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2022-DSE
CHEM
PAPER 1B

B

Level 2 Exemplar 1
Paper 1B

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2022

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.

A140E01B

PART I

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

1. Iodine is a halogen. It can form potassium iodide and hydrogen iodide.

(a) Name the relationship between $^{127}_{53}I$ and $^{129}_{53}I$.

Isotopes

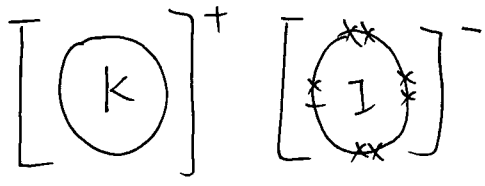
(1 mark)

(b) The electronic arrangement of an iodine atom is 2, 8, x, 18, y. What is x ?

7

(1 mark)

(c) Draw the electron diagram for potassium iodide, showing ELECTRONS IN THE OUTERMOST SHELLS only.



(1 mark)

(d) Suggest why an aqueous solution of hydrogen iodide can conduct electricity.

Because aqueous solution of hydrogen iodide is contain mobile ions to conduct electricity.

(1 mark)

(e) In terms of bonding and structure, explain whether potassium iodide or hydrogen iodide would have a higher melting point.

Potassium iodide would have higher melting point. Because potassium iodide is giant ionic structure, their is ionic bonding. While hydrogen iodide is simple molecular structure, their is van der Waal force. Ionic bonding is stronger than Van der Waal force. So potassium iodide would have higher melting point.

(2 marks)

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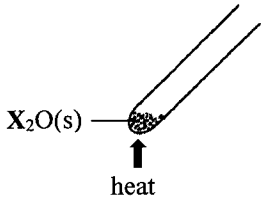
Answers written in the margins will not be marked.

2. The diagram below shows an experimental set-up in which a metal oxide $X_2O(s)$ is decomposed upon strong heating. A silvery metal **X** and a colourless gas **Z** are formed.



(a) State what **Z** is and suggest a test for it.

Oxygen. It can relight the sprint.

(2 marks)

(b) When 3.028 g of $X_2O(s)$ is completely decomposed, 2.819 g of metal **X** can be obtained.

(i) Calculate the relative atomic mass of **X**.
(Relative atomic mass : O = 16.0)

$2X_2O \longrightarrow 4X + O_2$

mass	3.028(g)	(2.819g)	0.209g
mole	0.026125	0.05225	0.0130625
mole ratio	2 :	4 :	1

(ii) Suggest what **X** is.

(3 marks)

(c) Explain whether the decomposition of $X_2O(s)$ is a redox reaction.

Because the oxygen number of X_2O and X is difference.

(1 mark)

Answers written in the margins will not be marked.

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3. Antacid is a drug for neutralising stomach acid. A sample of an antacid contains $NaHCO_3(s)$ and other soluble inert substances. 1.52 g of the antacid sample was completely dissolved in deionised water to give a weakly alkaline solution. The solution was then titrated with 0.644 M HCl(aq) using a suitable indicator. 25.20 cm^3 of the HCl(aq) was required to reach the end point.

(a) Write the chemical equation for the reaction between $NaHCO_3(s)$ and HCl(aq).

$NaHCO_3 + HCl \rightarrow NaCl + CO_2 + H_2O$

(1 mark)

(b) Calculate the percentage by mass of $NaHCO_3(s)$ in the antacid sample.
(Relative atomic masses : H = 1.0, C = 12.0, O = 16.0, Na = 23.0)

No. of mole of HCl $= \frac{25.20}{1000} \times 0.644 = 0.016233$ mol

No. of mole of $NaHCO_3 = 0.016233$ mol

mass of $NaHCO_3 = 0.016233 \times (23+1+12+16\times3)$

$= 1.363$ g

% by mass of $NaHCO_3 = \frac{1.363}{1.52} \times 100\%$

$= 89.7\%$

(2 marks)

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3. (c) The pH of the solution at the end point of the titration was found to be between 3 and 4.

(i) Suggest a suitable indicator for this titration and state the colour change at the end point.

Methyl orange.

It turns from yellow to orange.

(ii) Suggest an instrument to measure the pH of the solution accurately.

pH meter

(3 marks)

(d) State one advantage of taking antacids containing $Mg(OH)_2(s)$ over those containing $NaHCO_3(s)$.

(1 mark)

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Answers written in the margins will not be marked.

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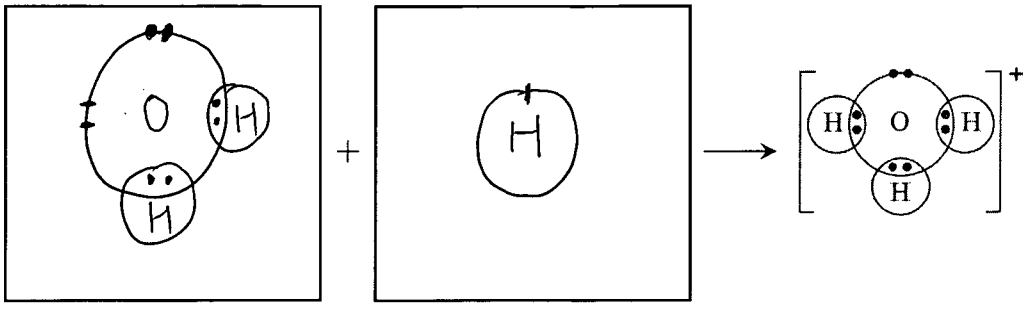
4. Consider the molecules H_2O, BF_3 and SF_6.

(a) H_2O molecules can form H_3O^+ ions.

(i) In each of the following boxes, draw the electron diagram (showing ELECTRONS IN THE OUTERMOST SHELLS only) for a suitable chemical species to show the formation of a H_3O^+ ion.

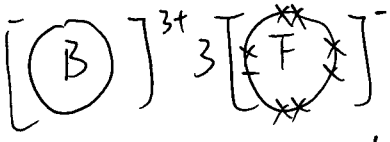


(ii) Describe the formation of dative covalent bond using H_3O^+ as an example.

H_2O and H^+ to form H_3O^+. And they loss one electron to fully fill the electrons to obey octet rule.

(3 marks)

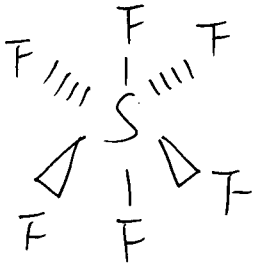
(b) Explain whether the boron atom in a BF_3 molecule has an octet structure.



Boron lose 3 electrons and the outermost shells is fully filled. So boron atom in BF_3 molecule has an octet structure.

(1 mark)

(c) (i) Draw the three-dimensional structure of a SF_6 molecule.



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4. (c) (ii) Explain whether SF_6 is a polar molecule.

