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Level 5 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 $^{129}_{53}I$.

They are isotopes.

(1 mark)

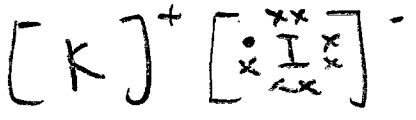
(b) The electronic arrangement of an iodine atom is 2, 8, x, 18, y. What is x ?

18 7

18

(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.

There are mobile ions ($H^+(aq)$, $I^-(aq)$)

in the solution.

(1 mark)

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

Hydrogen iodide has simple molecular structure.
Molecules are held by weak van der Waals' forces.

Potassium iodide has giant ionic structure.
K^+ & I^- ions are held by strong ionic bonds.
More energy are required to break ionic bonds.

Potassium iodide have higher melting point. (2 marks)

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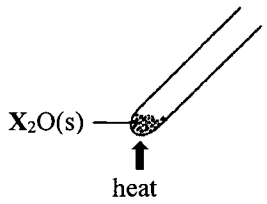
2. The diagram below shows an experimental set-up in which a metal oxide $X_2O(s)$ is decomposed upon strong heating. A silvery metal **X** and a colourless gas **Z** are formed.



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

Z is 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)

Mass of O in X_2O = 3.028 - 2.819 = 0.209 g

No. of mole of 3.028 g X_2O = $\frac{0.209}{16}$ = 0.01306 mol

$\frac{3.028}{2x + 16}$ = 0.01306

$x = 107.9 \approx 108$

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

∴ Relative atomic mass is 108

X is silver

(3 marks)

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

Yes. Oxidation number of O increases from -2 in X_2O to 0 in O_2.

(1 mark)

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).

$NaHCO_3(s) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l) + CO_2(g)$

(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 $HCl = \frac{25.20}{1000} \times 0.644 = 0.01622$ mol

mole ratio of $NaHCO_3 : HCl = 1:1$

No. of mole of $NaHCO_3 = 0.1622$ mol

Mass of $NaHCO_3 = 0.1622 \times (23+1+12+16\times3)$

$= 1.363\,g$

% by mass of $NaHCO_3(s) = \frac{1.363}{1.52} \times 100\% = 89.7\%$

(2 marks)

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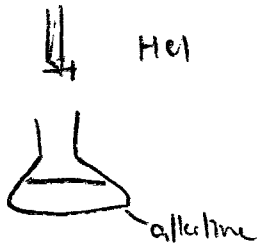

3. (c) The pH of the solution at the end point of the titration was found to be between 3 and 4.

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

Methyl orange.

From yellow to orange.

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

pH sensor connected to data logger.

(3 marks)

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

Antacids with $NaHCO_3(s)$ produces $CO_2(g)$ which can irritate and upset the stomach.

(1 mark)

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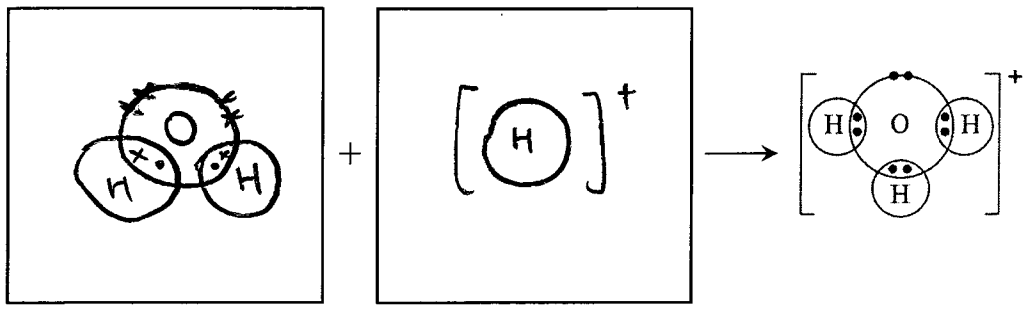
4. Consider the molecules H_2O, BF_3 and SF_6.

(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.

O atom in H_2O has 2 lone pairs of electron in its outermost shell.

dative covalent bond is formed

H atom in H^+ does not have any outermost shell electrons.

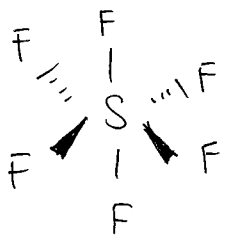
By accepting a lone pair electrons from O atom, H atom attain stable electronic arrangement of noble gas. (3 marks)

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

No. Boron atom in BF_3 only has 6 outermost shell electrons.

(1 mark)

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



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

SF_6 has octahedral shape.

The polarities of S-F bonds can cancel each other out.

SF_6 is non-polar. (2 marks)

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

$BF_3 < SF_6 < H_2O$

H_2O is held by strong hydrogen bonds while BF_3 and SF_6 are held by weak van der Waals' forces.

More energy is required to break the hydrogen bonds.

H_2O has highest boiling point.

The molecular size of SF_6 is larger than BF_3.

van der Waals' forces between SF_6 molecules are stronger than BF_3 molecules.

SF_6 has higher boiling point than BF_3.

