

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2024

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 substances has delocalised electrons ?

- A. NaCl(s)
- B. Br₂(l)
- C. Hg(l)
- D. I₂(s)

2. Which of the following methods can be used to directly obtain common salt from sea water ?

- A. filtration
- B. dissolution
- C. electrolysis
- D. crystallisation

3. What is the theoretical mass of hydrogen gas formed when 13.50 g of aluminium reacts with excess dilute hydrochloric acid ?

(Relative atomic masses : H = 1.0, Al = 27.0)

- A. 0.67 g
- B. 0.75 g
- C. 1.00 g
- D. 1.50 g

4. Y is a monobasic acid. The pH of 0.1 M Y(aq) is 2.91. Which of the following statements concerning the 0.1 M Y(aq) is correct ?

- A. It is a concentrated solution of a weak acid.
- B. It is a concentrated solution of a strong acid.
- C. It is a dilute solution of a weak acid.
- D. It is a dilute solution of a strong acid.

5. Which of the following is the best process to prepare lead(II) sulphate ?

- A. adding lead granules to dilute sulphuric acid
- B. adding lead(II) carbonate powder to dilute sulphuric acid
- C. adding lead(II) chloride solid to sodium sulphate solution
- D. adding lead(II) nitrate solution to sodium sulphate solution

6. The thermal decomposition of the nitrate of metal M is shown below :



When 0.164 g of $M(NO_3)_2(s)$ is decomposed, the total number of moles of gases evolved is 2.50×10^{-3} mol.
What is metal M ?

(Relative atomic masses : N = 14.0, O = 16.0)

- A. Mg
- B. Ca
- C. Sr
- D. Ba

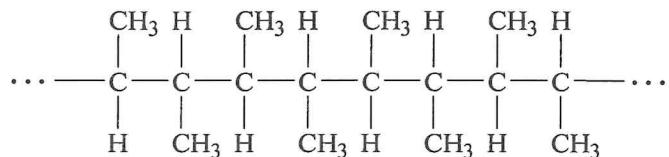
7. Which of the following air pollutants can be removed by the electrostatic precipitators installed in coal-fired power plants ?

- A. suspended particulates
- B. carbon monoxide
- C. nitrogen oxides
- D. sulphur dioxide

8. In a hydrogen-oxygen fuel cell, hydrogen is

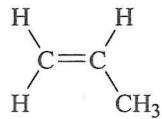
- A. oxidised at the anode.
- B. oxidised at the cathode.
- C. reduced at the anode.
- D. reduced at the cathode.

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

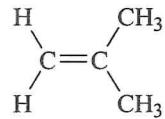


Which of the following is the monomer of this polymer ?

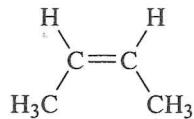
A.



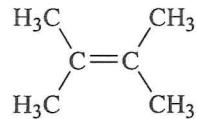
B.



C.



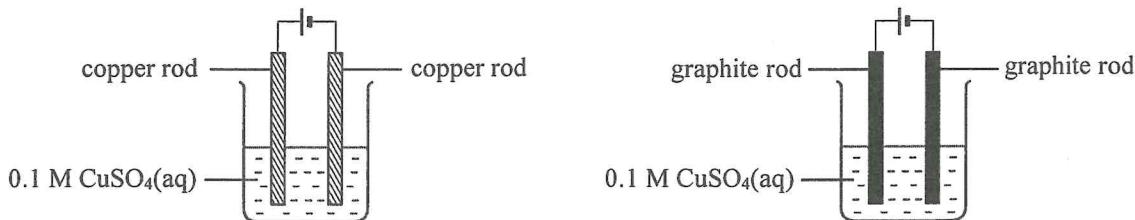
D.



10. 12.80 cm^3 of a $\text{H}_2\text{SO}_4(\text{aq})$ sample is completely neutralised by 25.0 cm^3 of 0.10 M KOH(aq) . What is the concentration of the $\text{H}_2\text{SO}_4(\text{aq})$ sample ?
- A. $2.56 \times 10^{-2} \text{ M}$
B. $9.77 \times 10^{-2} \text{ M}$
C. $1.95 \times 10^{-1} \text{ M}$
D. $3.91 \times 10^{-1} \text{ M}$
11. Which of the following statements about intermolecular forces is INCORRECT ?
- A. Hydrogen bonding is an electrostatic attraction.
B. Van der Waals' forces exist between polar molecules and also between non-polar molecules.
C. The intermolecular forces in bromine are stronger than those in chlorine.
D. The intermolecular forces in hydrogen chloride are stronger than those in hydrogen fluoride.
12. In which of the following chemical species does V (vanadium) have the lowest oxidation number ?
(Given: The oxidation number of oxygen in each of the following species is -2 .)
- A. V_2O_3
B. VO_2
C. VO_2^+
D. VO_4^{3-}
13. Which of the following is NOT a redox reaction ?
- A. $\text{BaCO}_3(\text{s}) \rightarrow \text{BaO}(\text{s}) + \text{CO}_2(\text{g})$
B. $4\text{KClO}_3(\text{s}) \rightarrow 3\text{KClO}_4(\text{s}) + \text{KCl}(\text{s})$
C. $\text{Cl}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{HCl}(\text{aq}) + \text{HOCl}(\text{aq})$
D. $\text{Zn}(\text{s}) + \text{CuSO}_4(\text{aq}) \rightarrow \text{ZnSO}_4(\text{aq}) + \text{Cu}(\text{s})$
14. Refer to the following reaction and the given information under certain conditions :
- $$2\text{FeO}(\text{s}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{Fe}_2\text{O}_3(\text{s})$$
- Enthalpy change of formation of $\text{FeO}(\text{s}) = -270 \text{ kJ mol}^{-1}$
Enthalpy change of formation of $\text{Fe}_2\text{O}_3(\text{s}) = -820 \text{ kJ mol}^{-1}$
- Which of the following expressions gives the enthalpy change for the above reaction under these conditions ?
- A. $[(-820 \times \frac{1}{2}) - (-270)] \text{ kJ mol}^{-1}$
B. $[-270 - (-820 \times \frac{1}{2})] \text{ kJ mol}^{-1}$
C. $[-820 - (-270 \times 2)] \text{ kJ mol}^{-1}$
D. $[(-270 \times 2) - (-820)] \text{ kJ mol}^{-1}$