Because the electronegativity cannot cancel out each other. So SF_6 is polar molecule

(2 marks)

(d) Explain the following increasing order of the boiling points of the three compounds :

$BF_3 < SF_6 < H_2O$

Only H_2O is contain hydrogen bond which SF_6 and BF_3 don't contain.

So H_2O has the highest boiling points.

SF_6 is a polar molecule while BF_3 is a non-polar molecule. So SF_6 has the higher boiling point than BF_3

(3 marks)

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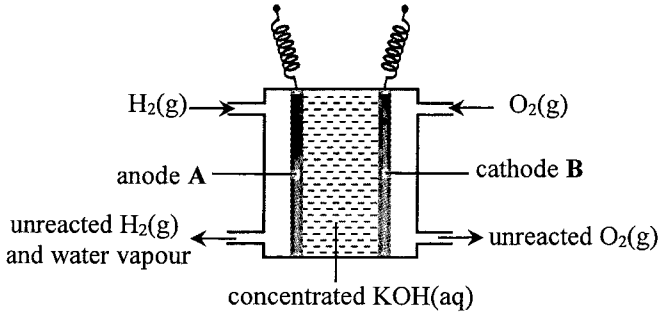
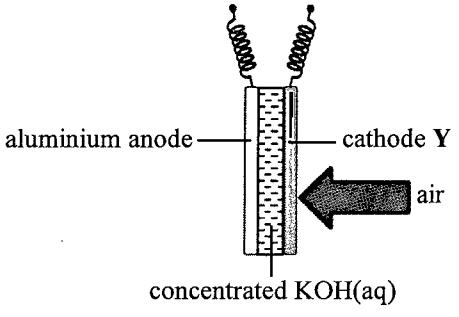
5. The following hydrogen-oxygen fuel cell and aluminium-air cell are primary cells. Their simplified structures are shown below :



hydrogen-oxygen fuel cell



aluminium-air cell

(a) What is meant by the term 'primary cell' ?

It cannot be changing.

(1 mark)

(b) For the above hydrogen-oxygen fuel cell,

(i) write the half equation for the change that occurs at anode **A**.

$H_{2(g)} \longrightarrow 2H^+ + 2e^-$

(ii) suggest one disadvantage of using this hydrogen-oxygen fuel cell.

It is environmental friendly.

(2 marks)

(c) In the above aluminium-air cell, oxygen in air reacts with water to form hydroxide ions at cathode **Y**.

(i) Write the half equation for the change that occurs at cathode **Y**.

$O_2 + 2H_2O + 4e^- \longrightarrow 4OH^-$

(ii) The half equation for the change that occurs at the aluminium anode is as follows :

$$Al(s) + 3OH^-(aq) \rightarrow Al(OH)_3(s) + 3e^-$$

Write the chemical equation for the overall reaction in the aluminium-air cell.

$3O_2 + 6H_2O + 4Al \longrightarrow 4Al(OH)_3$

(iii) Suggest how aluminium can be obtained from aluminium oxide.

electrolyte

(3 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

6. Consider the following chemical equation for the formation of CH_3Cl from methane and chlorine :

$$CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g)$$

(a) Name the type of reaction involved.

redox reaction.

(1 mark)

(b) State the condition needed for the reaction to occur at room temperature.

UV light

(1 mark)

(c) The reaction involves three stages: initiation, propagation and termination. In the initiation stage, chlorine free radicals ($Cl\bullet$) are formed from chlorine molecules.

(i) With reference to the electronic structure, explain why a chlorine free radical ($Cl\bullet$) is a reactive chemical species.

(ii) Complete the chemical equations below by filling in a suitable chemical species in each of the following boxes :

One of the steps in the propagation stage :

$Cl\bullet + CH_4 \rightarrow$ [Cl·] + [CH_4·]

One of the steps in the termination stage :

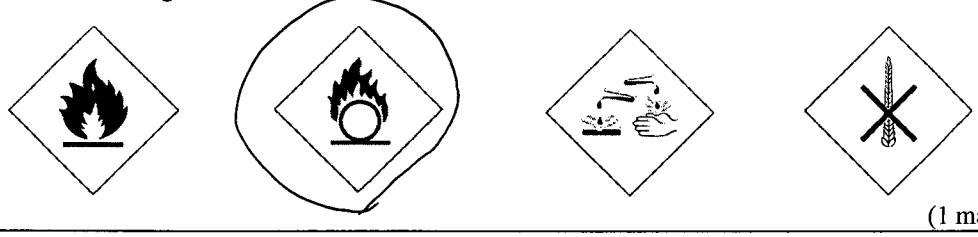
[CH_3·] + [Cl·] $\rightarrow CH_3Cl$

(3 marks)

(d) Explain why CH_3Cl is not the only organic product formed in the reaction between methane and chlorine.

(1 mark)

(e) From the hazard warning labels shown below, circle a label that should be displayed on a gas cylinder containing methane.



(1 mark)

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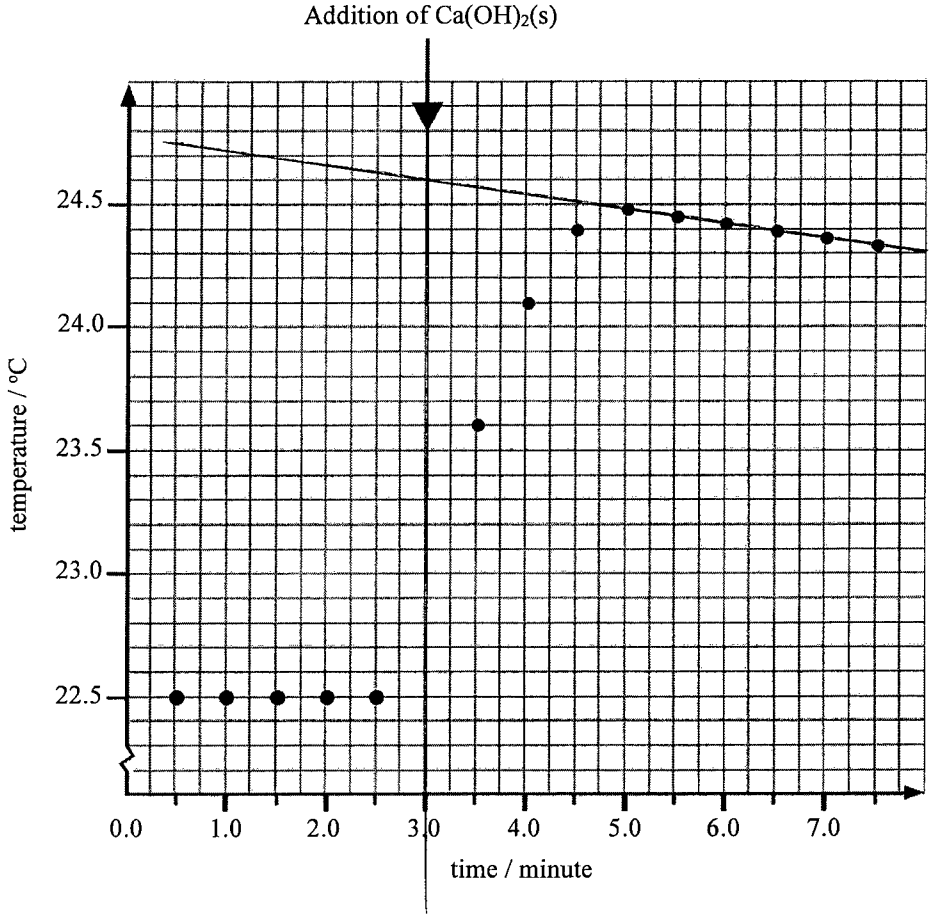
0.1 mol