More energy is required to break the van der Waals' forces between SF_6 molecules. (3 marks)

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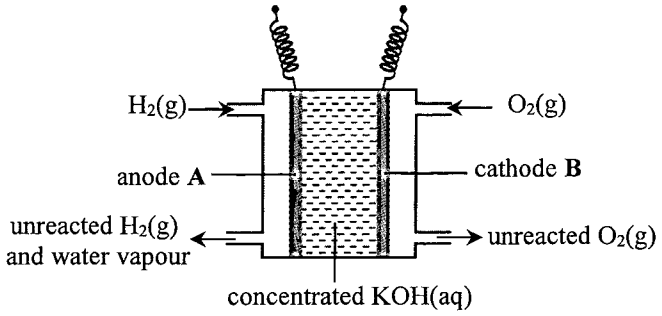
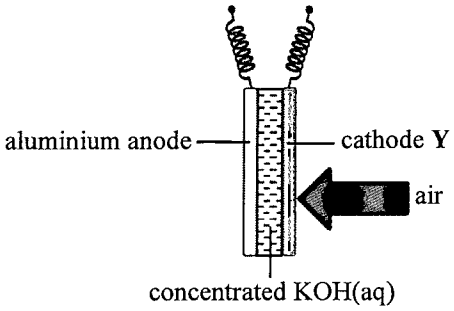
A: $2OH^- + H_2 \rightarrow 2H_2O + 2e^-$

C: $4e^- + 2H_2O + O_2 \rightarrow 4OH^-$

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' ?

A cell that is rechargeable. (1 mark)

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

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

$2OH^-(aq) + H_2(g) \rightarrow 2H_2O(l) + 2e^-$

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

It does not produce toxic products.

(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**.

$4e^- + 2H_2O(l) + O_2(g) \rightarrow 4OH^-(aq)$

(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.

$4Al(s) + 6H_2O(l) + 3O_2(g) \rightarrow 4Al(OH)_3(s)$

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

From electrolysis of molten aluminium oxide ore.

(3 marks)

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.

Substitution.

(1 mark)

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

Sunlight

(1 mark)

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

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

It only has 7 outermost shell electrons.

It is unstable.

(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 :

$Cl\bullet + CH_4 \rightarrow$ [HCl] + [$CH_3\bullet$]

One of the steps in the termination stage :

[$CH_3\bullet$] + [$Cl\bullet$] $\rightarrow CH_3Cl$

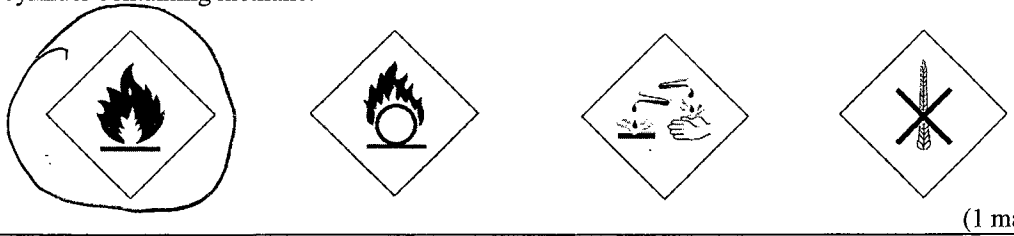
(3 marks)

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

Other products such as CH_2Cl_2, $CHCl_3$ are formed.

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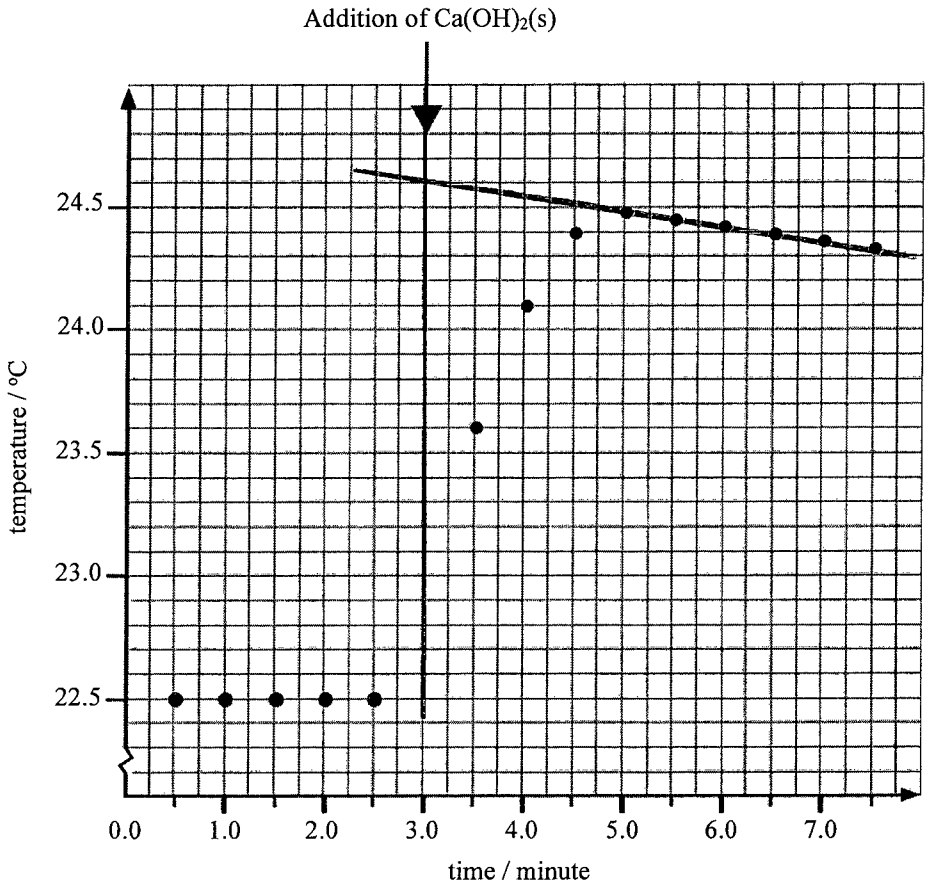
7. An experiment was performed to determine the enthalpy change of neutralisation between $Ca(OH)_2(s)$ and HCl(aq). 100.0 cm^3 of 1.0 M HCl(aq) was placed in an expanded polystyrene cup. The temperature of the contents in the cup was measured at half-minute intervals. Right at the third minute, 0.502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

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)

No. of mole of $Ca(OH)_2$: $= \frac{0.502}{40.1+(16+1)\times 2} = 6.774\times10^{-3}$ mol

∴ Mole ratio of $Ca(OH)_2 : H_2O = 1:2$

No. of mole of $H_2O = 6.774\times10^{-3}\times 2 = 0.01354$ mol

Heat released $= 100\times1\times4.2\times2.1 = 882$ J

$\Delta H_n^\theta = -\frac{882}{0.01354} = -65100$ J mol^{-1}

$= -65.1$ kJ mol^{-1} //

(5 marks)

(c) Standard enthalpy changes of neutralisation ΔH_n^θ for two reactions are given below :

	ΔH_n^θ / 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.

