2023-DSE
CHEM
PAPER 1B

B

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HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2023

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.

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PART I

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

1. Both calcium (Ca) and strontium (Sr) are elements in Group II of the Periodic Table.

(a) What is the name of Group II ?

(1 mark)

(b) Limewater is a saturated solution of calcium hydroxide.

(i) Carbon dioxide gas is passed into limewater until the solution turns milky. Write the chemical equation for the reaction involved.

(1 mark)

(ii) When excess carbon dioxide gas is passed into the milky solution in (b)(i), a colourless solution is formed. What is the product of this reaction ?

(1 mark)

(c) The table below shows the abundance of each isotope in a sample of strontium :

Isotope	^{84}Sr	^{86}Sr	^{87}Sr	^{88}Sr
Abundance (%)	0.56	9.86	7.02	82.56

Calculate the relative atomic mass of strontium in the sample.

(2 marks)

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Answers written in the margins will not be marked.

1. (d) Strontium reacts with chlorine to form strontium chloride.

(i) Draw the electron diagram for strontium chloride, showing ELECTRONS IN THE OUTERMOST SHELLS only.

(1 mark)

(ii) Complete the following sentences :

(1) The bonding in solid strontium is the electrostatic attraction between _____ and _____.

(2) The type of structure in solid strontium chloride is _____ structure.

(2 marks)

(iii) State and explain the difference between the electrical conductivity of solid strontium and that of solid strontium chloride.

(2 marks)

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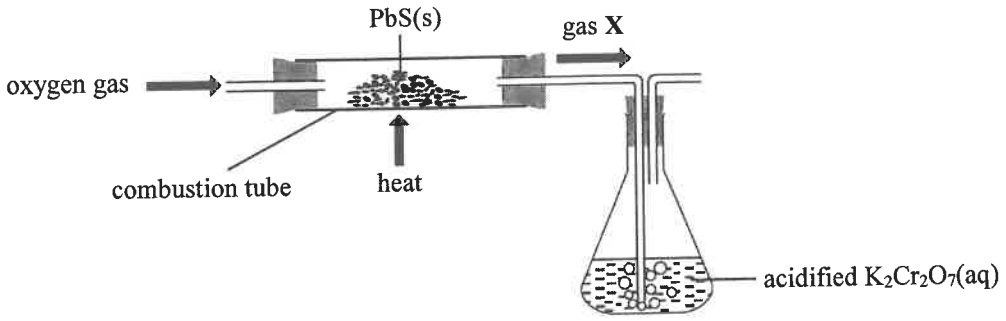
2. The extraction of lead metal from lead(II) sulphide (PbS) involves two stages.

Stage I : PbS(s) and oxygen gas are strongly heated using the experimental set-up shown below. Lead(II) oxide and a gas **X** are formed in the combustion tube. Gas **X** is passed into acidified $K_2Cr_2O_7(aq)$.



(a) Suggest a method to obtain oxygen from air.

(1 mark)

(b) Gas **X** turns acidified $K_2Cr_2O_7(aq)$ from orange to green.

(i) What is gas **X** ?

(1 mark)

(ii) Write an ionic equation for the reaction between gas **X** and acidified $K_2Cr_2O_7(aq)$.

(1 mark)

(c) Write the chemical equation for the reaction that occurs in the combustion tube.

(1 mark)

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

(1 mark)

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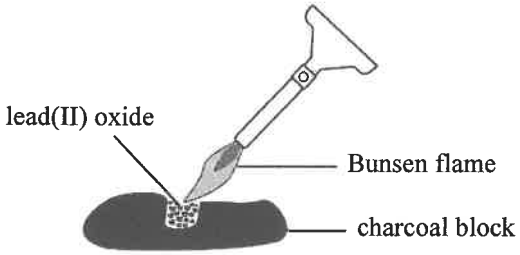
2. **Stage II :** The lead(II) oxide formed in the combustion tube is separated and placed on a charcoal block. The oxide is then strongly heated as shown below.