7. An experiment was performed to determine the enthalpy change of neutralisation between $Ca(OH)_2(s)$ and HCl(aq). 100.0 cm^3 of 1.0 M HCl(aq) was placed in an expanded polystyrene cup. The temperature of the contents in the cup was measured at half-minute intervals. Right at the third minute, 0.502 g of $Ca(OH)_2(s)$ was added to the cup with thorough stirring. The recordings of temperature are shown in the graph below :



(a) Write a chemical equation for the reaction between $Ca(OH)_2(s)$ and HCl(aq).

$Ca(OH)_2 + 2HCl \longrightarrow CaCl_2 + 2H_2O$

(1 mark)

(b) (i) By SKETCHING on the graph above, estimate the greatest temperature rise of the contents in the cup.

The greatest temperature rise = 2.1 °C

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7. (b) (ii) It is given that the enthalpy change of neutralisation is the enthalpy change when solutions of an acid and an alkali react together to produce one mole of water.

In the experiment, HCl(aq) is in excess. Calculate the enthalpy change of neutralisation between $Ca(OH)_2(s)$ and HCl(aq), in kJ mol^{-1}, under the experimental conditions.

(Volume of the reaction mixture = 100.0 cm^3;
density of the reaction mixture = 1.00 g cm^{-3};
specific heat capacity of the reaction mixture = 4.2 J g^{-1} K^{-1};
heat capacity of the expanded polystyrene cup : negligible)
(Relative atomic masses : H = 1.0, O = 16.0, Cl = 35.5, Ca = 40.1)

$E = mc\Delta T$

No. of mole of $Ca(OH)_2 = \frac{0.502}{40.1+(16+1)\times 2} = 6.775 \times 10^{-3}$ mol

No. of mole of HCl $= \frac{100}{1000} \times 1 = 0.1$ mol

∴ HCl is in excess.

No. of mole of HCl $= 6.775 \times 10^{-3} \times 2 = 0.0135$ mol

No. of mole of water = 0.0135 mole

$E = 0.2438 \times 4.2 \times 2 \times 1$

$= 2.151$ J

$\Delta H = \frac{-2.151}{0.0135}$

$= 159.3$ J mol^{-1}

$= 0.1593$ kJ mol^{-1}

(5 marks)

(c) Standard enthalpy changes of neutralisation $\Delta H_n^\ominus$ for two reactions are given below :

	$\Delta H_n^\ominus$ / kJ mol^{-1}
Reaction between $Ca(OH)_2(s)$ and HCl(aq)	−58.6
Reaction between CaO(s) and HCl(aq)	−186.0

Calculate the standard enthalpy change of the following reaction.

$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s)$

$\Delta H_n^\ominus = -186 - (-58.6)$

$= -127.4$ kJ mol^{-1}

(3 marks)

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*8. Describe and explain the similarities and differences between the chemical principles involved in tin-plating and galvanising in the rusting prevention of iron-made objects.

(6 marks)

Similarities: ① avoid the iron to contact air and water

②

differences: ① Tin is toxic while galvanising in the rusting prevention of iron-made is not.

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PART II

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

9. At a certain temperature, the equilibrium constant K_c for the following reaction is 2.25×10^{-2} mol dm^{-3}.

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g) \qquad \Delta H > 0$$

In an experiment, 0.84 mol of $PCl_5(g)$, 0.16 mol of $PCl_3(g)$ and 0.16 mol of $Cl_2(g)$ were initially introduced in a closed container of a fixed volume of 4.0 dm^3, and the system was allowed to attain equilibrium at that temperature.

(a) (i) Calculate the reaction quotient Q_c for the system under the initial conditions.

(ii) Explain whether the concentration of $PCl_5(g)$ would increase or decrease just after the reaction started.

(4 marks)

(b) Explain whether K_c would increase, decrease or remain unchanged if the temperature of the equilibrium mixture is increased.

Temperature increased, the equilibrium will shift to right. Kc would decreased.

$K_c \propto \frac{1}{[PCl_5]}$

(2 marks)

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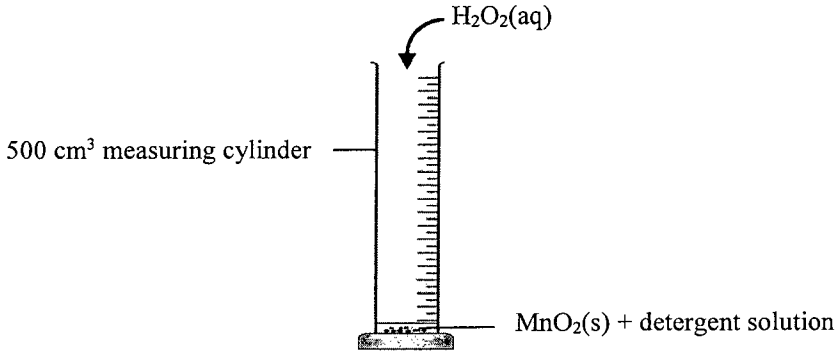
10. At room conditions, $H_2O_2(aq)$ would decompose into $O_2(g)$ and $H_2O(l)$ very slowly in the absence of $MnO_2(s)$. An experiment was performed as shown in the set-up below :



When 10.0 cm^3 of 3.00 M $H_2O_2(aq)$ was mixed with a small amount of $MnO_2(s)$ and detergent solution at room conditions, $O_2(g)$ started to be released rapidly and foam was produced. The $MnO_2(s)$ remained chemically unchanged at the end of the reaction.

(a) Write a chemical equation for the decomposition of $H_2O_2(aq)$.

$O_2 + H_2O \longrightarrow H_2O_2$

(1 mark)

(b) Explain how manganese illustrates a characteristic of transition metals according to the results of this experiment.

