaction would change the equilibrium constant of the reaction.

2nd statement

An increase in the concentration of a reactant in a reversible reaction would increase the rate of the forward reaction, but decrease the rate of the backward reaction.

- A. Both statements are true and the 2nd statement is a correct explanation of the 1st statement.
- B. Both statements are true and 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

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
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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





PART I

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

1. The aluminium oxide layer on the surface of aluminium window frames can enhance the corrosion resistance of aluminium.

(a) In terms of bonding and structure, explain why aluminium is malleable.

(2 marks)

(b) Draw the electron diagram for aluminium oxide, showing ELECTRONS IN THE OUTERMOST SHELLS only.

(1 mark)

(c) Why can the aluminium oxide layer enhance the corrosion resistance of aluminium ?

(1 mark)

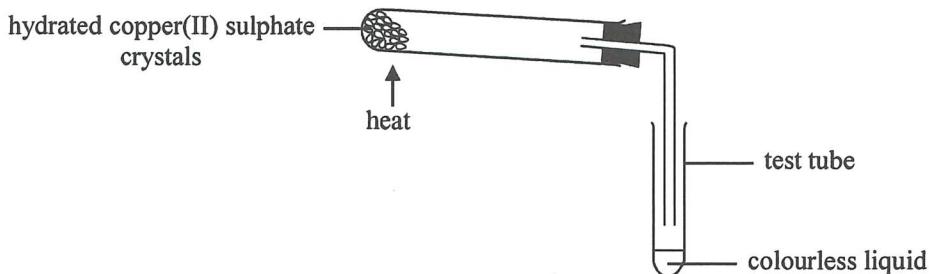
(d) Name the process that can increase the thickness of the aluminium oxide layer on aluminium window frames.

(1 mark)

Answers written in the margins will not be marked.

Please stick the barcode label here.

2. The diagram below shows an experimental set-up in which hydrated copper(II) sulphate crystals are heated. A colourless liquid is collected in the test tube.



- (a) What is the colourless liquid collected?

(1 mark)

- (b) State the expected colour change in the hydrated copper(II) sulphate crystals.

(1 mark)

- (c) A bluish green flame can be observed when a flame test is conducted with hydrated copper(II) sulphate crystals. Briefly describe how the flame test is carried out in a school laboratory.

(2 marks)

Answers written in the margins will not be marked.

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Answers written in the margins will not be marked.

3. (a) In an experiment, 2.10 g of dry nitrogen gas reacted with 1.85 g of magnesium ribbon at a high temperature. Magnesium nitride (Mg_3N_2) solid was the only product formed from the reaction.

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

(1 mark)

(ii) Calculate the theoretical mass of magnesium nitride that can be formed.
(Relative atomic masses : N = 14.0, Mg = 24.3)

(3 marks)

(b) In another experiment, a piece of magnesium ribbon was burnt in air to give white magnesium oxide solid and a small amount of magnesium nitride.

(i) State another expected observation in this experiment.

(1 mark)

(ii) Although nitrogen is the most abundant gas in air, magnesium nitride is NOT the main product formed from the reaction in (b). In explaining this result, there is a view : 'Nitrogen is less reactive than oxygen.'. In terms of bonding, suggest a reason to support this view.

(1 mark)



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Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

4. Ethane, propene and octane are hydrocarbons.

- (a) Both ethane and octane belong to the same homologous series. Write the general formula for this homologous series.

(1 mark)

- (b) In the following tables, fill in the required information concerning the reactions shown below.

- (i) The reaction between bromine (dissolved in an organic solvent) and a large excess of ethane under diffused sunlight :

Structural formula of the main organic product	Expected observation of the reaction

(2 marks)

- (ii) The polymerisation of propene :

Repeating unit of the polymer formed	Name of the type of polymerisation involved

(2 marks)

- (c) Octane is a component of petrol. The combustion of octane can produce greenhouse gases which can lead to global warming. State one environmental problem caused by global warming.

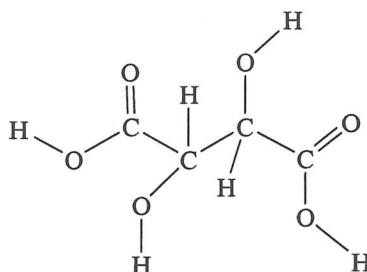
(1 mark)

Answers written in the margins will not be marked.

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5. Tartaric acid, $C_4H_6O_6$, is present in grapes. It can act as an antioxidant in grape wines.

- (a) Tartaric acid is found to be a dibasic acid from titration. Circle ALL the ionisable hydrogen atom(s) in the structure of tartaric acid shown below.