(e) (i) A solid product is formed from the reaction in Stage II. Describe the appearance of the solid product.

(1 mark)

(ii) In terms of oxidation number, explain whether the reaction in Stage II is a redox reaction.

(1 mark)

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3. The following table shows the results of some experiments carried out on three metals **A**, **B** and **C**.

Experiment \ Metal	A	B	C
Reaction with water	no observable change	no observable change	reacts vigorously
Reaction with dilute hydrochloric acid	a colourless gas **Y** evolves moderately	no observable change	(This experiment is dangerous and should NOT be carried out.)
Strong heating in air	a white solid is obtained after cooling	no observable change	burns with a lilac flame

(a) According to the above experimental results, arrange these three metals in descending order of reactivity.

(1 mark)

(b) Suggest a test for gas **Y**.

(1 mark)

(c) (i) State an expected observation when metal **C** reacts vigorously with water.

(1 mark)

(ii) Explain why it is dangerous to carry out the reaction of metal **C** with dilute hydrochloric acid.

(1 mark)

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3. (d) Using the following items ONLY, outline the experimental procedure and state an expected observation to confirm the relative reactivities of metal **A** and metal **B**.

a strip of metal **A**, a strip of metal **B**, $\mathbf{A}(NO_3)_2(aq)$, $\mathbf{B}NO_3(aq)$, test tubes

(2 marks)

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4. Tartronic acid ($C_3H_4O_5$) is an organic acid found in cucumbers.

(a) 24.62 cm^3 of 0.207 M NaOH(aq) can completely neutralise 25.00 cm^3 of 0.102 M tartronic acid.

(i) Calculate the basicity of tartronic acid.

(2 marks)

(ii) A molecule of tartronic acid contains a hydroxyl group. Write the structural formula of tartronic acid.

(1 mark)

(b) Under certain conditions, the pH of 0.102 M tartronic acid is 1.87. By calculation, show that tartronic acid is NOT completely ionised in water.

(2 marks)

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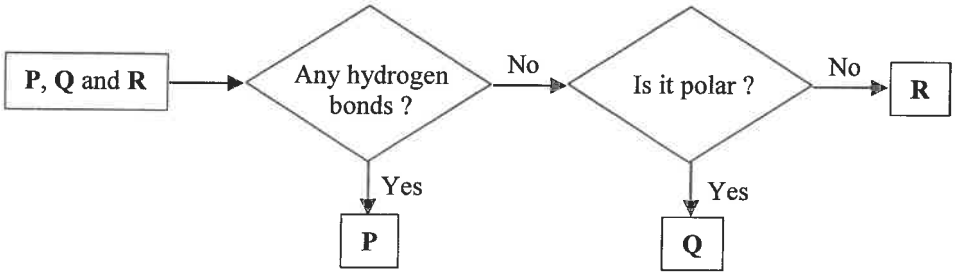
5. **P**, **Q** and **R**, each represents one of the following compounds :

CH_3F CF_4 HF

The following flowchart can be used to identify **P**, **Q** and **R**.



(a) With the aid of a diagram, describe and explain the formation of hydrogen bonding between **P** molecules.

(3 marks)

(b) (i) What is **Q** ?

(1 mark)

(ii) Explain, from molecular level, why **Q** is polar.

(1 mark)

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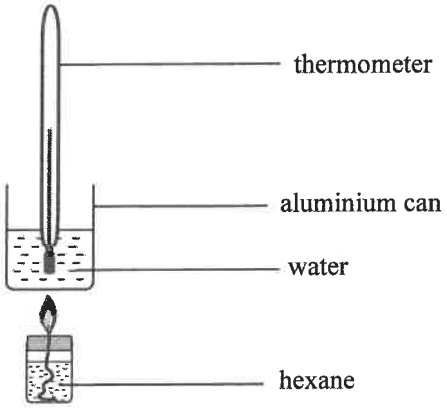
6. Hexane (C_6H_{14}) is a liquid fuel. Under certain experimental conditions, the enthalpy change of combustion of hexane was determined using the following set-up. The combustion of 0.120 g of hexane increased the temperature of 100.0 g of water by 13.4 °C.