(1 mark)

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10. (c) Upon completion of the reaction, all the $H_2O_2(aq)$ was used up. Calculate the theoretical volume of $O_2(g)$ released at room conditions.
(Molar volume of gas at room conditions = 24 dm^3)

(2 marks)

(d) In the experiment, the time taken for the foam to rise from the mark at 100 cm^3 to the mark at 200 cm^3 of the measuring cylinder was 18 seconds, while the time taken for the foam to rise from the mark at 200 cm^3 to the mark at 300 cm^3 was 63 seconds. Explain these results.

(2 marks)

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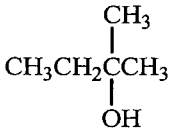
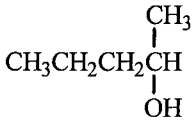
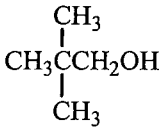
11. Compounds **P**, **Q** and **R** are structural isomers having the molecular formula of $C_5H_{12}O$. Their structures are shown below :



P



Q



R

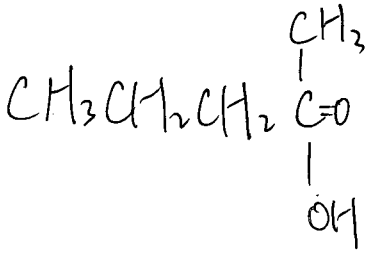
(a) Give the systematic name of **P**.

3-methyl-butan-1-ol

(1 mark)

(b) Heating **Q** with acidified $K_2Cr_2O_7(aq)$ under reflux will give an organic product.

(i) Draw a labelled diagram to show the set-up for this reaction.



(ii) State the expected observation for this reaction.

(iii) Write the structural formula of the organic product.

(4 marks)

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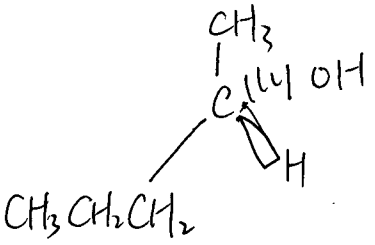
11. (c) **W** is an organic compound containing five carbon atoms. Under suitable conditions, **R** can be prepared from the reduction of **W**.

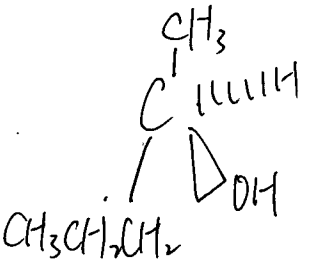
(i) Suggest the structural formula of **W**.

(ii) Suggest a reducing agent required for the reaction.

(2 marks)

(d) Compound **S** is an optically active secondary alcohol. It is also a structural isomer of compounds **P**, **Q** and **R**. Write the structural formula of **S**.





(1 mark)

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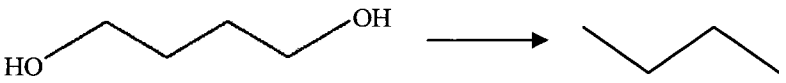
12. Outline a synthetic route, with NO MORE THAN THREE STEPS, to accomplish the following conversion. For each step, give the reagent(s), reaction conditions (as appropriate) and structure of the organic product.



(3 marks)

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*13. Describe the acid-base properties of the products formed (if any) when the following oxides are added to water separately. Chemical equations are NOT required.

Na_2O MgO Al_2O_3 Cl_2O

(5 marks)

END OF SECTION B
END OF PAPER

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Answers written in the margins will not be marked.

PERIODIC TABLE 周期表

GROUP 族

atomic number 原子序

relative atomic mass 相對原子質量

I	II											III	IV	V	VI	VII	0
				1 **H** 1.0													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)

2022 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

Level 2 Exemplar 1
Paper 2

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

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.

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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.

(a) (i) (1) higher atom economy

(2) CO is toxic

(ii) (1) to save time because catalyst increased the speed.

(2) it may not to form completely combustion.

(ii) soapless detergent

(b) (i) H_2O

(ii) (1) H_2

(2)

(iii) (1) $O_2 + 2H_2O + 4e^- \longrightarrow 4OH^-$

(2)

(iv) HCl

(c) (i) The reaction speed during the first time.

(ii)

(iii)

(iv) $\log k - \log A = \frac{Ea}{2.3R}\left(\frac{1}{308} - \frac{1}{298}\right)$

$\log 1 - \log 1.9 = \frac{Ea}{2.3(8.31)}\left(\frac{1}{308} - \frac{1}{298}\right)$

$Ea = 5.80 \times 10^{-4}\ kJ\,mol^{-1}$

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

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

(a)(i) Use limewater. CO_2 will turns limewater from colourless to milky. SO_2 has no observable change.

(ii) Tolly's method: CH_3COCH_3 will form a silver mirror while CH_3CH_2CHO don't.

(iii) Anhydrous sodium sulphate.

(b)(i)

(ii) Because it is satisfy.

(iii) condensation

(iv) Because the impurity Z is been filtered.

(v)(1) The colour Y is far away than the Z.

(2) Z. Because the Rf value of Y is greater than that of Z.

(c)(i)(1) Fe^{3+} is pale yellow and Mn^{2+} is pale pink. The concentration of Mn^{2+} is larger than Fe^{3+}.

(2) No. of mole of $KMnO_4 = \frac{32.35}{1000} \times 0.0041 = 1.326 \times 10^{-4}$ mol

No. of mole of $Fe^{2+} = 1.326 \times 10^{-4} \times 5 = 6.632 \times 10^{-4}$ mol

No. of concentration of $Fe^{2+} = \frac{6.632 \times 10^{-4}}{\frac{25}{1000}} = 0.0265$ M

(ii)(1)

(2)

寫於邊界以外的答案，將不予評閱。
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2022-DSE
CHEM
PAPER 1B

B

Level 2 Exemplar 2
Paper 1B

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2022

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.

A140E01B

PART I

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

1. Iodine is a halogen. It can form potassium iodide and hydrogen iodide.

(a) Name the relationship between $^{127}_{53}I$ and $^{129}_{53}I$.

They are Isotopes.

(1 mark)

(b) The electronic arrangement of an iodine atom is 2, 8, x, 18, y. What is x ?

8

(1 mark)

(c) Draw the electron diagram for potassium iodide, showing ELECTRONS IN THE OUTERMOST SHELLS only.

(1 mark)

(d) Suggest why an aqueous solution of hydrogen iodide can conduct electricity.

It has mobile ions.

(1 mark)

(e) In terms of bonding and structure, explain whether potassium iodide or hydrogen iodide would have a higher melting point.

Potassium Iodide has giant Ionic structure while hydrogen Iodide has simple molecular structure. Potassium Iodide Iodide are held together by strong Ionic bond while molecules in hydrogen Iodide are held by weak Van der Waals' forces. Thus, potassium Iodide have a higher melting point.

(2 marks)

Answers written in the margins will not be marked.

