2021-DSE
CHEM
PAPER 1B

B

Level 5 Exemplar
Paper 1B

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2021

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.

* A 1 4 0 E 0 1 B *

PART I

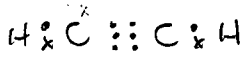
Answer **ALL** questions. Write your answers in the spaces provided.

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

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

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

(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.

$2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$

(1 mark)

(c) Refer to Reaction (I) :

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

$H_2(g)$

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

$H_2(g)$ is flammable and explosive

(2 marks)

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

To neutralize the acidic soil

(1 mark)

Answers written in the margins will not be marked.

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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 $PbBr_2$ Anode = Br_2	Graphite anode	**(a) Observation:** Brown gas forms.		
	Graphite cathode			**(b) Half equation:** $Pb^{2+}_{(l)} + 2e^- \rightarrow Pb_{(s)}$
Very dilute $ZnCl_2$ solution	Platinum anode			**(c) Half equation:** Anode : $4OH^-_{(aq)} \rightarrow O_{2(g)} + 2H_2O_{(l)} + 4e^-$
	Platinum cathode		**(d) Product:** Hydrogen gas	
Concentrated $CuSO_4$ solution	Copper anode		**(e) Product:** $Cu^{2+}_{(aq)}$	
	Copper cathode	**(f) Observation:** Copper deposits		**(g) Justification:** Cu at anode will preferentially discharge as it has a stronger reducing power than $OH^-_{(aq)}$. Cu^{2+} at cathode will preferentially discharge as it has a stronger oxidizing power than $H^+_{(aq)}$.

(7 marks)

Answers written in the margins will not be marked.

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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' ?

Isotope is different atoms of the element, with the same number of protons but different number of neutrons.

(1 mark)

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

$y = 100 - 92.20 - x$.

$28(92.20\%) + 29(x\%) + 30((7.8 - x)\%) = 28.1$

$25.816 + 0.29x + 2.34 - 0.3x = 28.1$

$-0.01x = -0.056$

$x = 5.6$ ✓

(2 marks)

(c) Silicon dioxide is an oxide of silicon.

(i) Explain why silicon dioxide has a high melting point.

Si and O atoms in SiO_2 are held together by strong covalent bond.
(SiO_2 has a giant covalent structure.)
A large amount of energy is needed to overcome the strong covalent bond.

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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)

No. of moles of SiO_2 = (1g / 28.1 + 16 x 2) = 0.0166

Theoretical no. of moles of Mg = 0.0166 x 2 = 0.0332

Actual no. of moles of Mg = 1g / 24.3 = 0.04115

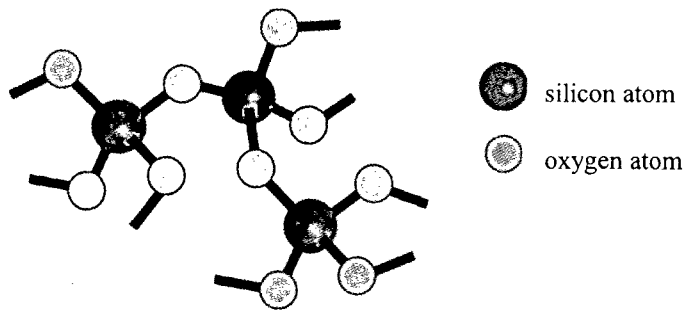
∴ SiO_2 is the limiting reactant.

Mass of Si formed = (0.0166 x 28.1)

= 0.47g

(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 ?

Quartz

(1 mark)

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

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

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

Propene

(1 mark)

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

Add acidified Potassium permaganate solution to X and butane separately.
Only X can turn acidified $KMnO_4$ (aq) from purple to colourless while butane cannot.

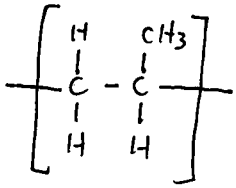
(2 marks)

(c) **X** can form a polymer **Z**.

(i) Suggest why **X** can form a polymer.

As X contains a C = C bond

(ii) Draw the repeating unit of **Z**.



