2021-DSE
CHEM
PAPER 1B

B

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HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2021

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. Acetylene (C_2H_2) is a fuel. It can be obtained from calcium carbide (CaC_2) by two different reactions as represented by the equations shown below :

$$CaC_2 + A \xrightarrow{2200\ ^\circ C} C_2H_2 + Ca \qquad \text{Reaction (I)}$$

$$CaC_2 + 2H_2O \xrightarrow{25\ ^\circ C} C_2H_2 + Ca(OH)_2 \qquad \text{Reaction (II)}$$

(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)

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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)

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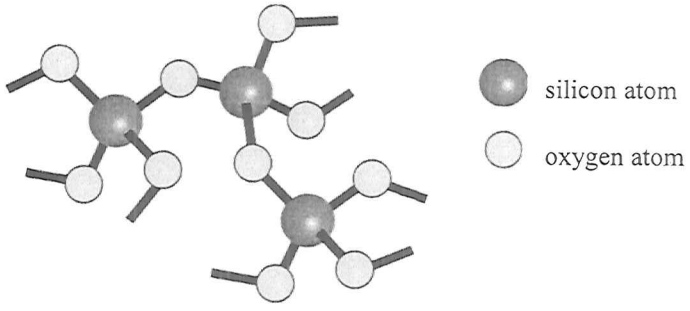
3. (c) (ii) Under certain conditions, 1.0 g of SiO_2 is allowed to react with 1.0 g of Mg. The equation for the reaction is shown below :

$$SiO_2 + 2Mg \rightarrow 2MgO + Si$$

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 :

$$C_{10}H_{22} \rightarrow C_4H_{10} + 2X$$

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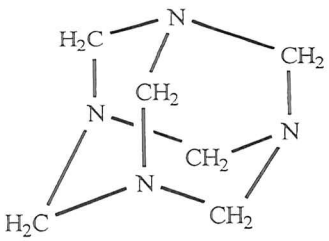
5. Hexamine ($C_6H_{12}N_4$) is the main component of a portable solid fuel. It is a solid under room conditions and its structure is shown below :



(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 :

$$C_6H_{12}N_4(s) + 13O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l) + 4NO_2(g)$$

Calculate the standard enthalpy change of combustion of hexamine.

(3 marks)

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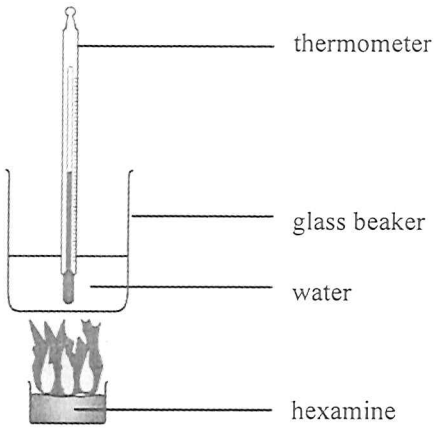
5. (c) The following diagram shows an experimental set-up for determining the enthalpy change of combustion of hexamine under certain experimental conditions.



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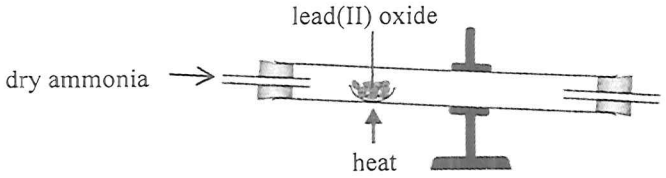
6. Lead can be obtained from lead(II) oxide using the experimental set-up shown below. Besides lead, nitrogen gas and steam are also formed.



(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)

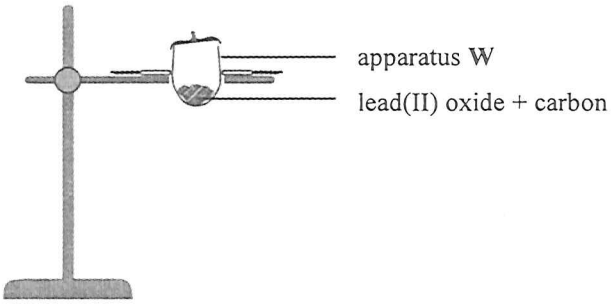
(c) Explain which of the reagents is a reducing agent in the reaction.

(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 cm^3.

Step (2) : 25.0 cm^3 of the standard solution obtained in Step (1) was transferred to a clean conical flask and then a few drops of methyl orange were added.

Step (3) : The sample of hydrochloric acid was put into a burette. The standard solution in the conical flask was titrated with the hydrochloric acid.

Step (2) and Step (3) were repeated for several times. The table below shows the results of the titrations :

	Trial	1	2	3	4
Final burette reading / cm^3	30.85	28.75	28.30	31.35	27.25
Initial burette reading / cm^3	2.00	1.50	1.00	3.00	0.00

(a) Describe the procedure in preparing the standard sodium carbonate solution in Step (1).

(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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*8. You are provided with the following items :

lemon, multimeter, connecting wires, Zn strip, Cu strip, Ag strip

With the aid of a labelled diagram, suggest how you can perform an experiment to confirm (with explanation) the order of reducing power of metals as Zn > Cu > Ag.