15. Which of the following statements concerning the combustion of ethanol is correct ?
- A. The combustion of ethanol is endothermic.
 - B. The total enthalpy of products is less than that of reactants.
 - C. Ethanol burns immediately when it is exposed to air at room conditions.
 - D. The total energy involved in the bond-breaking processes is more than that in the bond-formation processes.
16. Consider these atoms: $^{74}_{32}\text{Ge}$, $^{75}_{33}\text{As}$ and $^{76}_{34}\text{Se}$.
 Which of the following statements is / are correct ?
- (1) They have different numbers of protons.
 - (2) They have different numbers of neutrons.
 - (3) They have different numbers of outermost shell electrons.
- A. (1) only
 - B. (2) only
 - C. (1) and (3) only
 - D. (2) and (3) only
17. The monosubstitution of $\text{CH}_4(\text{g})$ with $\text{Cl}_2(\text{g})$ under diffuse sunlight involves three steps : initiation, propagation and termination. Which of the following steps can lead to a termination of the reaction ?
- (1) $\text{Cl}_2 \rightarrow \text{Cl}\bullet + \text{Cl}\bullet$
 - (2) $\text{CH}_3\bullet + \text{Cl}\bullet \rightarrow \text{CH}_3\text{Cl}$
 - (3) $\text{CH}_4 + \text{Cl}\bullet \rightarrow \text{CH}_3\bullet + \text{HCl}$
- A. (1) only
 - B. (2) only
 - C. (1) and (3) only
 - D. (2) and (3) only
18. In electrolytic cell X, dilute $\text{H}_2\text{SO}_4(\text{aq})$ is used as the electrolyte and platinum is used as the electrodes. At the beginning of electrolysis, which of the following electrolytic cells can give the same product at the cathode as at the cathode in electrolytic cell X ?
- | Electrolytic cell | Electrolyte | Anode | Cathode |
|--------------------------|--|--------------|----------------|
| (1) | dilute $\text{AgNO}_3(\text{aq})$ | graphite | graphite |
| (2) | dilute $\text{CH}_3\text{COOH}(\text{aq})$ | graphite | graphite |
| (3) | dilute $\text{NaOH}(\text{aq})$ | platinum | platinum |
- A. (1) only
 - B. (2) only
 - C. (1) and (3) only
 - D. (2) and (3) only

19. Refer to the following two electrolytic cells :



Which of the following statements is / are correct ?

- (1) During electrolysis, a reddish brown solid is deposited at the cathode in both electrolytic cells.
(2) During electrolysis, gas bubbles are given out at the anode in both electrolytic cells.
(3) During electrolysis, the pH of the solution decreases in both electrolytic cells.
- A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

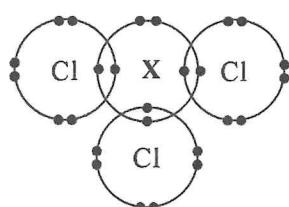
20. Which of the following processes can be used to distinguish between K_2CO_3 (aq) and CaCl_2 (aq) ?

- (1) performing a flame test
(2) adding dilute hydrochloric acid
(3) adding acidified silver nitrate solution
- A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

21. Which of the following statements can show that metal Y is more reactive than gold ?

- (1) Y can react with dilute hydrochloric acid whilst gold cannot.
(2) Y can displace copper from copper(II) nitrate solution whilst gold cannot.
(3) Gold can be extracted from its ore by physical method whilst Y cannot.
- A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

22. Element X is one of the first twenty elements in the Periodic Table. X can form two chlorides, XCl_3 and XCl_5 . The electron diagram (only electrons in the outermost shells are shown) of XCl_3 is shown below :



Which of the following statements about X are correct ?

- (1) X belongs to Group V of the Periodic Table.
 - (2) X is in the third period of the Periodic Table.
 - (3) The X atom in XCl_5 has an octet electronic arrangement.
- A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

23. Refer to the following thermochemical equation :



Which of the following statements are correct ?