(2 marks)

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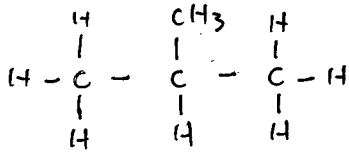
4. (d) Compound **Y** is a structural isomer of butane.

(i) Draw one possible structure of **Y**.



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

Decane should have the highest boiling point.

Molecules of decane, butane and Y are held together by van der Waals' forces and their boiling point depends on their shape.

Decane has a linear shape while butane has a linear shape with a shorter hydrocarbon chain. Y has a more spherical shape. As a result, molecules of Decane have the largest contact area result in a stronger van der Waals' forces between its molecules.

(3 marks)

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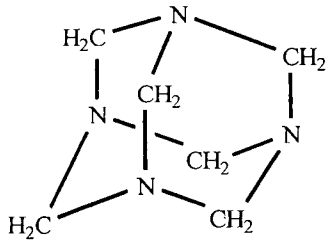
5. Hexamine ($C_6H_{12}N_4$) is the main component of a portable solid fuel. It is a solid under room conditions and its structure is shown below :



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

The energy absorbed for bond-breaking of hexamine is less than the energy released for bond-forming during the combustion. Thus, the combustion of hexamine is exothermic.

(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.

$6C_{(graphite)} + 6H_{2(g)} + 2N_{2(g)} \rightarrow C_6H_{12}N_{4(s)} \quad \Delta H_f^\ominus = +123\ kJ\ mol^{-1}$

(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.

$\Delta H_c^\ominus [C_6H_{12}N_4] = (-394 \times 6 + (-286 \times 6) + (+33 \times 4)) - (123)$

$= -4071\ kJ\ mol^{-1}$

(3 marks)

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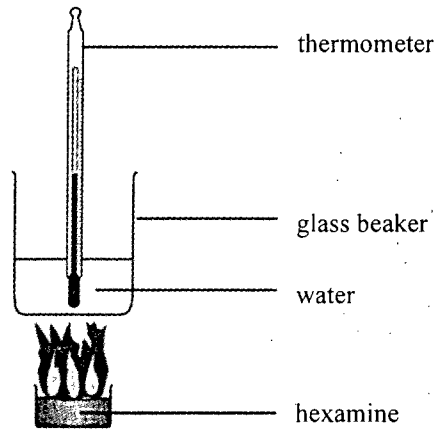
5. (c) The following diagram shows an experimental set-up for determining the enthalpy change of combustion of hexamine under certain experimental conditions.



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.

Heat released $= m c \Delta T$

$= (600)(4.2)(47.5°C - 23.5°C)$

$= 60480\ J$

Enthalpy change of combustion $= \dfrac{-60480\ J}{\frac{2.4\ g}{140}\ mol}$

$= -3528\ kJ\ mol^{-1}$ ✓

(3 marks)

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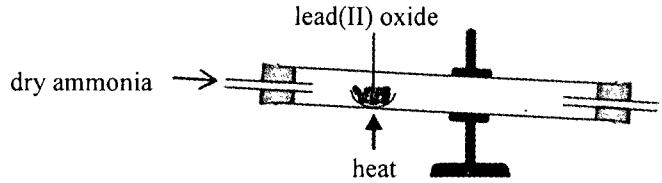
6. Lead can be obtained from lead(II) oxide using the experimental set-up shown below. Besides lead, nitrogen gas and steam are also formed.



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

(i) The reaction tube is placed in a downward slanted position.

To prevent the condensed steam (waterdroplets) from flowing back and crack the hot reaction tube

(ii) The experiment is performed in a fume cupboard.

Dry ammonia gas is toxic

(2 marks)

(b) Write a chemical equation for the reaction.

$3PbO + 2NH_3 \rightarrow 3Pb + N_2 + 3H_2O$

(1 mark)

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

NH_3. As the oxidation number of Pb decreases from +2 in PbO to 0 in Pb.