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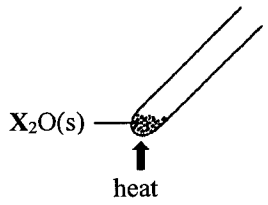
Answers written in the margins will not be marked.

2. The diagram below shows an experimental set-up in which a metal oxide $X_2O(s)$ is decomposed upon strong heating. A silvery metal **X** and a colourless gas **Z** are formed.



(a) State what **Z** is and suggest a test for it.

Oxygen. It relights a glowing splint.

(2 marks)

(b) When 3.028 g of $X_2O(s)$ is completely decomposed, 2.819 g of metal **X** can be obtained.

(i) Calculate the relative atomic mass of **X**.
(Relative atomic mass : O = 16.0)

$2X_2O \rightarrow 4X + O_2$
3.028g 2.819g

No. of mole of $X_2O = \frac{3.028}{X\times4+16.0\times2} = \frac{3.028}{4X+32.0}$

$\frac{3.028}{4X+32.0} \times 2(X) = 2.819$

$\frac{6.056X}{4X+32.0} = 2.819$

$6.056X = 11.276X + 90.208$

(ii) Suggest what **X** is.

Mercury

(3 marks)

(c) Explain whether the decomposition of $X_2O(s)$ is a redox reaction.

Yes, it is as it is reducing.

(1 mark)

Answers written in the margins will not be marked.

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Answers written in the margins will not be marked.

Go on to the next page

3. Antacid is a drug for neutralising stomach acid. A sample of an antacid contains $NaHCO_3(s)$ and other soluble inert substances. 1.52 g of the antacid sample was completely dissolved in deionised water to give a weakly alkaline solution. The solution was then titrated with 0.644 M HCl(aq) using a suitable indicator. 25.20 cm^3 of the HCl(aq) was required to reach the end point.

(a) Write the chemical equation for the reaction between $NaHCO_3(s)$ and HCl(aq).

$NaHCO_3 + HCl \rightarrow NaCl + CO_2 + H_2O$

(1 mark)

(b) Calculate the percentage by mass of $NaHCO_3(s)$ in the antacid sample.
(Relative atomic masses : H = 1.0, C = 12.0, O = 16.0, Na = 23.0)

No. of mole of HCl(aq) used $= 0.644 \times \frac{25.20}{1000}$

$= 0.0162$ mol

Mass of $NaHCO_3 = 0.0162 \times (23.0 + 1.0 + 12.0 + 16.0 \times 3)$

$= 1.36$ g

% by mass of $NaHCO_3 = \frac{1.36}{1.52} \times 100\%$

$= 89\%$

(2 marks)

Answers written in the margins will not be marked.

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3. (c) The pH of the solution at the end point of the titration was found to be between 3 and 4.

(i) Suggest a suitable indicator for this titration and state the colour change at the end point.

Methyl orange. It changes from yellow to red.

(ii) Suggest an instrument to measure the pH of the solution accurately.

PH meter

(3 marks)

(d) State one advantage of taking antacids containing $Mg(OH)_2(s)$ over those containing $NaHCO_3(s)$.

If using antacids containing $NaHCO_3(s)$, it will give out CO_2. A gas pressure occurs which will make the patient uncomfortable. feels

(1 mark)

Answers written in the margins will not be marked.

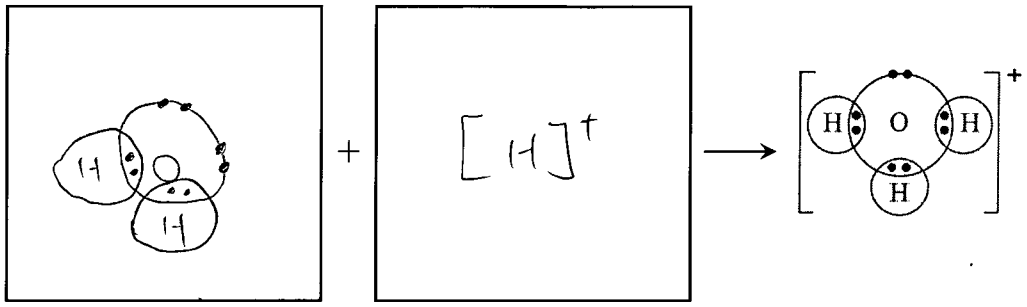
Answers written in the margins will not be marked.

Go on to the next page

4. Consider the molecules H_2O, BF_3 and SF_6.

(a) H_2O molecules can form H_3O^+ ions.

(i) In each of the following boxes, draw the electron diagram (showing ELECTRONS IN THE OUTERMOST SHELLS only) for a suitable chemical species to show the formation of a H_3O^+ ion.



(ii) Describe the formation of dative covalent bond using H_3O^+ as an example.

H_2O with lone pairs of electron in the outermost shells

H^+ with no electron in the outermost shell.

H_2O shared it lone pair of electron to H^+ and formed H_3O^+.

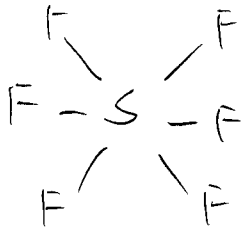
(3 marks)

(b) Explain whether the boron atom in a BF_3 molecule has an octet structure.

No. It only has 6 electrons in the outermost shells but not 8.

(1 mark)

(c) (i) Draw the three-dimensional structure of a SF_6 molecule.



Answers written in the margins will not be marked.

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4. (c) (ii) Explain whether SF_6 is a polar molecule.

Yes, It is because It has symetrical structure.

(2 marks)

(d) Explain the following increasing order of the boiling points of the three compounds :

$BF_3 < SF_6 < H_2O$

BF3 has a simple molecular structure.
Its molecules are held together by weak van der Waals' forces.
Thus, It has the lowest melting point.

SF6 has a larger surface area so It require larger heat energy to overcome It. Thus SF6 has a higher boiling points than BF3.

H2O has strong H-O bond. Hence, H2O has the highest boiling points.

(3 marks)

Answers written in the margins will not be marked.

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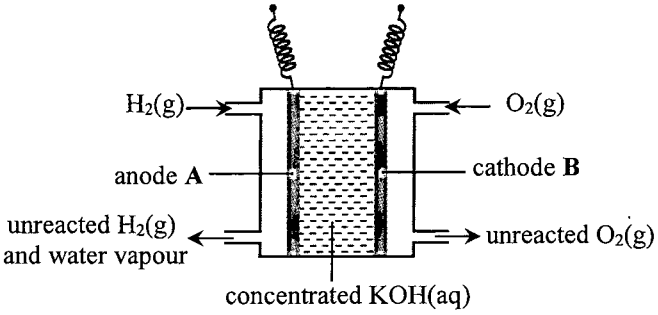
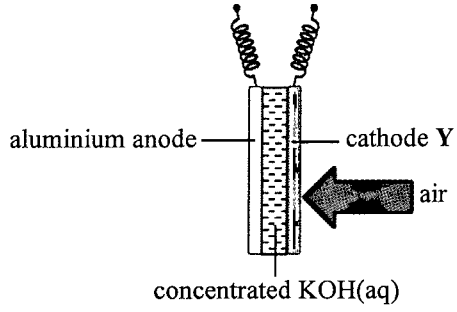
5. The following hydrogen-oxygen fuel cell and aluminium-air cell are primary cells. Their simplified structures are shown below :



hydrogen-oxygen fuel cell



aluminium-air cell

(a) What is meant by the term 'primary cell' ?