- (1) The standard enthalpy change of formation of $\text{Na}_2\text{O}_2\text{(s)}$ is -515 kJ mol^{-1} .
 - (2) The standard enthalpy change of combustion of Na(s) is -515 kJ mol^{-1} .
 - (3) When 2 mol of Na(s) reacts with 1 mol of $\text{O}_2\text{(g)}$ to form 1 mol of $\text{Na}_2\text{O}_2\text{(s)}$ under standard conditions, 515 kJ of heat is released.
- 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

Copper can react with dilute nitric acid but not with dilute ethanoic acid.

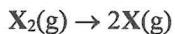
2nd statement

Nitric acid is a strong acid while ethanoic acid is a weak acid.

- 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. An experiment was performed to study the rate of the following reaction :

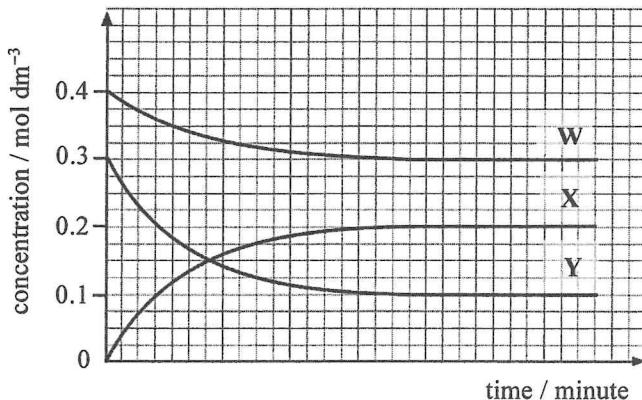


In a closed container of fixed volume at a certain temperature, the concentration of $X_2(g)$ decreased from 0.10 mol dm^{-3} to 0.04 mol dm^{-3} in the first 4 minutes.

What is the average rate of formation of $X(g)$ in the first 4 minutes ?

- A. $0.010 \text{ mol dm}^{-3} \text{ min}^{-1}$
- B. $0.015 \text{ mol dm}^{-3} \text{ min}^{-1}$
- C. $0.020 \text{ mol dm}^{-3} \text{ min}^{-1}$
- D. $0.030 \text{ mol dm}^{-3} \text{ min}^{-1}$

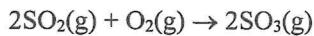
26. The graph below shows the changes in the concentrations of the chemical species (W, X and Y) of a reaction with time :



Which of the following equations can best represent the reaction involved ?

- A. $2W + Y \rightleftharpoons 2X$
- B. $2X \rightleftharpoons 2W + Y$
- C. $W + 2Y \rightleftharpoons 2X$
- D. $2X \rightleftharpoons 3W + Y$

27. Consider the rate and the collisions between particles of the following reaction :



Which of the following combinations is correct when the concentration of $\text{SO}_2(\text{g})$ is increased at a constant temperature ?

	Rate of reaction	Collisions between particles
A.	increases	have more energy on average
B.	increases	have higher frequency
C.	remains unchanged	have more energy on average
D.	remains unchanged	have higher frequency

28. Refer to the following conversion :

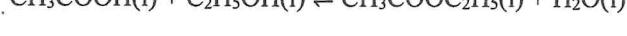


Which of the following combinations of steps is correct ?

- | Step 1 | Step 2 |
|--|---|
| A. concentrated $\text{H}_2\text{SO}_4(\text{l})$, heat | PCl ₃ (l) |
| B. Al ₂ O ₃ (s), heat | HCl(g) |
| C. NaOH(aq) | concentrated HCl(aq) |
| D. NaOH(aq) | Cl ₂ (dissolved in an organic solvent) |
29. An acyclic hydrocarbon R contains C=C bond as the only functional group. 0.4 mol of R completely reacts with 19.2 dm³ of hydrogen gas at room conditions. How many C=C bond(s) may R have ?

(Molar volume of gas at room conditions = 24 dm³)

- A. 1
B. 2
C. 3
D. 4
30. Refer to the following catalysed reaction at a certain temperature :

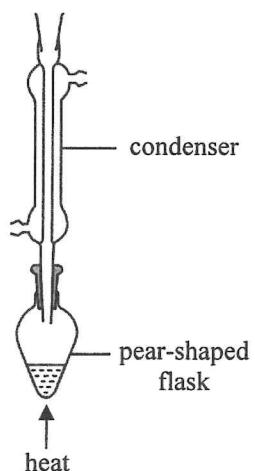


A mixture of 2.50 mol of CH₃COOH(l) and 2.50 mol of C₂H₅OH(l) was placed in a closed container and kept at this temperature. When equilibrium was attained, 0.85 mol of CH₃COOH(l) remained in the reaction mixture. What is the numerical value of the equilibrium constant K_c for the above reaction at this temperature ?