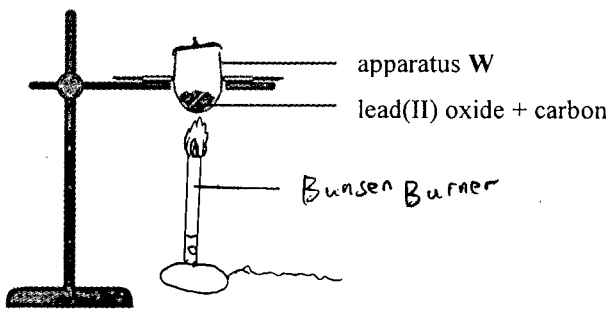
(1 mark)

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

(i) Write a chemical equation for the reaction.

$2PbO + C \rightarrow 2Pb + CO_2$

(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**.

Crucible

(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).

Accurately weigh the anhydrous sodium carbonate (Na_2CO_3).
Dissolve anhydrous Na_2CO_3 completely in distilled water.
Pour the Na_2CO_3 (aq) and all washings into a 250.0 cm^3 of volumetric flask.
Continue to add distilled water up to the graduation mark.

(2 marks)

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

From yellow to orange.

(1 mark)

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

27.43 cm^3 ✓

(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)

No. of moles of anhydrous Na_2CO_3 = (2.750 g) / ($\frac{250}{1000}$)
= 0.6875 mol

No. of moles of Na_2CO_3 reacted with HCl = 0.6875 × ($\frac{25}{250}$) = 0.06875 mol

No. of moles of HCl reacted = 0.06875 mol × 2 = 0.1375 mol

Concentration of HCl = ($\frac{0.1375 \text{ mol}}{36.5}$) / ($\frac{27.43}{1000}$) = 0.137 g dm^{-3} ✓

(3 marks)

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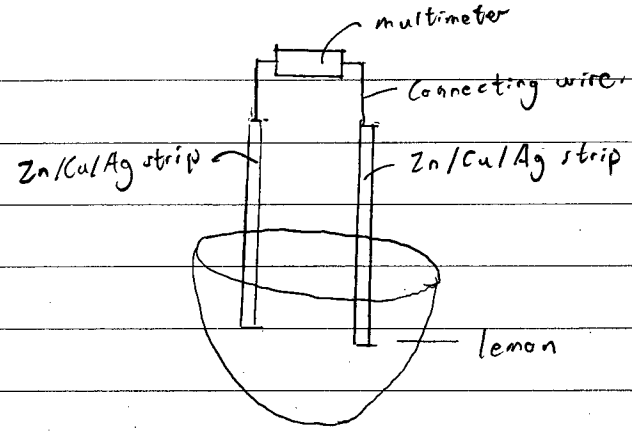
*8. You are provided with the following items :

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)



Prepare the above set-up and use Zn and Cu strip first. (Zn-Cu)

The electrons should flow from zinc to copper with a positive reading on multimeter.

Repeat the experiment by changing the metal couple (Zn-Ag, Cu-Ag).

Record the readings on multimeter in each experiment.

The metal couple (Zn-Ag) should have the greatest value while the metal couple (Cu-Ag) should have the least value.

As Zn is the most reactive metal among the 3 metals, it will oxidize to lose electrons more readily than Cu and Ag.

Thus, Zn has the greatest reducing power, followed by Cu and Ag.

(Keep the temperature, size of strip, the lemon the same in each experiment)

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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.

$$K_c = \frac{[CS_{2(g)}]_{eqm}[H_{2(g)}]^4_{eqm}}{[H_2S_{(g)}]^2_{eqm}[CH_{4(g)}]_{eqm}}$$

(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	0.055	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.

(ii) $K_c = \frac{(0.0125)(0.01)^4}{(0.055)^2(0.0275)}$

$= 1.50 \times 10^{-6}\ mol^2 dm^{-6}$ ✓

(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.

The value of K_c will remain unchanged.

As K_c can only be affected by change in temperature.