(1 mark)

- (b) An experiment was performed to determine the concentration of tartaric acid in a white wine sample. Firstly, 25.0 cm^3 of the sample was diluted to 100.0 cm^3 with distilled water. Then, several portions of 25.0 cm^3 of the diluted sample were titrated with 0.0105 M NaOH(aq) using phenolphthalein as an indicator. Finally, an average of 16.80 cm^3 of NaOH(aq) was used to reach the end point.

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

(1 mark)

- (ii) Assuming that tartaric acid is the only species in white wine to react with NaOH(aq) , calculate the concentration of tartaric acid, in g dm^{-3} , in the white wine sample.
(Relative molecular mass of tartaric acid = 150.0)

(3 marks)

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5. (b) (iii) A student repeated this experiment to determine the concentration of tartaric acid in a red wine sample. However, the colour change at the end point in the titration was masked by the intense red colour of the red wine.
Suggest how to modify this experiment and determine the end point in the titration with a red wine sample.

(2 marks)

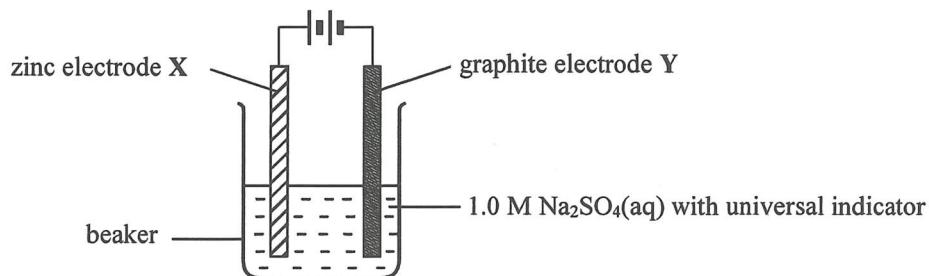
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6. The diagram below shows an experimental set-up :



- (a) What is the function of Na_2SO_4 (aq) in the above experiment ?

(1 mark)

- (b) State the colour change of the solution around electrode Y after a period of time. Explain your answer.

(3 marks)

- (c) What would be the change at electrode X ? Write the half equation for this change.

(2 marks)

- (d) After a period of time, a white precipitate is formed in the beaker. Write an ionic equation for the formation of this white precipitate.

(1 mark)

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Please stick the barcode label here.

7. (a) (i) For each of the following molecules, draw its three-dimensional structure.



(1 mark)



(1 mark)

(ii) Explain whether the molecules of BF_3 and NF_3 are polar.

(2 marks)

(b) Arrange the following three liquids in descending order of viscosity. Explain your answer in terms of intermolecular attractions.



(2 marks)

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8. (a) Refer to the following thermochemical equation of a chemical reaction :



- (i) State the meaning of the term ‘standard enthalpy change of formation of $\text{H}_2\text{O}_2(\text{l})$ ’.

(1 mark)

- (ii) Explain why the enthalpy change of formation of $\text{H}_2\text{O}_2(\text{l})$ CANNOT be determined directly by experiments.

(1 mark)

- (iii) (1) Complete the table below by stating all covalent bonds that are broken and formed in the formation of one H_2O_2 molecule in the above reaction. Also state the corresponding numbers of the bonds involved.
(It is given that the oxygen atoms in a H_2O_2 molecule have octet structures.)

Covalent bonds broken and their corresponding numbers	
Covalent bonds formed and their corresponding numbers	

(2 marks)

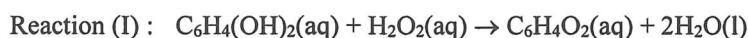
- (2) Suggest a reason to explain why the standard enthalpy change of formation of $\text{H}_2\text{O}_2(\text{l})$ is a negative value in terms of the breaking and forming of covalent bonds.

(1 mark)

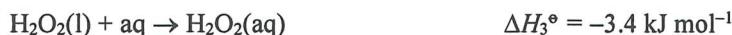
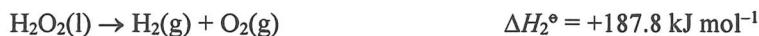
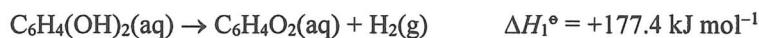
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Answers written in the margins will not be marked.

8. (b) A certain kind of insects can release a toxic substance, $C_6H_4O_2$. This substance can be formed from the reaction between the aqueous solutions of hydroquinone ($C_6H_4(OH)_2(aq)$) and hydrogen peroxide ($H_2O_2(aq)$), as shown in Reaction (I).



Given :



- (i) Using the above given enthalpy changes to construct an enthalpy change cycle can give the standard enthalpy change of Reaction (I). Draw, with labels, this enthalpy change cycle.