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

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

$+2HCl(aq)$ $\qquad$ $+2HCl(aq)$

$\Delta H_n^\theta = -186$ kJ mol^{-1} $\qquad$ $\Delta H_n^\theta = -58.6$ kJ mol^{-1}

$CaCl_2(aq) + 2H_2O(l)$

Standard enthalpy change $= -186 - (-58.6) = -127.4$ 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)

Tin-plating and galvanising both forms a protective layer on iron which can prevent iron in contact with water and oxygen. Formation of $Fe^{2+}(aq)$ inhibited.

Tin-plating is a coat of tin. If it is scratched off, as Fe is more reactive than Sn, Fe loses electrons more readily than Sn. Formation of $Fe^{2+}(aq)$ is promoted. Iron rust at a faster rate.

Galvanising is a coat of Zn. If it is scratched off, Zn still acts as sacrificial protection. Zn is more reactive than Fe, Zn loses electrons more readily than Fe. Formation of $Fe^{2+}(aq)$ is inhibited.

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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}.

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

endo

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.

	$PCl_5(g)$	$\rightleftharpoons$	$PCl_3(g)$	+	$Cl_2(g)$
Initial concentration / mol dm^{-3}	$\frac{0.84}{4}$		$\frac{0.16}{4}$		$\frac{0.16}{4}$
	$= 0.21$		$= 0.04$		$= 0.04$

$$Q_c = \frac{[PCl_3(g)][Cl_2(g)]}{[PCl_5(g)]}$$

$$= \frac{(0.04)(0.04)}{0.21}$$

$$= 7.62 \times 10^{-3} \text{ mol dm}^{-3}$$

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

$Q_c < K_c$.

Equilibrium position would shift to the right.

Concentration of $PCl_5(g)$ would decrease. (4 marks)

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

Increasing the temperature favours the endothermic reaction.

The forward reaction is endothermic.

Equilibrium position would shift to the right. (2 marks)

K_c would increase.

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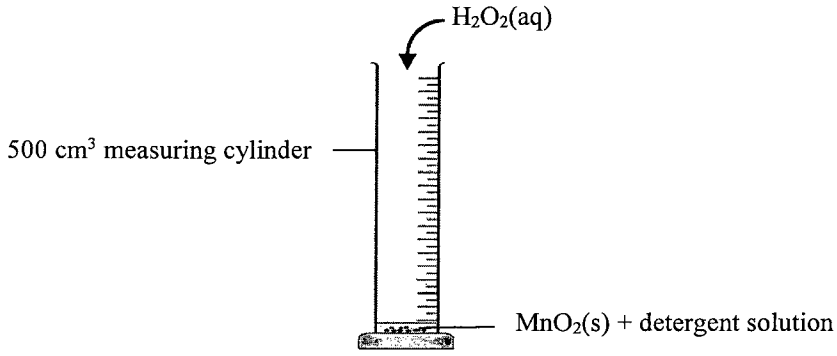
10. At room conditions, $H_2O_2(aq)$ would decompose into $O_2(g)$ and $H_2O(l)$ very slowly in the absence of $MnO_2(s)$. An experiment was performed as shown in the set-up below :



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 $H_2O_2(aq)$.

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

(1 mark)

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

Manganese and its compounds can act as catalysts.

$MnO_2(s)$ increases the rate of decomposition of H_2O_2.

It remains chemically unchanged at the end. (1 mark)

$MnO_2(s)$ is the catalyst in decomposition of H_2O_2.

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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)

No. of mole of H_2O_2 = $\frac{10}{1000} \times 3$ = 0.03 mol

Mole ratio of H_2O_2 : O_2 = 2 : 1

No. of mole of O_2 = $\frac{0.03}{2}$ = 0.015 mol

Volume of $O_2(g)$ released = 24 × 0.015 = 0.36 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.

$\frac{1}{t}$ ∝ rate of reaction.

Rate of reaction from 100 cm^3 to 200 cm^3 ($\frac{1}{18}$) is greater than from 200 cm^3 to 300 cm^3 ($\frac{1}{63}$). Rate of reaction decreases.

As the reaction continues, concentration of $H_2O_2(aq)$ decreases. Molecules are less close and crowded together. Number of collisions decreases. Number of effective collision decreases. Rate of reaction decreases. (2 marks)

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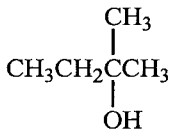
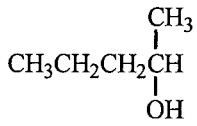
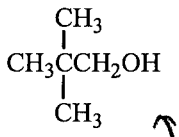
11. Compounds **P**, **Q** and **R** are structural isomers having the molecular formula of $C_5H_{12}O$. Their structures are shown below :