(4 marks)

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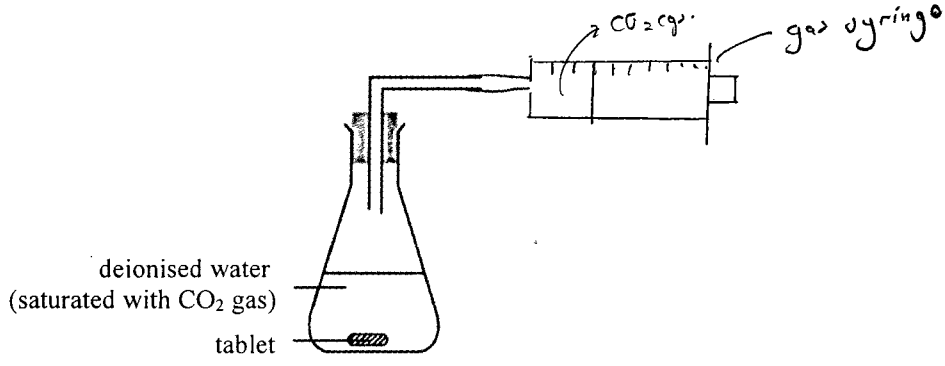
10. A tablet contains solid sodium hydrogencarbonate and solid citric acid (water soluble). An experiment was performed under room conditions to study the rate of formation of CO_2 gas when the tablet was placed in deionised water.

(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.

To prevent the CO_2 produced from reaction of $NaHCO_3$ and citric acid from dissolving into the deionised water.

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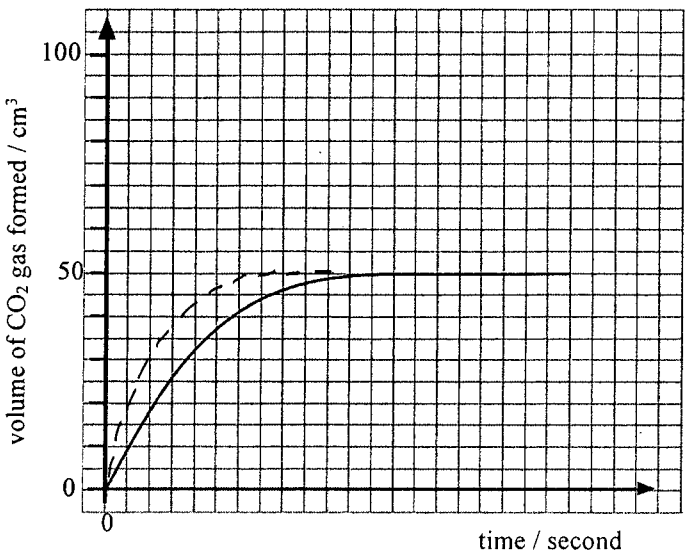
10. (b) (i) The graph below shows the variation of the volume of CO_2 gas formed with time for the experiment :



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)

No. of moles of CO_2 : $\frac{50}{1000} = 2.083 \times 10^{-3}$ mol
$\overline{24}$

2 mole of $NaHCO_3$ will react with 1 mole of citric acid to produce 2 mole of CO_2.

Therefore, no. of moles of $NaHCO_3$ = 2.083×10^{-3} mol $\times$ 84 g mol^{-1}

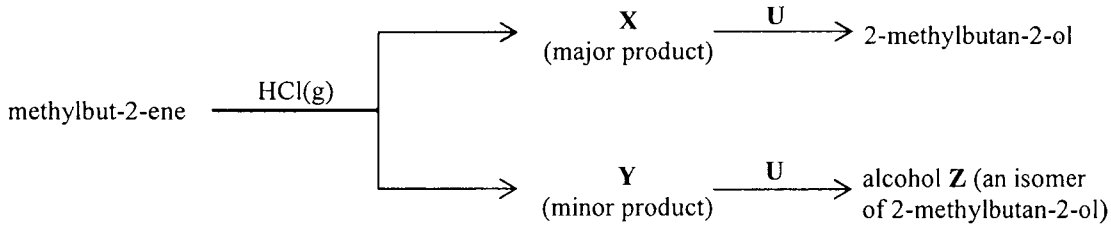
= 0.175 g ✓

(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)

Go on to the next page

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 :

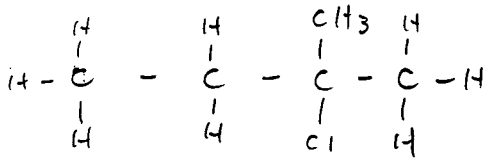


(a) State the Markovnikov's rule.