It can only be used once.

(1 mark)

(b) For the above hydrogen-oxygen fuel cell,

(i) write the half equation for the change that occurs at anode **A**.

$H_2 \rightarrow 2H^+ + 2e^-$

(ii) suggest one disadvantage of using this hydrogen-oxygen fuel cell.

Air pollution

(2 marks)

(c) In the above aluminium-air cell, oxygen in air reacts with water to form hydroxide ions at cathode **Y**.

(i) Write the half equation for the change that occurs at cathode **Y**.

$Al \rightarrow Al^{3+} + 3e^-$

(ii) The half equation for the change that occurs at the aluminium anode is as follows :

$$Al(s) + 3OH^-(aq) \rightarrow Al(OH)_3(s) + 3e^-$$

Write the chemical equation for the overall reaction in the aluminium-air cell.

(iii) Suggest how aluminium can be obtained from aluminium oxide.

Heat it with carbon

(3 marks)

Answers written in the margins will not be marked.

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6. Consider the following chemical equation for the formation of CH_3Cl from methane and chlorine :

$$CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g)$$

(a) Name the type of reaction involved.

decomposition

(1 mark)

(b) State the condition needed for the reaction to occur at room temperature.

Carry out the experiment in a fume cupboard. (1 mark)

(c) The reaction involves three stages: initiation, propagation and termination. In the initiation stage, chlorine free radicals ($Cl\bullet$) are formed from chlorine molecules.

(i) With reference to the electronic structure, explain why a chlorine free radical ($Cl\bullet$) is a reactive chemical species.

(ii) Complete the chemical equations below by filling in a suitable chemical species in each of the following boxes :

One of the steps in the propagation stage :

$Cl\bullet + CH_4 \rightarrow$ [ ] + [ ]

One of the steps in the termination stage :

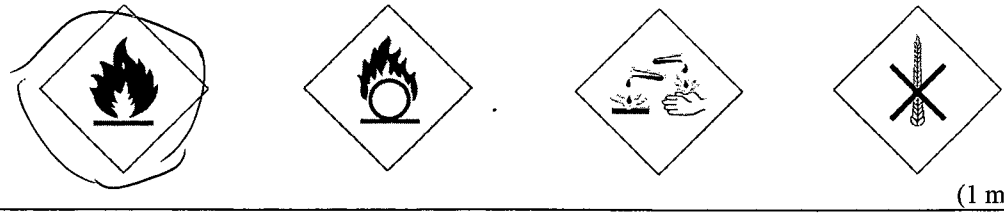
[ ] + [ ] $\rightarrow CH_3Cl$

(3 marks)

(d) Explain why CH_3Cl is not the only organic product formed in the reaction between methane and chlorine.

(1 mark)

(e) From the hazard warning labels shown below, circle a label that should be displayed on a gas cylinder containing methane.



(1 mark)

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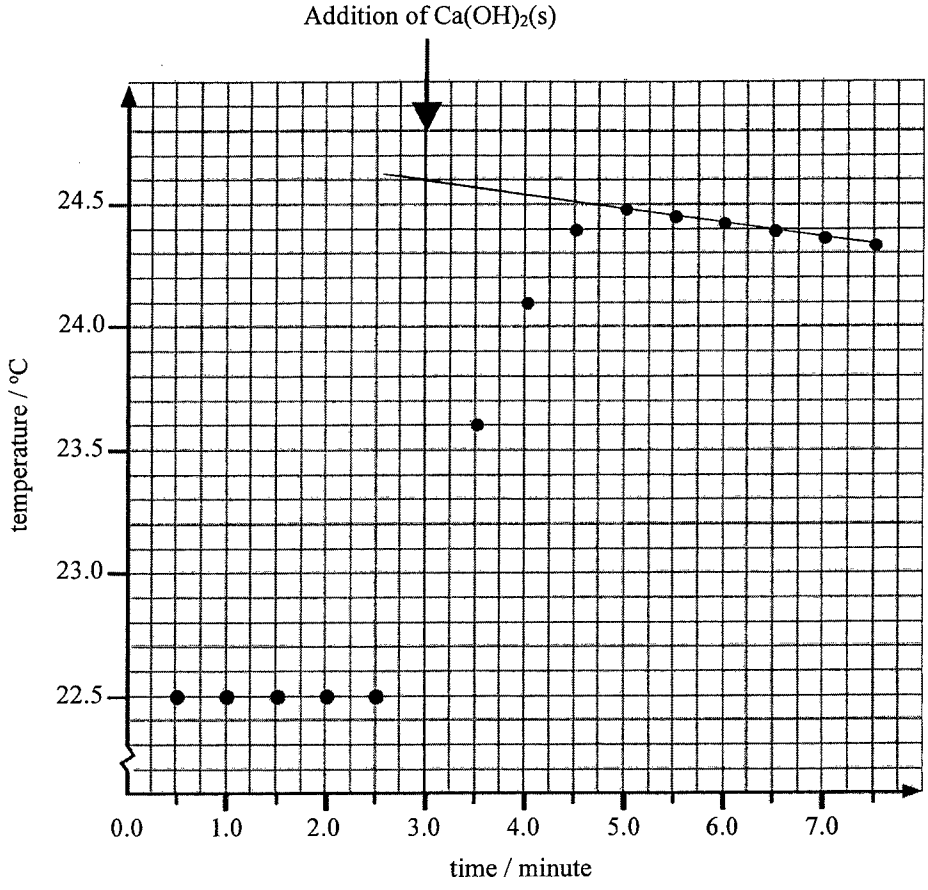
7. An experiment was performed to determine the enthalpy change of neutralisation between $Ca(OH)_2(s)$ and HCl(aq). 100.0 cm^3 of 1.0 M HCl(aq) was placed in an expanded polystyrene cup. The temperature of the contents in the cup was measured at half-minute intervals. Right at the third minute, 0.502 g of $Ca(OH)_2(s)$ was added to the cup with thorough stirring. The recordings of temperature are shown in the graph below :



(a) Write a chemical equation for the reaction between $Ca(OH)_2(s)$ and HCl(aq).

$Ca(OH)_2(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$

(1 mark)

(b) (i) By SKETCHING on the graph above, estimate the greatest temperature rise of the contents in the cup.