P



Q



R

↑ reduce W

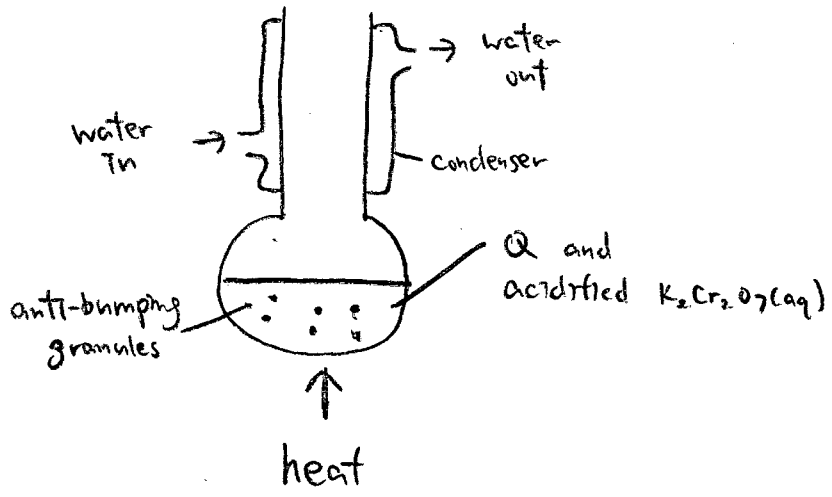
(a) Give the systematic name of **P**.

2,2-dimethylpropan-1-ol

(1 mark)

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

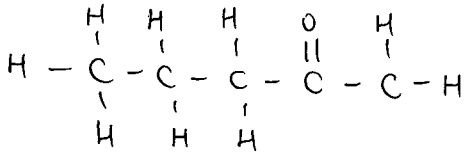
(i) Draw a labelled diagram to show the set-up for this reaction.



(ii) State the expected observation for this reaction.

One layer becomes two layers.

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



(4 marks)

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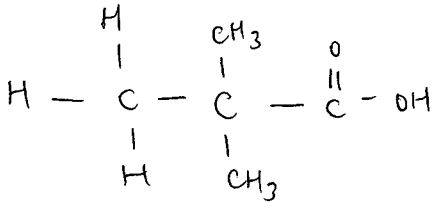
11. (c) **W** is an organic compound containing five carbon atoms. Under suitable conditions, **R** can be prepared from the reduction of **W**.

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



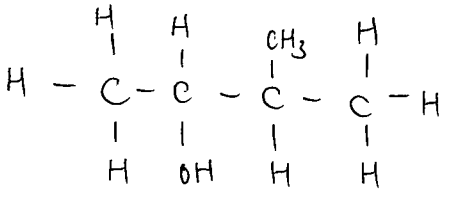
(ii) Suggest a reducing agent required for the reaction.

1. $LiAlH_4$ / ether

2. $H^+(aq)$

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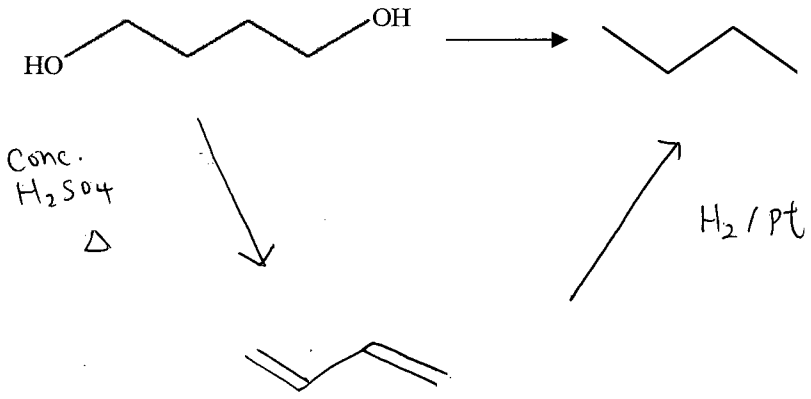
12. Outline a synthetic route, with NO MORE THAN THREE STEPS, to accomplish the following conversion. For each step, give the reagent(s), reaction conditions (as appropriate) and structure of the organic product.



(3 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

HOCl

*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)

Na_2O and MgO are basic. In water, they show basic properties. They dissolve to give alkaline NaOH(aq) and $Mg(OH)_2$(aq) respectively.

Al_2O_3 is amphoteric. However, it does not show any acid-base properties in water.

Cl_2O is acidic. In water, it shows acidic properties. It dissolves to give acidic HOCl(aq).

END OF SECTION B
END OF PAPER

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PERIODIC TABLE 周期表

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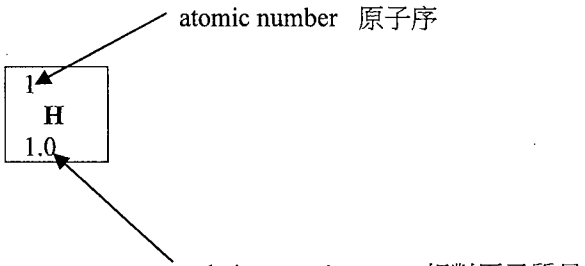

I	II											III	IV	V	VI	VII	0
																	2 **He** 4.0
3 **Li** 6.9	4 **Be** 9.0											5 **B** 10.8	6 **C** 12.0	7 **N** 14.0	8 **O** 16.0	9 **F** 19.0	10 **Ne** 20.2
11 **Na** 23.0	12 **Mg** 24.3											13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	18 **Ar**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

Level 5 Exemplar 1
Paper 2

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

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.

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

a i. (1) The atom economy is 100%.

(2) CO (g) is toxic

ii. (1) Increases the surface area of catalyst, further increasing the rate of reaction.

(2) The catalyst may be poisoned by impurities such as lead.

iii. Glass bottle

b i. Water

ii. (1) Chlorine.