Markovnikov's rule states that

(1 mark)

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



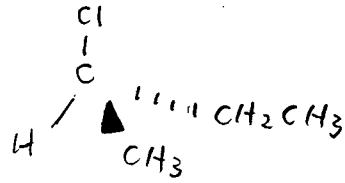
(1 mark)

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

NaOH (aq).

(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' ?

Y can rotate the plane of polarization of a beam of light.

(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.

Add acidified $K_2Cr_2O_7$ (aq) into 2-methylbutan-2-ol and Z separately.

Only Z can turn the solution from orange to green while 2-methylbutan-2-ol (Tertiary alcohol) cannot.

(2 marks)

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

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

As SiO_2 can react with alkali to form salt and water.

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

As SiO_2 cannot dissolve in water.
The concentration of $H^+_{(aq)}$ and $OH^-_{(aq)}$ in the mixture will still be the same.

(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.

$$P_2O_5 + 3H_2O \rightleftharpoons 2H_3PO_4$$

Phosphorus (V) oxide can dissolve in water to form phosphoric acid which is a tribasic weak acid.
Thus, the concentration of $H^+_{(aq)}$ in the mixture increases to lower the pH.

(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.

Cu exhibits coloured ions. As Cu^{2+} in $CuSO_4$ is blue in colour.

Cu also exhibits variable oxidation state. The oxidation number of Cu in Cu_2O increases from +1 to +2 in $CuSO_4$ and decrease from +1 to 0 in Cu.

(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)

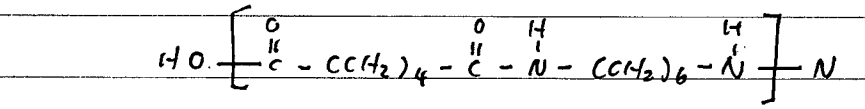
Condensation polymerisation is a process which difunctional monomers is joined repeatedly to form a polymer chain while small molecules are eliminated during the process.

The two difunctional monomers will be:

Each monomer has two functional groups.

Hence, one monomer can react with two another monomers to form amide linkage, with the elimination of small molecule (H_2O).

The repeating unit of nylon-6,6 will be:



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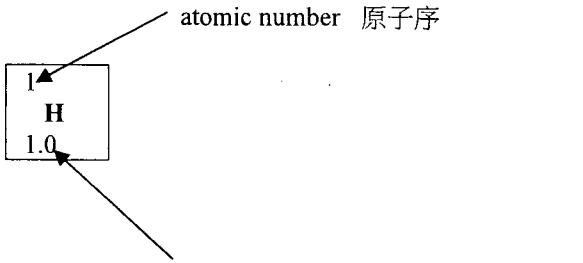
PERIODIC TABLE 周期表

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)

Level 5 Exemplar
Paper 2

2021 DSE (D)

香 港 考 試 及 評 核 局
HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

香 港 中 學 文 憑 考 試
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION

答 題 簿
ANSWER BOOK

由考生填寫 To be filled in by the candidate	
試題編號 Question No.	1a
	1b
	1c
	3a
	3b
	3c

考生須知

(一) 宣布開考後，考生須首先在第 1 頁之適當位置填寫考生編號，並在第 1 及 3 頁之適當位置貼上電腦條碼。

(二) 每題(非指分題)必須另起新頁作答，並須在每一頁的相應試題編號方格填畫「X」號，以表示選答的題號(見下例)，並在第一頁之適當位置填寫作答的試題編號。

(三) 紙張兩面均應使用，並應每行書寫。不可在各頁邊界以外位置書寫。寫於邊界以外的答案，將不予評閱。

(四) 如有需要，可要求派發方格紙及補充答題紙。每一紙張均須填寫考生編號、填畫試題編號方格、貼上電腦條碼，並用繩縛於**簿內**。

(五) 試場主任宣布停筆後，考生不會獲得額外時間貼上電腦條碼及填畫試題編號方格。

INSTRUCTIONS

(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 and 3.

(2) Start each question (not part of a question) on a new page. Put 'X' in the corresponding question number box on each page to indicate the appropriate question number (see the example below), and write the question number(s) of the question(s) attempted in the space provided on Page 1.

(3) Write on both sides using each line. Do not write in the margins. Answers written in the margins will not be marked.

(4) Graph paper and supplementary answer sheets will be supplied 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 book.