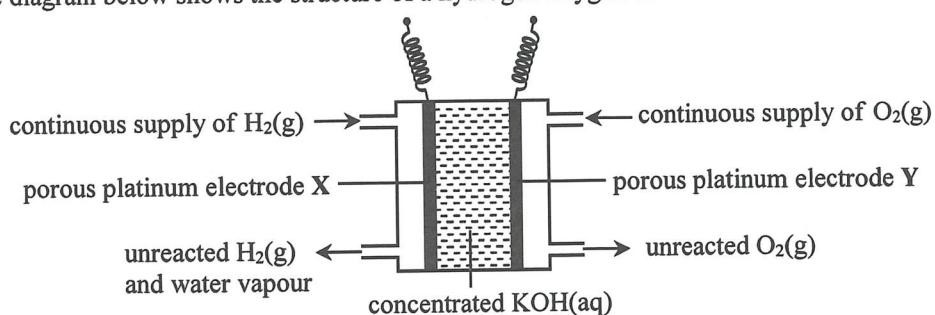
(2 marks)

- (ii) Calculate the standard enthalpy change of Reaction (I).

(2 marks)

Answers written in the margins will not be marked.

- *9. The diagram below shows the structure of a hydrogen-oxygen fuel cell :



With reference to the information provided in the above diagram, describe the working principle of this fuel cell.
(6 marks)

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Answers written in the margins will not be marked.

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PART II

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

10. Potassium superoxide (KO_2) solid can be used to remove carbon dioxide gas in spacecrafts. The reaction between potassium superoxide and carbon dioxide is as follows :



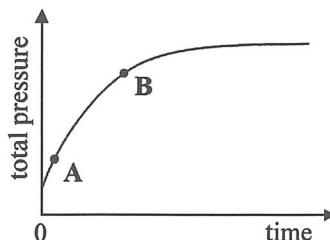
- (a) Calculate the minimum mass of potassium superoxide, in kg, needed to absorb 140.0 dm^3 of carbon dioxide at room conditions.
(Molar volume of gas at room conditions = 24.0 dm^3 ;
Relative atomic masses : C = 12.0, O = 16.0, K = 39.1)

(2 marks)

- (b) Suggest one advantage of using this method to remove carbon dioxide gas in spacecrafts.

(1 mark)

- (c) In an experiment, the above reaction was allowed to proceed in a closed system. The progress of the reaction was followed by measuring the total pressure of the reaction system at regular time intervals. The graph below shows the results of this experiment :



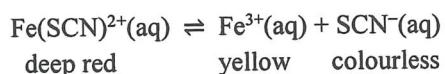
Based on the above graph, deduce whether the instantaneous rate of the reaction is higher at A or at B.

(1 mark)

Answers written in the margins will not be marked.



11. Consider an equilibrium mixture of the following chemical reaction at temperature T :



(a) At temperature T, the equilibrium mixture is prepared by mixing 10.0 cm³ of 0.0165 M Fe₂(SO₄)₃(aq) and 15.0 cm³ of 0.0255 M KSCN(aq). The concentration of Fe(SCN)²⁺(aq) in the equilibrium mixture is 0.00912 M at this temperature.

(i) Calculate the concentration of Fe³⁺(aq) in the equilibrium mixture.

(1 mark)

(ii) Calculate the equilibrium constant K_c for the above reaction.

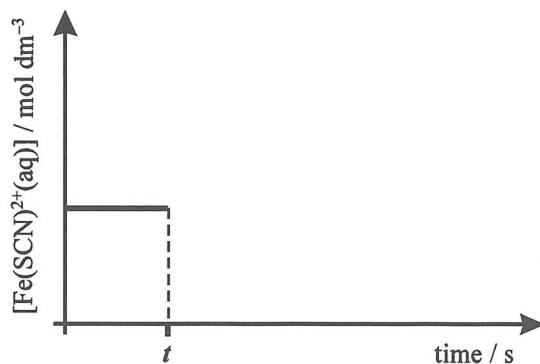
(2 marks)

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11. (b) A small amount of $\text{Fe}_2(\text{SO}_4)_3(s)$ is added to the equilibrium mixture in (a) at time t . On the graph below, sketch the variation of the concentration of $\text{Fe}(\text{SCN})^{2+}(\text{aq})$ with time until the reaction attains a new chemical equilibrium at temperature T.