(2) Both $Cl^-(aq)$ and $OH^-(aq)$ are attracted to the anode. Concentration of $Cl^-(aq)$ is higher. $Cl^-(aq)$ is preferentially discharged to form $Cl_2(g)$.

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

(2) The ion-permeable membrane only allows cations and not anions to pass through. $Na^+(aq)$ but not $Cl^-(aq)$ passes to the right compartment. $Na^+(aq)$ combines with $OH^-(aq)$ to form $NaOH(aq)$. (Solution does not contain $NaCl(aq)$.)

寫於邊界以外的答案，將不予評閱。
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每題另起新頁作答。
Start each question on a new page.

iv. NaOCl

c) Initial rate is the ~~instantaneous~~ rate of reaction at the start of reaction

ii. Concentration of $H^+(aq)$ was much higher than $S_2O_3^{2-}(aq)$.
Concentration of $H^+(aq)$ does not change a lot over the course of reaction. It is a constant.

$Rate = k[S_2O_3^{2-}(aq)]^a[H^+(aq)]^b$

As $[H^+(aq)]^b$ is a constant, rate equation rewritten as

$Rate = k'[S_2O_3^{2-}(aq)]^a$ where $k' = k[H^+(aq)]^b$

iii. Slope of graph $= \frac{(-1.10)-(-1.50)}{(-1.84)-(-2.24)} = 1$

$Rate = k'[S_2O_3^{2-}(aq)]^a$

$\log_{ra} = \log k' + a\log[S_2O_3^{2-}(aq)]$

a = slope of graph = 1

∴ Order of reaction with respect to $S_2O_3^{2-}(aq)$ is 1

iv. $\log\frac{k_1}{k_2} = -\frac{E_a}{2.3R}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)$

$\log\frac{1.0}{1.9} = -\frac{E_a}{2.3\times8.31}\left(\frac{1}{25+273}-\frac{1}{35+273}\right)$

$E_a = 48900\ J\,mol^{-1} = 48.9\ kJ\,mol^{-1}$

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

3a i. $SO_2(g)$ can turn acidified $K_2Cr_2O_7(aq)$ from orange to green while $CO_2(g)$ cannot.

ii. For CH_3COCH_3, there is a peak at $m/z = 28$.
For CH_3CH_2CHO, there isn't a peak at $m/z = 28$.
m/z indicates presence of CO^+ molecular ion which is present in CH_3COCH_3 but not CH_3CH_2CHO.

iii. Anhydrous sodium sulphate

b i. In $50\,cm^3$, no more than $3.04 \times \frac{50}{100} = 1.52\,g$ of Y can dissolve. $1.52\,g > 1.40\,g$.
All Y should have dissolved.

ii. To filter the charcoal and impurities in the solution.

iii. Crystallization.

iv. Some Y is dissolved in the solution. Not all of them was crystallized and collected.

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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.

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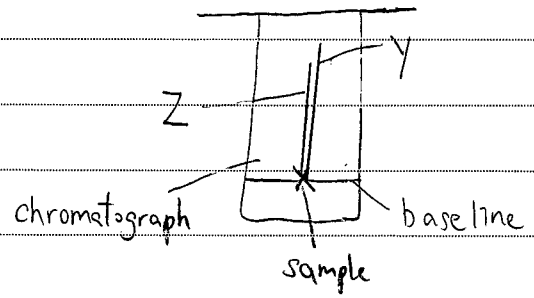
V. (1)



(2). Rf value of Y is greater than Z. Y travels faster than Z in the solvent. Y would be the first-collected fraction.

C 7.(1) Before end point, pale yellow was due to the existence pale yellow $Fe^{3+}(aq)$. At the end point, an extra drop of purple $MnO_4(aq)$ resulted in a pale pink colour.

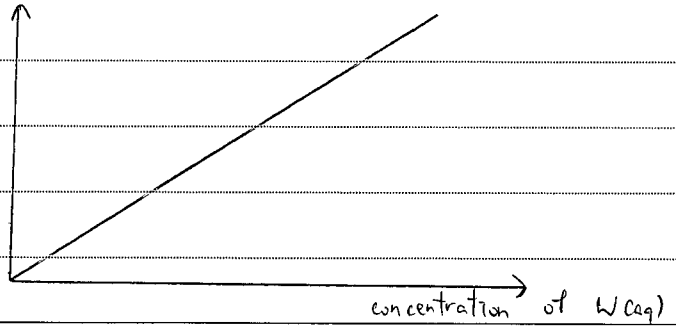
(2) No. of mole of $KMnO_4 = 0.0041 \times \frac{32.35}{1000} = 1.326 \times 10^{-4}$ mol

Mole ratio of $KMnO_4 : Fe^{2+} = 1:5$

No. of mole of $Fe^{2+}(aq) = 1.326 \times 10^{-4} \times 5 = 6.631 \times 10^{-4}$ mol

Concentration of $Fe^{2+}(aq) = 6.631 \times 10^{-4} \div (\frac{25}{1000}) = 0.0265 M$ //

17 (1)



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

(2) From the calibration curve, find the concentration of W(aq) in solution T using light absorbance.
Mole ratio of Fe^{2+} : W = 1 : 1
Concentration of $Fe^{2+}(aq)$ in T equals that of W(aq).
Multiply concentration of $Fe^{2+}(aq)$ in T by 100 to determine concentration of $Fe^{2+}(aq)$ in S.

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2022-DSE
CHEM
PAPER 1B

B

Level 5 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

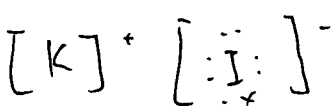
(1 mark)

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

$x = 18$

(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.