(5) 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.

例 Example:

試題編號 Question No. = 3

試題編號 Question No.

1	2	3	4	5	6	7	8	9	10	11	12	
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試題編號 Question No.

1	2	3	4	5	6	7	8	9	10	11	12
X											

13	14	15	16	17	18	19	20	21	22	23	24	≥25

每題另起新頁作答。
Start each question on a new page.

寫於邊界以外的答案，將不予評閱。
Answers written in the margins will not be marked.

1.(a)(i) $-77.7\ kJ\ mol^{-1}$ ✓

(ii) $\log k_1 = \text{constant} - \frac{65}{2.3(R)(T)}$

$\log k_1 = \text{constant} - 0.0113$ ... ①

let the rate constant at 37°C be k_2

$\log k_2 = \text{constant} - \frac{65}{2.3(R)(T)}$

$\log k_2 = \text{constant} - 0.01009$ ... ②

② − ①

$\log k_2 = \text{constant} - 0.0109$

$-\log k_1 = \text{constant} - 0.0113$

$\log\left(\frac{k_2}{k_1}\right) = 4 \times 10^{-4}$

$\frac{k_2}{k_1} = 1.00092$

$k_2 = k_1$ ✓

(iii) (1) $\frac{3}{2}$

(2) $mol^{\frac{-3}{2}} dm^{\frac{-45}{2}} s^{-1}$ ✓

(b)(i) To prevent the impurities on N_2 (g) and H_2 (g) from contaminating the Fe catalyst used in reaction chamber.

(ii) The unreacted N_2 (g) and H_2 (g) is heated to conserve heat for the Haber process.

(iii) As ammonia has a lower condensation point than N_2 (g) and H_2 (g).

(iv) (1) Finely divided iron

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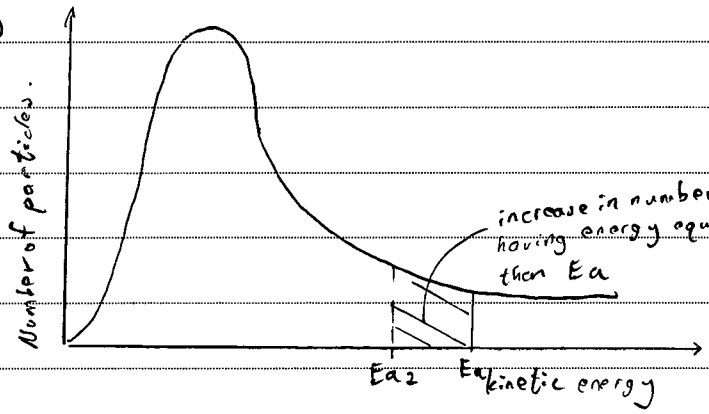
(b)(iv)(2)



When a catalyst is used, the catalyst can provide an alternative pathway that have a lower activation energy.
Thus, more reactants possessing energy equals or greater than activation energy (Ea).
As a result, the number of effective collision and the collision frequency increases to increase the reaction rate.

1.(c)(i) Toxic

(ii) Animal manure

(iii) When the temperature increases, the percentage conversion of $CH_4(g)$ at a constant pressure increases. from 800°C to 900°C

Therefore, the forward reaction should be endothermic as increase in temperature favours backward reaction (exothermic) in this case.

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每題另起新頁作答。
Start each question on a new page.

(c)(iii)(2) $CH_{4(g)} + H_2O_{(g)} \rightleftharpoons CO_{(g)} + 3H_{2(g)}$.

When the pressure increases, the percentage conversion of $CH_{4(g)}$ at a constant temperature drops.

(iv) $CO + 2H_2 \rightleftharpoons CH_3OH$

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每題另起新頁作答。
Start each question on a new page.

3.(a)(i) Add excess aqueous ammonia into $Al_2(SO_4)_3$ (aq) and $ZnSO_4$ (aq) separately.

$Al_2(SO_4)_3$ (aq) will form a white precipitate while $ZnSO_4$ (aq) will form a colourless solution.

(ii) Add sodium hydrogencarbonate solution into $(CH_3)_3COH$ (l) and CH_3COOH (aq) separately.