(a) Calculate the enthalpy change of combustion of hexane, in kJ mol^{-1}, under these experimental conditions.
(Assume that the heat capacity of the aluminium can is negligible and the specific heat capacity of water is 4.20 J g^{-1} K^{-1}.)
(Relative atomic masses : H = 1.0, C = 12.0)

(2 marks)

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6. (b) (i) Write the chemical equation for the complete combustion of hexane, showing all state symbols.

(1 mark)

(ii) The following standard enthalpy changes of formation are given :

$C_6H_{14}(l) = -167.2$ kJ mol^{-1}, $H_2O(l) = -285.9$ kJ mol^{-1}, $CO_2(g) = -393.5$ kJ mol^{-1}

Calculate the standard enthalpy change of combustion of hexane.

(2 marks)

(c) Besides heat loss, suggest one reason why the answers obtained from (a) and (b)(ii) are different.

(1 mark)

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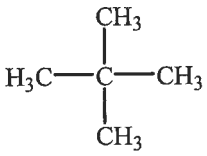
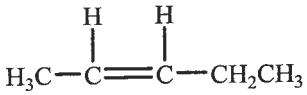
7. **X** and **Y** are hydrocarbons. Their structural formulae are shown below :

X :



Y :



(a) Write the systematic name of **X**.

(1 mark)

(b) Suggest one difference between the burning characteristics of **X** and **Y**.

(1 mark)

(c) Besides burning, suggest a chemical test to distinguish between **X** and **Y**.

(2 marks)

(d) **Y** can form a polymer. Draw the repeating unit of this polymer.

(1 mark)

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8. Using the following items ONLY, design an experiment to electroplate nickel (Ni) on an iron rod.

d.c. power supply, a nickel strip, an iron rod, nickel(II) sulphate solution, connecting wires, a beaker

(a) Draw a labelled diagram to show the experimental set-up.

(2 marks)

(b) State one function of nickel(II) sulphate solution in this experiment.

(1 mark)

(c) Write the half equation for the formation of nickel on the iron rod.

(1 mark)

(d) Ni(s) is a stronger reducing agent than OH^-(aq) ions and SO_4^{2-}(aq) ions. Nickel(II) sulphate solution is green in colour. Would there be any expected observable change in the solution in this experiment ? Explain your answer.

(2 marks)

(e) State one purpose of electroplating nickel on iron objects.

(1 mark)

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*9. Outline the steps in preparing magnesium sulphate crystals from solid magnesium carbonate and dilute sulphuric acid. You do NOT need to mention the apparatus involved.

(5 marks)

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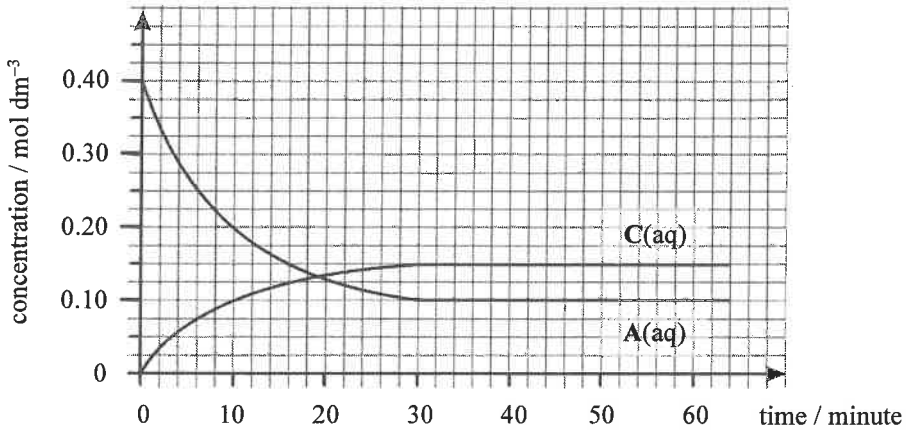
PART II

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

10. Consider the reaction represented by the equation below :

$$2\mathbf{A}(aq) \rightleftharpoons 2\mathbf{B}(aq) + \mathbf{C}(aq) \qquad \Delta H > 0$$

In an experiment, a certain volume of 0.40 mol dm^{-3} **A**(aq) was initially placed in a container, and this system was allowed to attain chemical equilibrium at constant temperature $\mathbf{T_1}$. The following graph shows the variation of the concentrations of **A**(aq) and **C**(aq) with time.