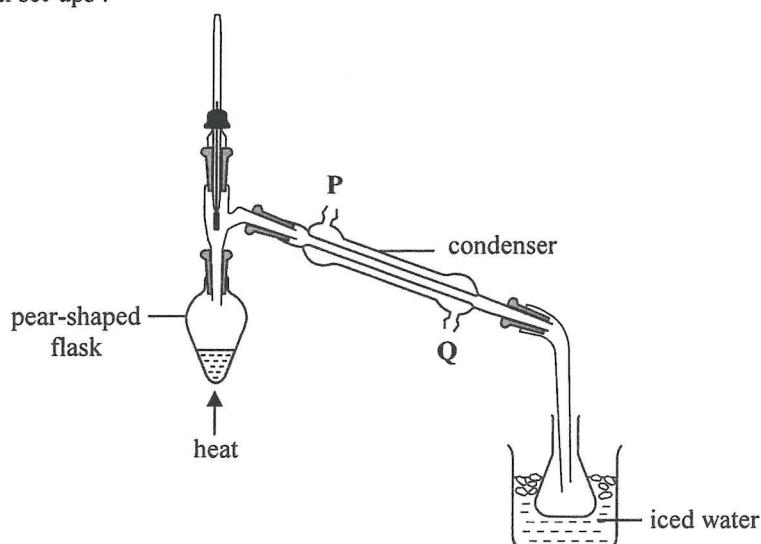
- A. 0.27
B. 2.28
C. 3.77
D. K_c cannot be determined because the total volume of the mixture is not known.
31. Which of the following statements concerning the elements in the Periodic Table is correct ?

- A. The electrical conductivities of metals in the third period decrease from left to right.
B. The melting points of the Group I elements increase down the group.
C. The atomic sizes of noble gases decrease down the group.
D. The boiling points of halogens increase down the group.

32. Refer to the following two experimental set-ups :



Set-up A

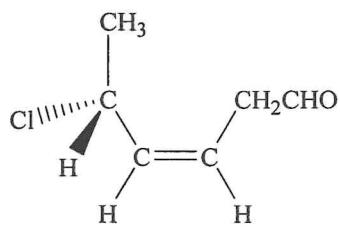
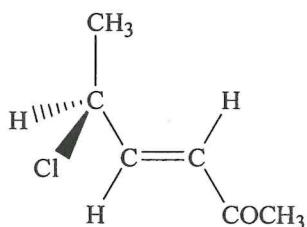


Set-up B

Which of the following statements concerning these two set-ups is / are correct ?

- (1) Anti-bumping granules should be placed in the pear-shaped flasks in both set-ups.
 - (2) Water should flow into the condenser at position P and flow out from position Q in set-up B.
 - (3) Set-up A is suitable to be used to prepare ethanal from the reaction between ethanol and excess acidified $K_2Cr_2O_7(aq)$ under prolonged heating.
- A. (1) only
 B. (2) only
 C. (1) and (3) only
 D. (2) and (3) only

33. Refer to the following two compounds :



Which of the following statements is / are correct ?

- (1) They are enantiomers.
 - (2) They are structural isomers.
 - (3) They are *cis-trans* isomers.
- A. (1) only
 B. (2) only
 C. (1) and (3) only
 D. (2) and (3) only

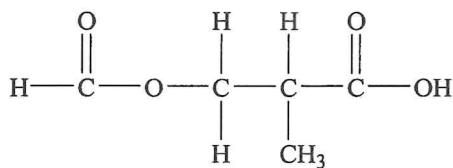
34. Refer to the following equilibrium system in a closed container of volume V at temperature T :



Which of the following changes would increase the number of moles of $\text{PCl}_3(\text{g})$ in the system ?

- (1) adding a catalyst to the system
 - (2) removing a small amount of $\text{Cl}_2(\text{g})$ from the system
 - (3) increasing the volume of the system at temperature T
- A. (1) and (2) only
 - B. (1) and (3) only
 - C. (2) and (3) only
 - D. (1), (2) and (3)

35. An organic compound has the following structure :



Which of the following statements concerning this compound are correct ?

- (1) It is optically active.
 - (2) It is soluble in $\text{NaOH}(\text{aq})$.
 - (3) It has an aldehyde functional group.
- 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

Iron exhibits variable oxidation states in its compounds.

2nd statement

Iron forms coloured compounds.

- 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

Please stick the barcode label here.

Candidate Number											
------------------	--	--	--	--	--	--	--	--	--	--	--

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.



PART I

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

1. (a) Carbon occurs naturally in two stable isotopes, ^{12}C and ^{13}C .
(i) Give one difference between a ^{12}C atom and a ^{13}C atom.

(1 mark)

- (ii) The relative atomic mass of carbon is 12.011. Assuming that carbon only has two isotopes, ^{12}C and ^{13}C , calculate the percentage abundance of ^{12}C .

Answers written in the margins will not be marked.

- (b) Diamond and graphite are two different forms of carbon. Diamond is a poor conductor of electricity while graphite is a good conductor of electricity. State the similarity and difference of diamond and graphite in terms of bonding and structure. Hence, account for their difference in electrical conductivity.

(2 marks)

- (c) C_2N_2 is a compound of carbon and nitrogen. It contains one carbon-carbon single bond. Draw the electron diagram for a C_2N_2 molecule, showing ELECTRONS IN THE OUTERMOST SHELLS only.