As the aqueous solution contains mobile ions

(1 mark)

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

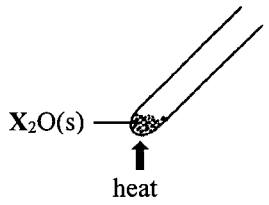
KI would have a higher melting point than HI
Potassium iodide is giant ionic structure while hydrogen iodide is simple molecular structure. The ionic bond between ions in KI is stronger than the van der Waal's forces between molecules in HI. More energy is needed to break the ionic bond (between ions) in KI than energy needed to overcome the van der Waal's forces between HI molecules.

(2 marks)

Answers written in the margins will not be marked.

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.

Z is oxygen;

Add glowing splint into tube with oxygen, the glowing splint relights. (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)

No. of mol of oxygen atom escaped = $\frac{3.028 - 2.819}{16}$

= 0.0131 mol.

No. of mol of X present in compound = 0.0131 × 2

= 0.0262 mol

relative atom ic mass = 2.819 ÷ 0.0262

= 108

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

X is silver

(3 marks)

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

Yes Since X^+ ions are reduced and its oxidation no. changes from +1 to 0, while O^{2-} ions are oxidised and its oxidation no. changes from -2 to 0. (1 mark)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

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 mol of HCl required $= 0.644 \times \frac{25.2}{1000}$

$= 0.0162$ mol.

No. of mol of $NaHCO_3$ reacted: 0.0162 mol

percentage by mass $= \frac{0.0162 \times (23+1+12+16\times3)}{1.52} \times 100\%$

$= 89.5\%$.

(2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

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

The colour change from yellow to orange at the end point

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

pH sensor with data logger

(3 marks)

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

When $Mg(OH)_2$ reacts with stomach acid, it does not produce gas e.g. CO_2 but $NaHCO_3$ does, which may be uncomfortable for patient.

(1 mark)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

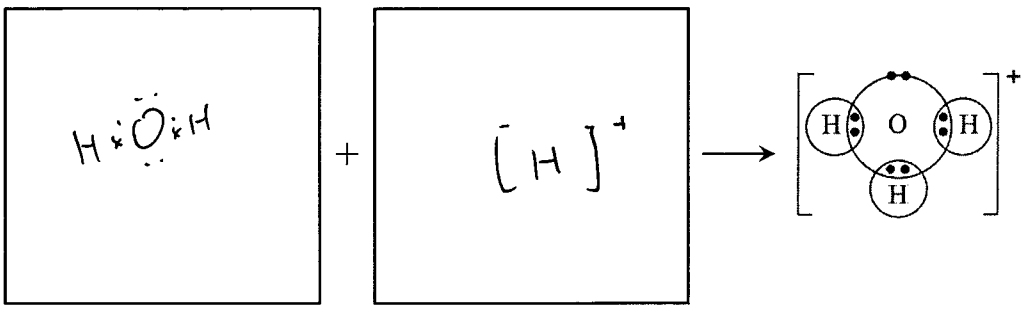
Answers written in the margins will not be marked.

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.

Dative covalent bond is formed by an atom with lone pair electrons (e.g. oxygen atom in H_2O molecules) donating its lone pair electrons to atom or ion with vacant site in its electron shell (e.g. vacant site in H^+ ions), forming dative covalent bond. (3 marks)

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

No since there is only 6 outermost shell electrons in boron atom in BF_3 molecules, which is not stable octet structure of 8 ~~ele~~ outermost electrons. (1 mark)

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

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

No since even though S-F bond is polar, the symmetrical arrangement of 6 S-F bonds lead to polarities cancel out each other. So there is no net polarity and SF_6 is non-polar molecule.

(2 marks)

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

$BF_3 < SF_6 < H_2O$

- The hydrogen bonds between H_2O molecules are stronger than the van der Waal's forces between SF_6 molecules and the van der Waal's forces between BF_3 molecules. More energy is needed to overcome the hydrogen bond between H_2O molecules than energy needed to overcom van der Waal's forces between BF_3 & SF_6 molecules, so H_2O has higher boiling point than SF_6 and BF_3.
- SF_6 molecule has a larger molecular size than BF_3 molecules, so the van der Waal's forces between SF_6 molecules are larger than the van der Waal's forces between BF_3 molecules. More energy is needed to overcome van der Waal's forces between SF_6 molecules than energy needed to overcom van der Waal's forces between BF_3 molecules. So SF_6 has high. boiling point than BF_3.

(3 marks)

Answers written in the margins will not be marked.

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Answers written in the margins will not be marked.

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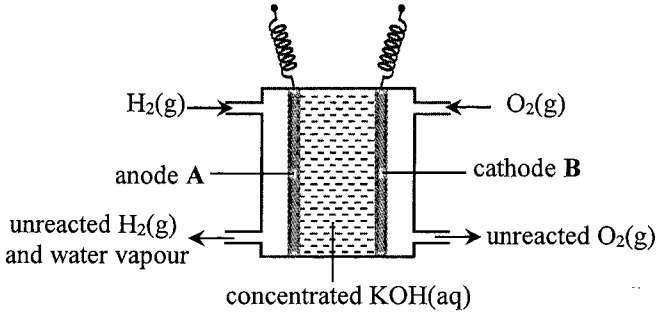
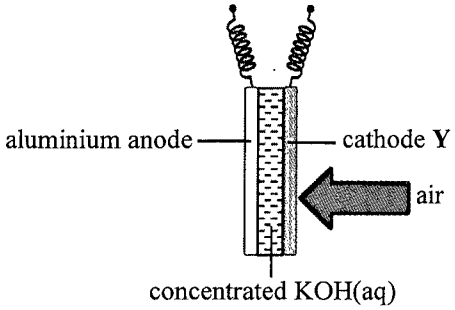
5. The following hydrogen-oxygen fuel cell and aluminium-air cell are primary cells. Their simplified structures are shown below :



hydrogen-oxygen fuel cell



aluminium-air cell

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

Cell that cannot be charged. (1 mark)

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

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

$H_2 + 2OH^- \rightarrow 2H_2O + 2e^-$

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

hydrogen-oxygen fuel cell is expensive.