(a) According to the above graph, give one reason to support the following statement :

'The system just attained chemical equilibrium at the 30th minute.'

(1 mark)

(b) Draw a curve on the graph to show the variation of the concentration of **B**(aq) with time. (1 mark)

(c) Calculate the equilibrium constant K_c for the reaction at temperature $\mathbf{T_1}$.

(2 marks)

(d) When the temperature of the equilibrium mixture changed from $\mathbf{T_1}$ to $\mathbf{T_2}$, a new chemical equilibrium was attained. The concentration of **A**(aq) was found to be 0.14 mol dm^{-3} in the new chemical equilibrium. Deduce whether $\mathbf{T_1}$ or $\mathbf{T_2}$ is the higher temperature.

(2 marks)

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11. Compounds **X** and **Y** are *cis-trans* isomers with the same molecular formula C_4H_8.

(a) **X** is polar but **Y** is non-polar.

(i) Give the systematic name of **X**.

(1 mark)

(ii) Write the structural formula of **Y**.

(1 mark)

(b) A mixture of **X** and **Y** can be formed from the dehydration of an optically active alcohol **Z**.

(i) Suggest a reagent and a reaction condition needed for this reaction.

(1 mark)

(ii) Write the structural formula of **Z**.

(1 mark)

(iii) Draw the three-dimensional diagrams for the structures of the pair of enantiomers of **Z**.

(2 marks)

(iv) Describe the difference in the optical activity between the pair of enantiomers of **Z**.

(1 mark)

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12. Outline a synthetic route, with NO MORE THAN THREE STEPS, to accomplish the following conversion. For each step, give the reagent(s), reaction conditions (as appropriate) and structure of the organic product.

$$CH_3CH_2CH_2CH_2OH \longrightarrow CH_3CH_2CH_2CONH_2$$

(3 marks)

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13. (a) In terms of bonding and structure, account for the difference in the melting points of the following oxides.

	SiO_2	P_4O_{10}	SO_2
Melting point (°C)	1 710	340	–72

(3 marks)

(b) $Fe^{2+}(aq)$ reacts with $H_2O_2(aq)$ in an acidic medium to form $Fe^{3+}(aq)$ and $H_2O(l)$.

(i) Write the chemical equation for the reaction.

(1 mark)

(ii) State how this reaction can demonstrate that iron exhibits TWO characteristics of transition metals.

(2 marks)

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*14. Consider the following reaction :

$$Br_2(aq) + HCOOH(aq) \rightarrow 2HBr(aq) + CO_2(g)$$

Describe and explain how to follow the progress of the above reaction by measuring the colour intensity of the reaction mixture. Experimental details are NOT required. Sketch a labelled graph to show the expected results and explain the shape of the graph.

(6 marks)

END OF SECTION B
END OF PAPER

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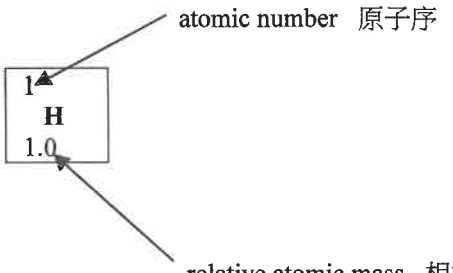
PERIODIC TABLE　周期表

GROUP 族



I	II											III	IV	V	VI	VII	0
																	2 **He** 4.0
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	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)	104 **Rf** (261)	105 **Db** (262)													

*	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)