The greatest temperature rise = 2.1 °C

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7. (b) (ii) It is given that the enthalpy change of neutralisation is the enthalpy change when solutions of an acid and an alkali react together to produce one mole of water.

In the experiment, HCl(aq) is in excess. Calculate the enthalpy change of neutralisation between $Ca(OH)_2(s)$ and HCl(aq), in kJ mol^{-1}, under the experimental conditions.

(Volume of the reaction mixture = 100.0 cm^3;
density of the reaction mixture = 1.00 g cm^{-3};
specific heat capacity of the reaction mixture = 4.2 J $g^{-1} K^{-1}$;
heat capacity of the expanded polystyrene cup : negligible)
(Relative atomic masses : H = 1.0, O = 16.0, Cl = 35.5, Ca = 40.1)

(5 marks)

(c) Standard enthalpy changes of neutralisation $\Delta H_n^\ominus$ for two reactions are given below :

	$\Delta H_n^\ominus$ / kJ mol^{-1}
Reaction between $Ca(OH)_2(s)$ and HCl(aq)	−58.6
Reaction between CaO(s) and HCl(aq)	−186.0

Calculate the standard enthalpy change of the following reaction.

$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s)$

$\Delta H_n^\ominus$ / kJ mol^{-1}

$Ca(OH)_2(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$ −58.6

$CaO(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l)$ −186.0

Standard enthalpy change = $-186.0 - (-186.0) - (-58.6)$

$= 58.6$ kJ mol^{-1}

(3 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.

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*8. Describe and explain the similarities and differences between the chemical principles involved in tin-plating and galvanising in the rusting prevention of iron-made objects.

(6 marks)

Tin-plating and galvanising are both prevent iron from rusting.
In tin-plating, tin is less reactive than iron. If the tin-plating get damaged, the iron inside will be soon rusted.
However, in galvanising, zinc is more reactive than iron. Iron won't be rusted, even if the zinc get damaged. Because zinc will sacrifice itself to have corrosion first. Thus, iron will be protected.

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.

9. At a certain temperature, the equilibrium constant K_c for the following reaction is 2.25×10^{-2} mol dm^{-3}.

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g) \qquad \Delta H > 0$$

In an experiment, 0.84 mol of $PCl_5(g)$, 0.16 mol of $PCl_3(g)$ and 0.16 mol of $Cl_2(g)$ were initially introduced in a closed container of a fixed volume of 4.0 dm^3, and the system was allowed to attain equilibrium at that temperature.

(a) (i) Calculate the reaction quotient Q_c for the system under the initial conditions.

(ii) Explain whether the concentration of $PCl_5(g)$ would increase or decrease just after the reaction started.

(4 marks)

(b) Explain whether K_c would increase, decrease or remain unchanged if the temperature of the equilibrium mixture is increased.

It would increase. The ⇌ equilibrium turns to right.

(2 marks)

Answers written in the margins will not be marked.

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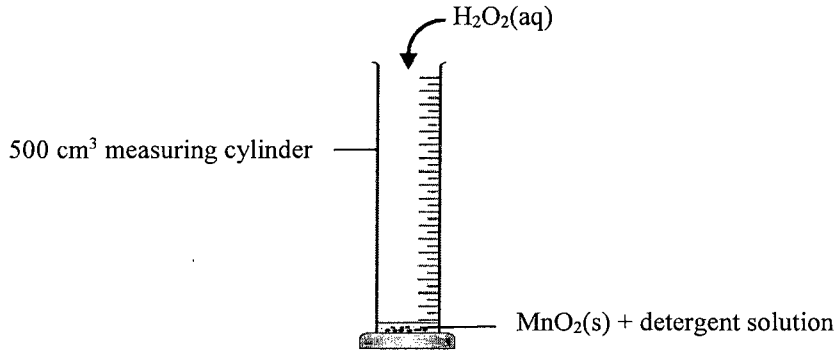
10. At room conditions, $H_2O_2(aq)$ would decompose into $O_2(g)$ and $H_2O(l)$ very slowly in the absence of $MnO_2(s)$. An experiment was performed as shown in the set-up below :



When 10.0 cm^3 of 3.00 M $H_2O_2(aq)$ was mixed with a small amount of $MnO_2(s)$ and detergent solution at room conditions, $O_2(g)$ started to be released rapidly and foam was produced. The $MnO_2(s)$ remained chemically unchanged at the end of the reaction.

(a) Write a chemical equation for the decomposition of $H_2O_2(aq)$.

$2H_2O_2(aq) \rightarrow O_2(g) + 2H_2O(l)$

(1 mark)

(b) Explain how manganese illustrates a characteristic of transition metals according to the results of this experiment.

It is purple in colour.

(1 mark)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

10. (c) Upon completion of the reaction, all the $H_2O_2(aq)$ was used up. Calculate the theoretical volume of $O_2(g)$ released at room conditions.
(Molar volume of gas at room conditions = 24 dm^3)

(2 marks)

(d) In the experiment, the time taken for the foam to rise from the mark at 100 cm^3 to the mark at 200 cm^3 of the measuring cylinder was 18 seconds, while the time taken for the foam to rise from the mark at 200 cm^3 to the mark at 300 cm^3 was 63 seconds. Explain these results.

(2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

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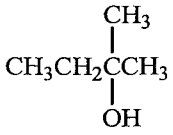
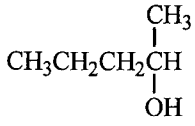
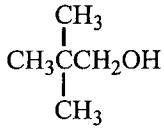
11. Compounds **P**, **Q** and **R** are structural isomers having the molecular formula of $C_5H_{12}O$. Their structures are shown below :



P



Q



R

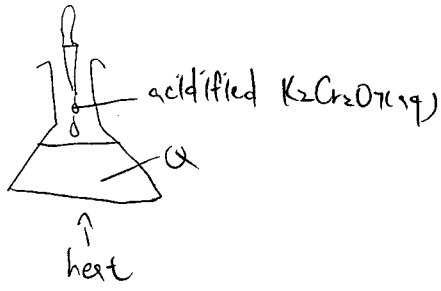
(a) Give the systematic name of **P**.

butan-2-ol

(1 mark)

(b) Heating **Q** with acidified $K_2Cr_2O_7(aq)$ under reflux will give an organic product.

(i) Draw a labelled diagram to show the set-up for this reaction.



(ii) State the expected observation for this reaction.

It will turns from green to otange.

(iii) Write the structural formula of the organic product.

C4H4

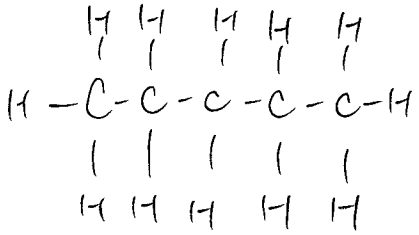
(4 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

11. (c) **W** is an organic compound containing five carbon atoms. Under suitable conditions, **R** can be prepared from the reduction of **W**.