(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**.

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

(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.

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

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

Obtaining it at cathode of (after fusing) electrolysis of liquid aluminium oxide. (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.

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.

Substitution reaction.

(1 mark)

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

under UV light.

(1 mark)

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

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

As chlorine free radical has an unpaired electron.

(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 :

$$Cl\bullet + CH_4 \rightarrow \boxed{CH_3\bullet} + \boxed{HCl}$$

One of the steps in the termination stage :

$$\boxed{CH_3\bullet} + \boxed{Cl\bullet} \rightarrow CH_3Cl$$

(3 marks)

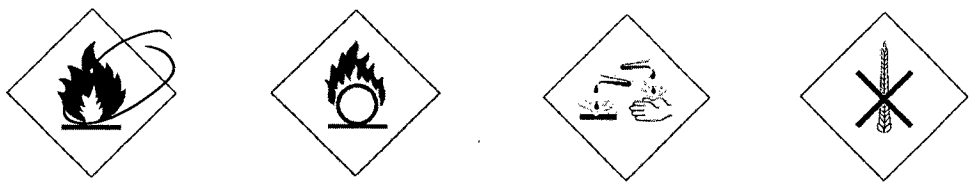
(d) Explain why CH_3Cl is not the only organic product formed in the reaction between methane and chlorine.

As the container contains mixture of compound as the reaction proceeds

As chlorine radical can also attack chemicals other than methane e.g. CH_3Cl to form other products e.g. CH_2Cl_2.

(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)

Answers written in the margins will not be marked.

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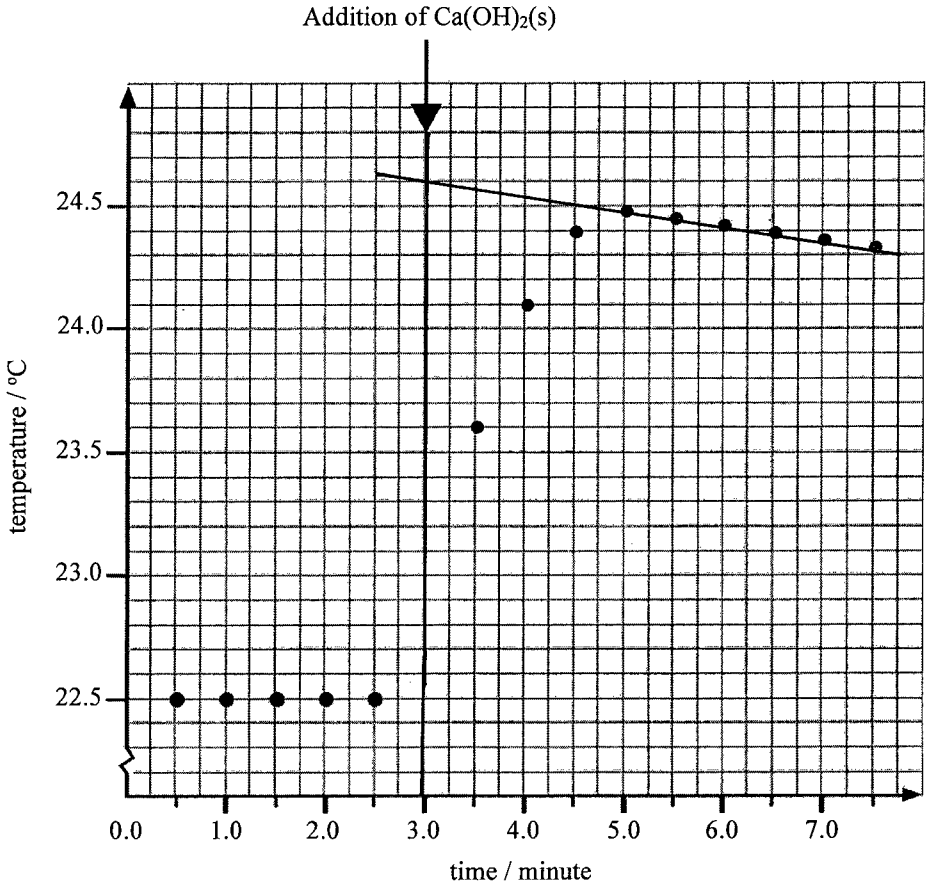
7. An experiment was performed to determine the enthalpy change of neutralisation between $Ca(OH)_2(s)$ and HCl(aq). 100.0 cm^3 of 1.0 M HCl(aq) was placed in an expanded polystyrene cup. The temperature of the contents in the cup was measured at half-minute intervals. Right at the third minute, 0.502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

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

(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

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

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)

Energy released = (4.2)(100)(2.1)(1).

= 882 J

enthalpy change of neutralization =

$-882 \div \left(\frac{0.502}{(40.1 + (16 \times 2) + 2)}\right) \div 2$

= −130 ~~kJ mol^{-1}~~ ÷ 2

= −65.1 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.

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

−186 − (−58.6)

= −127.4 kJ mol^{-1}.

(3 marks)

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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)

- Rusting of iron is due to oxidation of iron when iron come in contact with oxygen and water.
- Both tin-plating and galvanising can prevent iron from getting ~~rusted~~ oxidized and then rusted.
- ~~Tin-is~~ Tin-plating ~~is~~ protects iron by preventing iron from contacting ~~or~~ oxygen and air vapour in air. When the plating is damaged, tin-plating can no longer protects the iron but accelerates the rusting of iron.
- Galvanising protects iron ~~mainly by~~ by also covering iron to prevent iron containing with air and water, also acting as an ~~oxidising~~ reducing agent, to give out electrons the iron to prevent iron from getting oxidized by ~~or~~ oxygen or water in air. Even if the iron is exposed to the air, the zinc metal can still act as an reducing agent such that the protection effect is lasted.