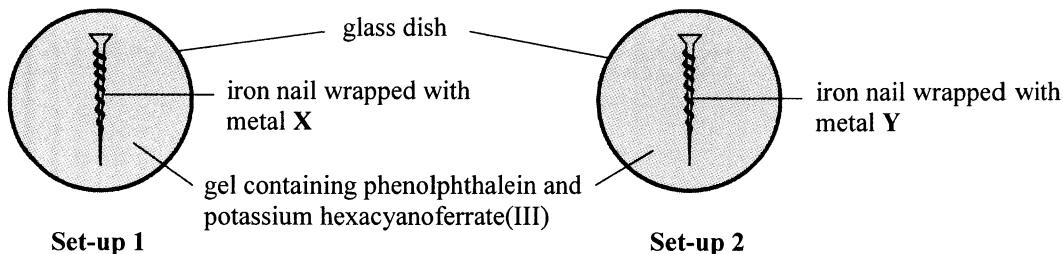
(3 marks)

(1 mark)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

2. An experiment was performed to investigate the rusting of iron with the set-ups shown below :



X, Y and iron are three different metals. After a period of time, a pink colour appeared in both set-up 1 and set-up 2, whereas a blue colour appeared around the iron nail in set-up 1 only.

- (a) State the essential conditions for the rusting of iron.

(1 mark)

- (b) Suggest which species changed to pink colour in set-up 1 and set-up 2.

(1 mark)

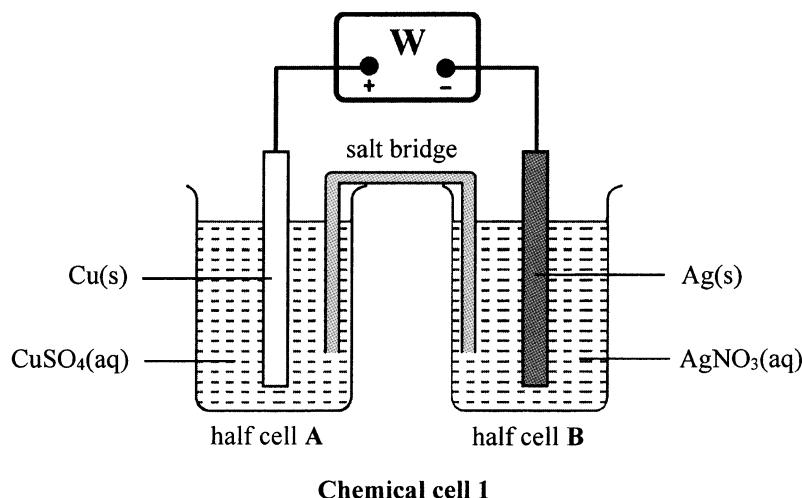
- (c) Explain why the blue colour appeared around the iron nail in set-up 1.

(2 marks)

- (d) Based on the above observations, arrange the three metals (X, Y and iron) in decreasing order of reactivity. Explain your answer.

(2 marks)

3. The diagram below shows the experimental set-up of a chemical cell. All the solutions used in the cell are 1.0 M. The voltage of the cell is measured by an apparatus W.



Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

- (a) Suggest what apparatus W is. (1 mark)
- (b) Suggest one function of a salt bridge. (1 mark)
- (c) In preparing the salt bridge in chemical cell 1,
- (i) explain why KCl(aq) cannot be used. (1 mark)
- (ii) suggest a suitable solution that can be used. (1 mark)

Answers written in the margins will not be marked.

Please stick the barcode label here.

3. (d) Three other experiments are conducted by using a set-up similar to chemical cell 1, but different combinations of electrodes and 1.0 M solutions ($\text{CuSO}_4\text{(aq)}$, $\text{AgNO}_3\text{(aq)}$, $\text{ZnSO}_4\text{(aq)}$ and $\text{MnSO}_4\text{(aq)}$) are used in the half cells. The table below shows the information of the chemical cells:

Chemical cell	Half cell A	Half cell B	Voltage / V
1	$\text{Cu(s) / Cu}^{2+}\text{(aq)}$	$\text{Ag(s) / Ag}^+\text{(aq)}$	-0.46
2	$\text{Cu(s) / Cu}^{2+}\text{(aq)}$	$\text{Zn(s) / Zn}^{2+}\text{(aq)}$	+1.10
3	$\text{Cu(s) / Cu}^{2+}\text{(aq)}$	$\text{Mn(s) / Mn}^{2+}\text{(aq)}$	+1.15
4	$\text{Ag(s) / Ag}^+\text{(aq)}$	$\text{Mn(s) / Mn}^{2+}\text{(aq)}$	y

- (i) With reference to chemical cells 1, 2 and 3, state and explain which of the four metals used in the above chemical cells is the strongest reducing agent.

(2 marks)

- (ii) Calculate the expected value of y .

(1 mark)

- (iii) Write the half equation for the change that occurs at the cathode of chemical cell 4.

(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.

4. Sulphamic acid (relative molecular mass = 97.1) can be used to remove limescale in water boilers. Limescale is mainly composed of CaCO_3 .

(a) Sulphamic acid only contains 3.09% of hydrogen, 14.42% of nitrogen, 49.43% of oxygen and 33.06% of sulphur by mass.

(i) Determine, by calculation, the empirical formula of sulphamic acid.
(Relative atomic masses : H = 1.0, N = 14.0, O = 16.0, S = 32.1)

(2 marks)

(ii) Deduce the molecular formula of sulphamic acid.

(1 mark)

(b) In an experiment, 0.486 g of sulphamic acid reacted with 100.0 cm^3 of 0.150 M NaOH(aq) , which was in excess. The remaining NaOH(aq) required 24.80 cm^3 of 0.202 M $\text{H}_2\text{SO}_4(\text{aq})$ for complete neutralisation.