Only the reaction mixture of CH_3COOH (aq) will react with $NaHCO_3$ (aq) to give colourless gas bubbles.

(iii) An orange precipitate will be formed.

(b)(i) Excess sodium carbonate solution should be added to the separating funnel and shake the funnel well for better mixing.

Release the pressure by opening the tap of the funnel.

If no more colourless gas bubbles envolve, discard the lower layer (aqueous layer), ~~which contains unreacted phosphoric acid~~

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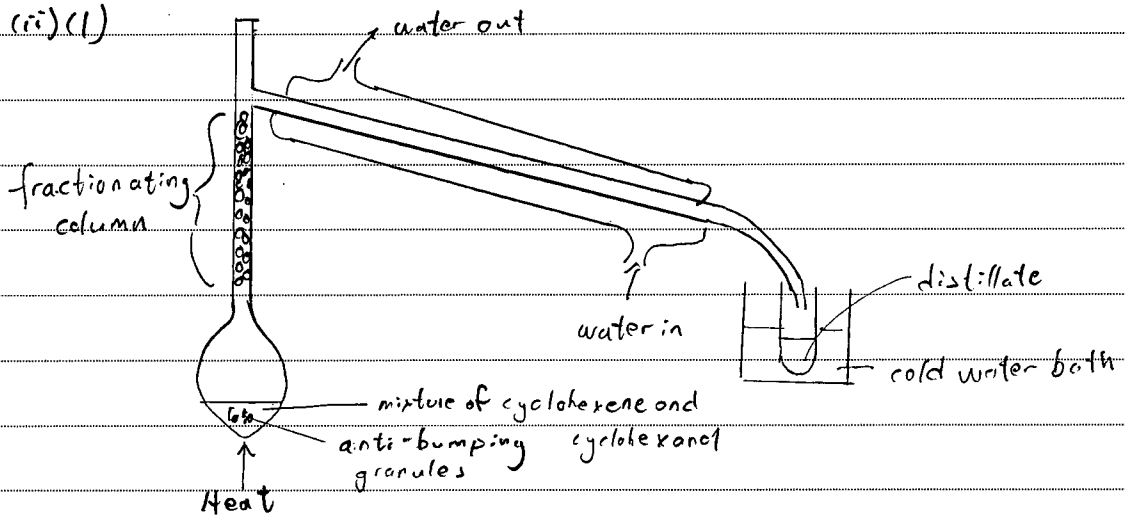
(b)(ii)(1)



(2) If the infra-red spectroscopy of the distillate does not show strong absorption peaks at wavenumber range 3230 to 3670 cm^{-1}, the distillate is cyclohexane.
As that absorption peak indicates the presence of hydroxyl group.

Assume A is 100g

3.(c)(i) The mole ratio of C : H : O = $\frac{70.6}{12} : \frac{5.9}{1} : \frac{23.5}{16}$

$= 5.88 : 5.9 : 1.46875$

$\approx 4 : 4 : 1$

$n(C_4H_4O_1) = 136$

$n(12\times4 + 4 + 16) = 136$

$n = 2$

Molecular formula of A = $C_8H_8O_2$.

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Start each question on a new page.

(ii) The peak of m/z = 105 indicates the presence of $C_6H_5CO^+$

The peak at m/z = 136 indicates the presence of $C_6H_5COOCH_3$.

Thus, structural formula of A = $C_6H_5COOCH_3$.

(iii) (1) $C_6H_5COOCH_3 + NaOH \rightarrow C_6H_5COONa + CH_3OH$

No. of moles of HCl used = $0.05\ M \times \left(\frac{20.4}{1000}\ dm^3\right)$

$= 1.02 \times 10^{-3}$

No. of moles of NaOH reacted with $C_6H_5COOCH_3$ =

$0.06\ M \times \left(\frac{50}{1000}\right) - 1.02 \times 10^{-3}$

$= 1.98 \times 10^{-3}$ mol

Mass of $C_6H_5COOCH_3 = 1.98 \times 10^{-3}\ mol \times 136\ g\ mol^{-1}$

$= 0.26928$

% by mass of A = $\frac{0.26928}{2.75} \times 100\%$

$= 9.8\%$

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