(i) Suggest the structural formula of **W**.



(ii) Suggest a reducing agent required for the reaction.

I_2

(2 marks)

(d) Compound **S** is an optically active secondary alcohol. It is also a structural isomer of compounds **P**, **Q** and **R**. Write the structural formula of **S**.

(1 mark)

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Answers written in the margins will not be marked.

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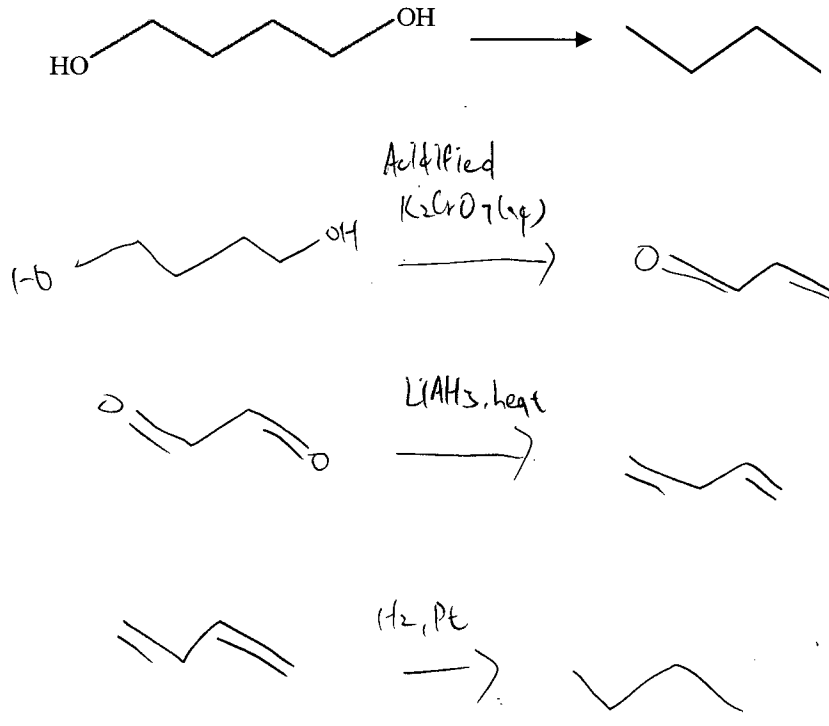
12. Outline a synthetic route, with NO MORE THAN THREE STEPS, to accomplish the following conversion. For each step, give the reagent(s), reaction conditions (as appropriate) and structure of the organic product.



(3 marks)

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Answers written in the margins will not be marked.

*13. Describe the acid-base properties of the products formed (if any) when the following oxides are added to water separately. Chemical equations are NOT required.

Na_2O MgO Al_2O_3 Cl_2O

(5 marks)

When Na_2O is added to water, NaOH is formed and it is alkaline.

When MgO is added to water, MgO dissolves and colourless evolves. Al_2O_3 will react with steam.

Cl_2O will not react with water.

END OF SECTION B
END OF PAPER

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

PERIODIC TABLE 周期表

GROUP 族

atomic number 原子序

relative atomic mass 相對原子質量

I	II											III	IV	V	VI	VII	0
				1 **H** 1.0													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)

2022 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

Level 2 Exemplar 2
Paper 2

由考生填寫 To be filled in by the candidate	
試題編號 Question No.	

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	
☐	☐	X	☐	☐	☐	☐	☐	☐	☐	☐	☐	
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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.

1.a) i) 1) It can reduce the toxic carbon monoxide.

2) Ethanoic acid could acidified water and harmful to water lives. It is

ii) 1) It could provide more surface area and rise the rate of reaction.

2) The catalyst becomes smaller after prolonged use.

iii) Glass bottle

b) i) H_2O

ii) Chlorine

2) Cl_2 pass through the ion-permeable membrane.

iii) 1) $2H^+ + 2e^- \rightarrow H_2$

2) Hydroxide is upper than chloride in series E.C.S.

iv) bleach

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

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

c) i) The original rate, before the experiment.

ii) $[\text{H}^+(aq)]^b = 1$

iii)

iv) $\log k = \text{Constant} - \frac{E_a}{2.3(8.31)(25+273)}$ — ①

$\log k = \text{Constant} - \frac{E_a}{2.3(8.31)(35+273)}$ — ②

$\frac{②}{①} = 1.9$

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		X																						

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

a) i) Add $SO_2(g)$ and $CO_2(g)$ into the water seperately. The one with $CO_2(g)$ will turn milky while the one with $SO_2(g)$ won't.

ii) $CH_3CH_2CHO(l)$ has O-H group while $CH_3COCH_3(l)$ is a ketone.

iii) Solid sodium hydroxide

b) i) $\frac{3.04g}{2}$

$= 1.52g > 1.40g$ ∴ Yes, all of Y should have dissolved.

ii) To move away impurities.

iii) Crystallization

iv) There are so many impurities.

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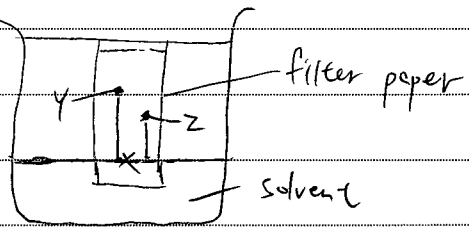
每題另起新頁作答。
Start each question on a new page.

v) i)



ii) Z will be the first-collected fraction in the column chromatography as Z has smaller Rf value than Y.

c) (i) I) Fe^{2+} is in yellow colour. And Mn^{2+} is in pale pink colour.

ii) No. of moles of $KMnO_4(aq)$ = $0.0041 \times \frac{32.35}{1000}$
= 1.33×10^{-4}

Concentration of Fe^{2+} in solution S = $\frac{5(1.33 \times 10^{-4})}{\frac{25.00}{1000}}$

= 0.0266 M

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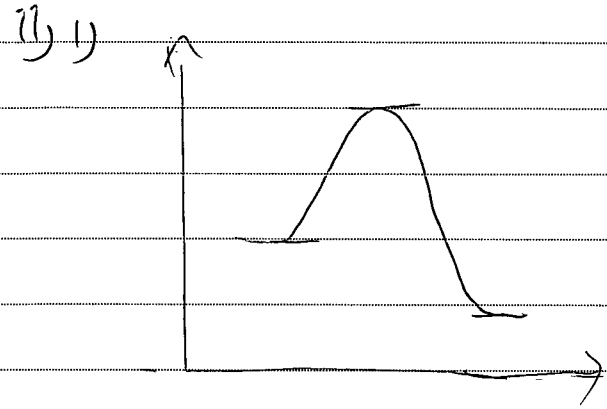

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