(i) Calculate the number of moles of NaOH(aq) that reacted with the $\text{H}_2\text{SO}_4(\text{aq})$.

(1 mark)

Please stick the barcode label here.

4. (b) (ii) Calculate the number of moles of NaOH(aq) that reacted with the sulphamic acid.

(1 mark)

(iii) Deduce the basicity of sulphamic acid.

(1 mark)

(c) Write an ionic equation for the reaction between CaCO₃(s) in limescale and H⁺(aq).

(1 mark)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

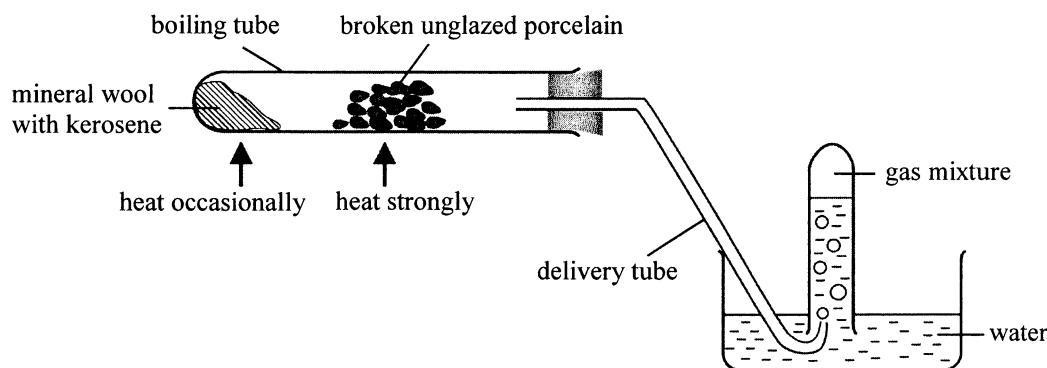
Answers written in the margins will not be marked.

5. Kerosene can be obtained from petroleum.

- (a) State a physical method to obtain kerosene from petroleum. Explain the underlying principle of this method.

(2 marks)

- (b) The following diagram shows the experimental set-up of a chemical process done on kerosene.



- (i) Name the chemical process that occurs in the boiling tube.

(1 mark)

- (ii) Why should the delivery tube be taken out of the water before removing the heat source?

(1 mark)

Please stick the barcode label here.

5. (b) (iii) Explain why the gas mixture collected can decolourise bromine water rapidly.

(1 mark)

- (iv) If only the mineral wool with kerosene is heated strongly, but the broken unglazed porcelain is not heated, the chemical process in (b)(i) would not occur significantly. Suggest TWO reasons to explain why.

(2 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.

6. Six solutions of 0.1 M are put into two groups as follows :

Group A	Group B
$\text{NH}_3(\text{aq})$	$\text{Na}_2\text{CO}_3(\text{aq})$
$\text{Mg}(\text{NO}_3)_2(\text{aq})$	$\text{FeSO}_4(\text{aq})$
$\text{H}_2\text{SO}_4(\text{aq})$	$\text{FeCl}_3(\text{aq})$

One solution from Group A is mixed with one solution from Group B.

- (a) (i) Which TWO solutions can give a green precipitate on mixing ?

(1 mark)

- (ii) Name the green precipitate mentioned in (a)(i).

(1 mark)

- (b) (i) Which TWO solutions can give a white precipitate on mixing ?

(1 mark)

- (ii) Write an ionic equation for the formation of the white precipitate mentioned in (b)(i).

(1 mark)

- (c) Which TWO solutions can give off gas bubbles on mixing ?

(1 mark)

7. (a) (i) Draw the three-dimensional structure of a dichloromethane molecule.

(1 mark)

(ii) Explain whether the bonds in a dichloromethane molecule are polar.

(2 marks)

(iii) Explain whether a dichloromethane molecule is polar.

(1 mark)

(b) Explain why the boiling point of dichloromethane is lower than that of ethanol.

(2 marks)

8. Five experiments were conducted to determine the enthalpy changes of neutralisation between different acids and alkalis as shown below. All experiments were performed by mixing 50.0 cm³ of 1.0 M acid with 50.0 cm³ of 1.0 M alkali at room conditions.

Experiment	Acid	Alkali
1	HCl(aq)	NaOH(aq)
2	HCl(aq)	KOH(aq)
3	HNO ₃ (aq)	NaOH(aq)
4	HNO ₃ (aq)	KOH(aq)
5	CH ₃ COOH(aq)	NaOH(aq)

- (a) In Experiment 1, the temperature of the reaction mixture was raised by 6.8 °C. Calculate the enthalpy change of neutralisation between HCl(aq) and NaOH(aq), in kJ mol⁻¹.
(Density of the reaction mixture = 1.0 g cm⁻³;
specific heat capacity of the reaction mixture = 4.20 J g⁻¹ K⁻¹)

(2 marks)

- (b) Explain why the enthalpy changes of neutralisation found in experiments 1 to 4 were approximately the same.

(1 mark)

- (c) The result of Experiment 5 showed that the enthalpy change of neutralisation between CH₃COOH(aq) and NaOH(aq) was -50.10 kJ mol⁻¹. Using your answer to (a), calculate the enthalpy change for the following reaction.