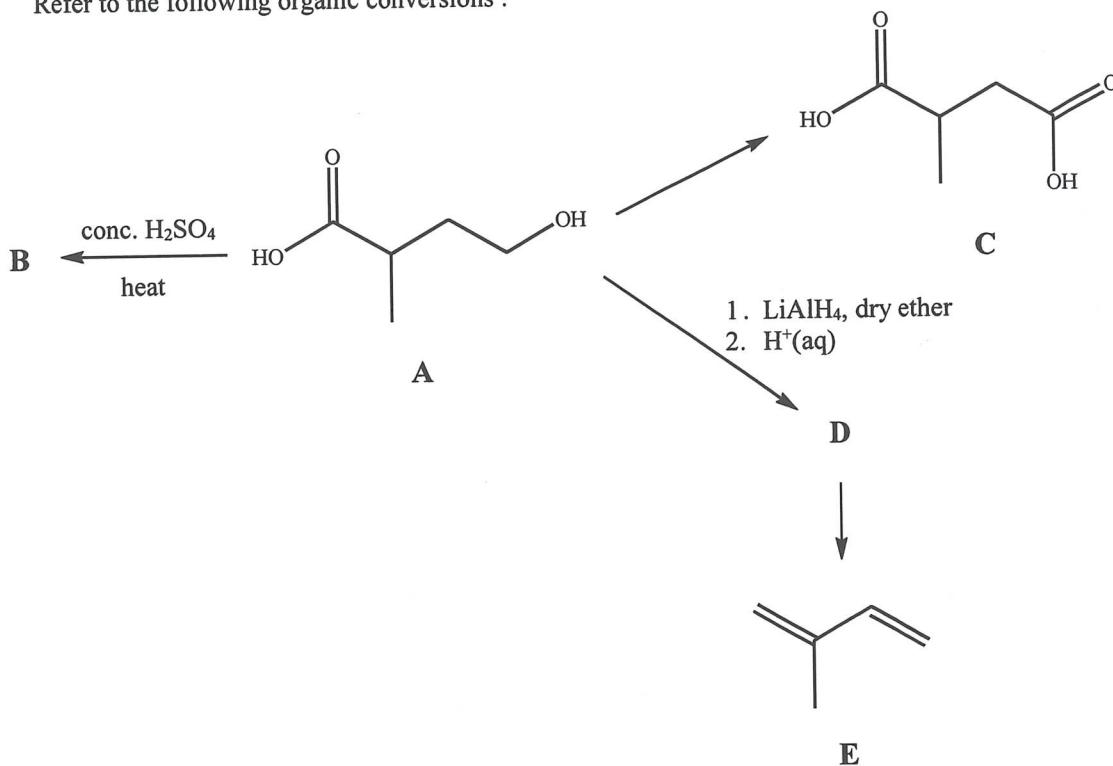
(1 mark)

- (c) When the temperature of the equilibrium mixture in (a) is lowered, the colour of the solution becomes deeper red. Deduce whether the forward reaction is endothermic or exothermic.

(2 marks)

Answers written in the margins will not be marked.

12. Refer to the following organic conversions :



- (a) B is a cyclic compound with the molecular formula C₅H₈O₂. With reference to the conversion of A to B,

- (i) write a possible structural formula of B.

(1 mark)

- (ii) explain whether the conversion of A to B involves condensation.

(1 mark)

- (b) Suggest the reagent(s) and reaction conditions (as appropriate) needed for the conversion of A to C.

(1 mark)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

12. (c) With reference to the conversion of A to D, write a possible structural formula of D.

(1 mark)

(d) With reference to the conversion of D to E,

(i) suggest the reagent(s) and reaction conditions (as appropriate) needed for this conversion.

(1 mark)

(ii) give the systematic name of E.

(1 mark)

(e) In the presence of a catalyst, E reacts with excess H₂(g) to form product F.

(i) Write the structural formula of F.

(1 mark)

(ii) Suggest a suitable catalyst for this reaction.

(1 mark)



13. (a) With reference to the following oxides :

Na₂O MgO Al₂O₃ SiO₂ Cl₂O

Which one of the above oxides, when added to water at room conditions, can form a solution with a pH lower than 7 ? Explain your answer.

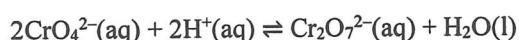
(2 marks)

- (b) Chromium is a transition metal commonly used to prevent iron from rusting.

- (i) Suggest a method that chromium can be used to prevent iron from rusting.

(1 mark)

- (ii) Refer to the following reversible reaction :



State how this reaction can demonstrate that chromium exhibits one characteristic of transition metals.

(1 mark)

- *14. Two acyclic organic compounds have the same molecular formula $C_3H_6O_2$ but different functional groups. Each of them has only one functional group and does not have any carbon-carbon double bonds. With reference to the structures of the two compounds, explain the difference in their boiling points. Also describe their chemical reactions with $NaOH(aq)$.

(6 marks)

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**END OF SECTION B
END OF PAPER**

Answers written in the margins will not be marked.

族 GROUP

周期表 PERIODIC TABLE

原子序 atomic number

*	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
**	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)