(6 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 $CH_4(g)$, $H_2S(g)$, $H_2(g)$ and $CS_2(g)$ 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 :

$$CH_4(g) + 2H_2S(g) \rightleftharpoons 4H_2(g) + CS_2(g)$$

(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 :

	$CH_4(g)$	$H_2S(g)$	$H_2(g)$	$CS_2(g)$
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 $CH_4(g)$ 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)

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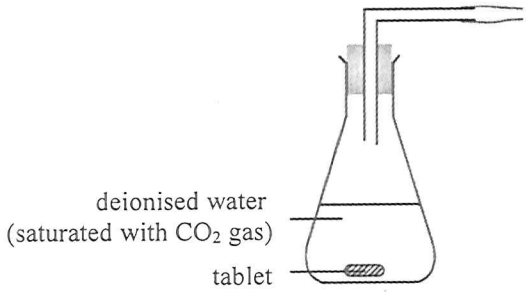
10. A tablet contains solid sodium hydrogencarbonate and solid citric acid (water soluble). An experiment was performed under room conditions to study the rate of formation of CO_2 gas when the tablet was placed in deionised water.

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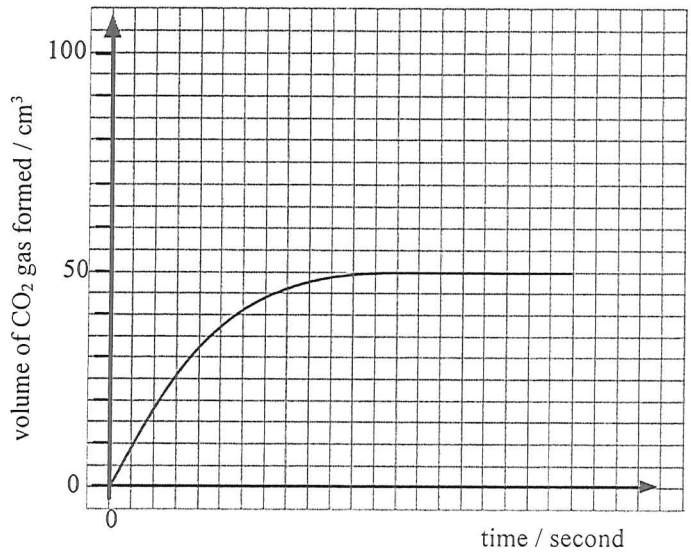
10. (b) (i) The graph below shows the variation of the volume of CO_2 gas formed with time for the experiment :



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)

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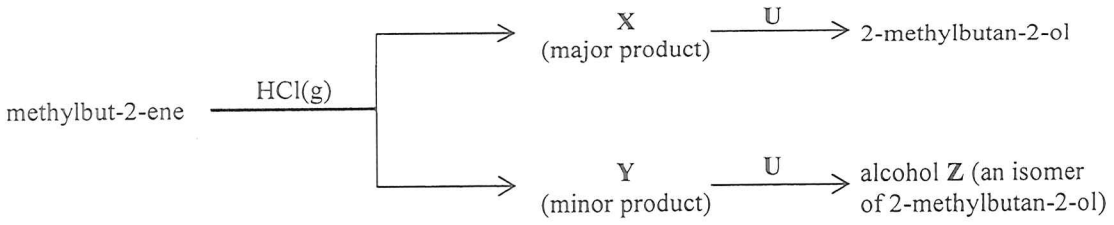
11. Methylbut-2-ene reacts with HCl(g) to give **X** as the major product as predicted from Markovnikov's rule. During the reaction, another product **Y** (minor product) can also be formed. Refer to the following organic conversions :



(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**.

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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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Answers written in the margins will not be marked.

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 :

$$Cu_2O(s) + H_2SO_4(aq) \rightarrow Cu(s) + CuSO_4(aq) + H_2O(l)$$

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

(2 marks)

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*13. Using nylon-6,6 as an example, illustrate the meaning of condensation polymerisation. Your answer should also include the structural feature of the monomers.

(5 marks)

END OF SECTION B
END OF PAPER

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PERIODIC TABLE 周期表

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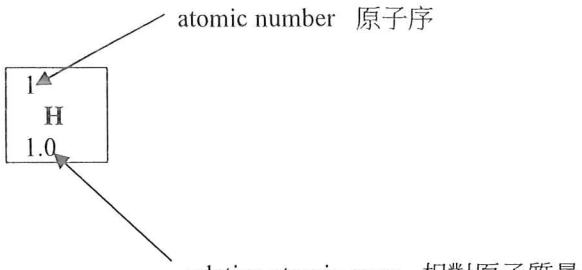

I	II											III	IV	V	VI	VII	0
																	2 **He** 4.0
3 **Li** 6.9	4 **Be** 9.0											5 **B** 10.8	6 **C** 12.0	7 **N** 14.0	8 **O** 16.0	9 **F** 19.0	10 **Ne** 20.2
11 **Na** 23.0	12 **Mg** 24.3											13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	18 **Ar** 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)

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