(2 marks)

- *9. Using silver oxide, lead(II) oxide and aluminium oxide as examples, state THREE different methods to extract metals from their oxides, and describe the relation between the extraction method of a metal and its position in the metal reactivity series.

(5 marks)

Answers written in the margins will not be marked.

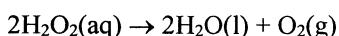
Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

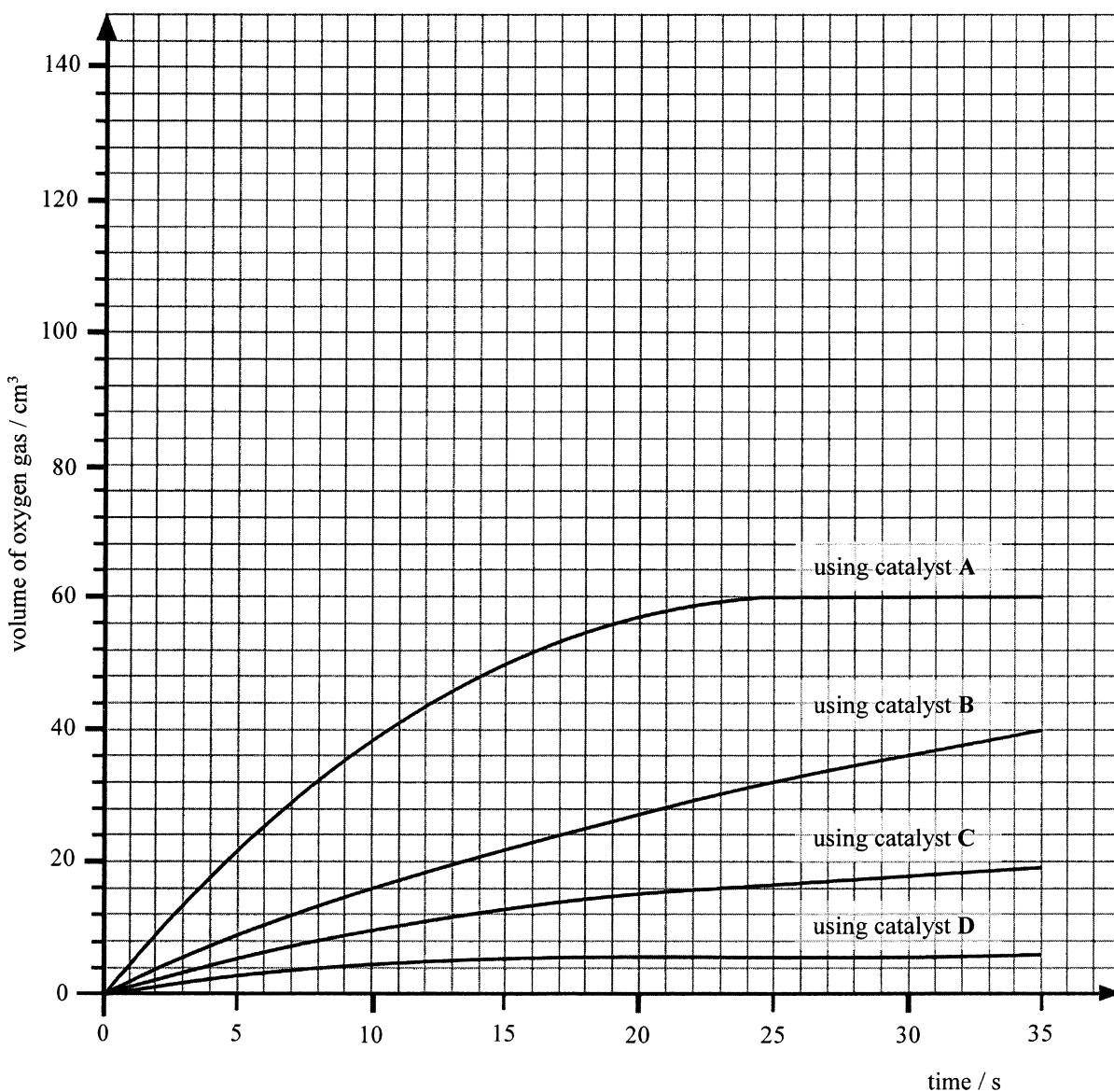
PART II

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

10. The decomposition of hydrogen peroxide is shown below :



Four experiments were performed to compare the effects of four different solid catalysts **A**, **B**, **C** and **D** on the decomposition of hydrogen peroxide at room conditions. In each experiment, the same amount of the respective catalyst was added to 10.0 cm^3 of $0.50 \text{ M H}_2\text{O}_2(\text{aq})$ and the decomposition was allowed to go to completion. The volumes of oxygen gas evolved were measured at regular time intervals. The graph below shows the results of the experiments in the first 35 seconds.

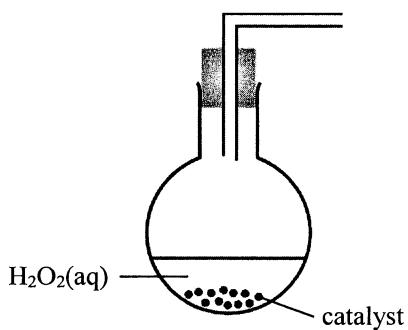


Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

10. (a) Complete the following set-up diagram (with label) to show how the volumes of oxygen gas formed can be measured in the above experiments.



(1 mark)

- (b) Which of the four catalysts is the most effective ? Explain your answer.

(1 mark)

- (c) What is the theoretical final volume of oxygen gas produced in the experiment using catalyst B ?

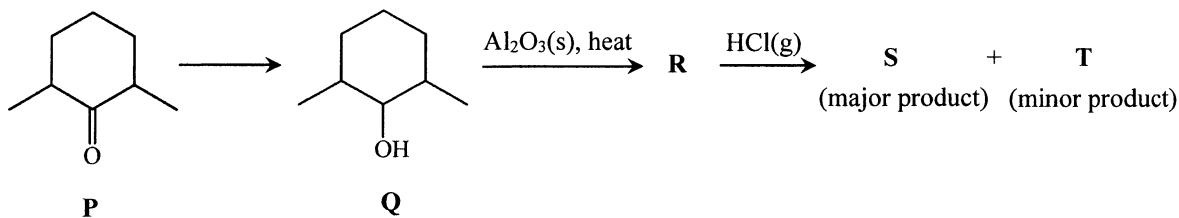
(1 mark)

- (d) A fifth experiment was conducted using the same amount of catalyst A, but 10.0 cm^3 of 1.00 M $\text{H}_2\text{O}_2(\text{aq})$ was used. The reaction completed at the 20^{th} second. Sketch a curve on the graph on page 14 to show the expected result in the first 35 seconds.
(Molar volume of gas at room conditions = 24 dm^3)

(2 marks)

Answers written in the margins will not be marked.

11. Refer to the following conversions involving five organic compounds **P**, **Q**, **R**, **S** and **T**.



- (a) Suggest the reagent(s) and condition(s) needed for the conversion of **P** to **Q**.

(1 mark)

- (b) State the type of reaction involved in the conversion of **Q** to **R**.

- (c) Draw the structure of **R**.

(1 mark)

- (d) Draw the structure of **S**.

(1 mark)

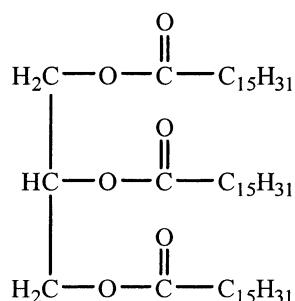
- (e) State which TWO of the four organic compounds, **Q**, **R**, **S** and **T**, can react with $\text{KMnO}_4(\text{aq})$ under appropriate conditions, and draw the structures of the organic products formed respectively.

Compound _____	Compound _____
Structure of organic product :	Structure of organic product :

(3 marks)

Answers written in the margins will not be marked.

12. An organic compound **Z** can be hydrolysed by concentrated NaOH(aq) to form product **A** and product **B**. Product **B** has a cleansing property. The structure of **Z** is shown below :



- (a) Give the systematic name of product **A**. (1 mark)
- (b) Draw the structure of product **B**. (1 mark)
- (c) (i) Apart from foam formation, suggest another expected observation when product **B** is added to an oil-water mixture and shaken. (1 mark)
- (ii) Based on the structure of product **B**, explain your suggested observation in (c)(i). (2 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.

Answers written in the margins will not be marked.

13. Aluminium, sulphur and chlorine are elements in the third period of the Periodic Table.

- (a) Based on the products formed (if any) when aluminium oxide reacts with dilute HCl(aq) and with dilute NaOH(aq) respectively, describe the acid-base behaviour of aluminium oxide.

(3 marks)

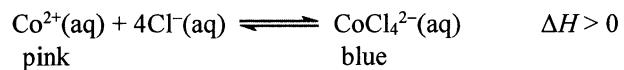
- (b) Explain, from molecular level, why sulphur is a solid but chlorine is a gas at room conditions.

(2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

- *14. With an addition of NaCl(s) to or an increase in the temperature of the following chemical equilibrium system, there are observable changes in the equilibrium mixtures in these TWO CASES.



Considering the effects on the equilibrium position and the equilibrium constant of the system in the above TWO CASES, state and explain the expected observable changes in these TWO CASES. (6 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

**END OF SECTION B
END OF PAPER**

Answers written in the margins will not be marked.

PERIODIC TABLE 周期表

GROUP 族

atomic number 原子序

H	1.0
----------	-----

I II

3 Li 4 Be

6.9 9.0

11 Na 12 Mg

23.0 24.3

19 K 20 Ca

39.1 40.1

37 Rb 38 Sr

85.5 87.6

55 Cs 56 Ba

132.9 137.3

87 Fr 88 Ra

(223) (226)

1 2 He

4.0 Ne

10 20.2

0

He

4.0

10 Ne

20.2

relative atomic mass 相對原子質量

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

41 Nb

95.9

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 Te

121.8

52 I

127.6

53 Xe

131.3

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)

89 ** Ac

(227)

104 Rf

(261)

105 Db

(262)

95 Sm

150.4

96 Gd

157.3

97 Tb

158.9

98 Dy

162.5

99 Ho

164.9

100 Er

167.3

101 Tm

168.9

102 Yb

173.0

103 Lu

175.0

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)