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.

$$Q_c = \frac{[Cl_2][PCl_3]}{[PCl_5]}$$

$$= \frac{\left(\frac{0.16}{4}\right)\left(\frac{0.16}{4}\right)}{\left(\frac{0.84}{4}\right)}$$

$$= 7.62 \times 10^{-3} \text{ mol dm}^{-3}$$

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

As $Q_c < K_c$, concentration of PCl_5 would decrease.

(4 marks)

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

As the forward reaction is endothermic, increase in temperature would lead to increase in K_c.

(2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

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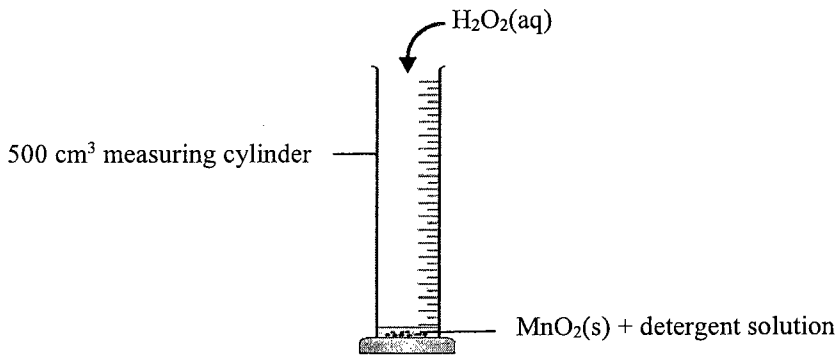
10. At room conditions, $H_2O_2(aq)$ would decompose into $O_2(g)$ and $H_2O(l)$ very slowly in the absence of $MnO_2(s)$. An experiment was performed as shown in the set-up below :



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 $H_2O_2(aq)$.

$2H_2O_2 \rightarrow O_2 + 2H_2O$

(1 mark)

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

Transition metal has catalytic property.

i.e. After addition of $MnO_{2(s)}$ in H_2O_2, the rate of formation of O_2 gas increases (1 mark) comparing to rate of formation of O_2 gas without $MnO_{2(s)}$

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)

No. of mol of H_2O_2 added: $3 \times \frac{10}{1000}$

$= 0.03$ mol

No. of mol of O_2 released = $0.03 \div 2 : 0.015$ mol

Theoretical volume of O_2 released =

$0.015 \times 24 = 0.36$ 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.

As start of reaction (from mark at 100 cm^3 to mark at 200 cm^3), reaction proceeds from mark at to middle or end of the reaction (from mark at 200 cm^3 to mark at 300 cm^3), the concentration of H_2O_2 is decreasing due to decomposition of H_2O_2. So the rate of decomposition decreased.

The concentration of H_2O_2 at middle of the reaction is lower than that of start of the reaction

(2 marks)

Answers written in the margins will not be marked.

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Answers written in the margins will not be marked.

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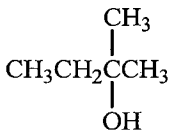
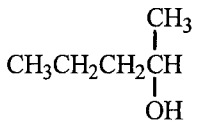
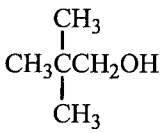
11. Compounds **P**, **Q** and **R** are structural isomers having the molecular formula of $C_5H_{12}O$. Their structures are shown below :



P



Q



R

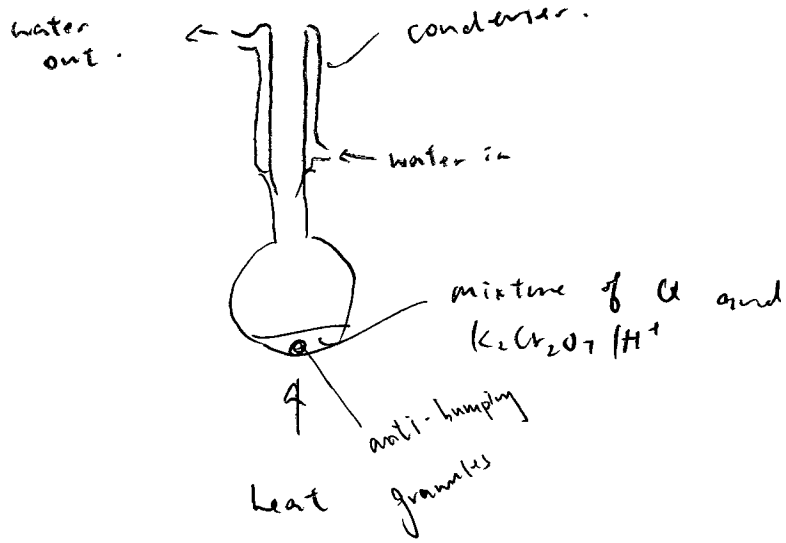
(a) Give the systematic name of **P**.

2-methylbutan-2-ol

(1 mark)

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

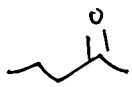
(i) Draw a labelled diagram to show the set-up for this reaction.



(ii) State the expected observation for this reaction.

The solution mixture changes from orange to green.

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



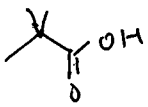
(4 marks)

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**.

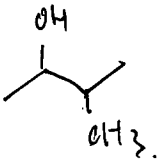


(ii) Suggest a reducing agent required for the reaction.

$LiAlH_4$.

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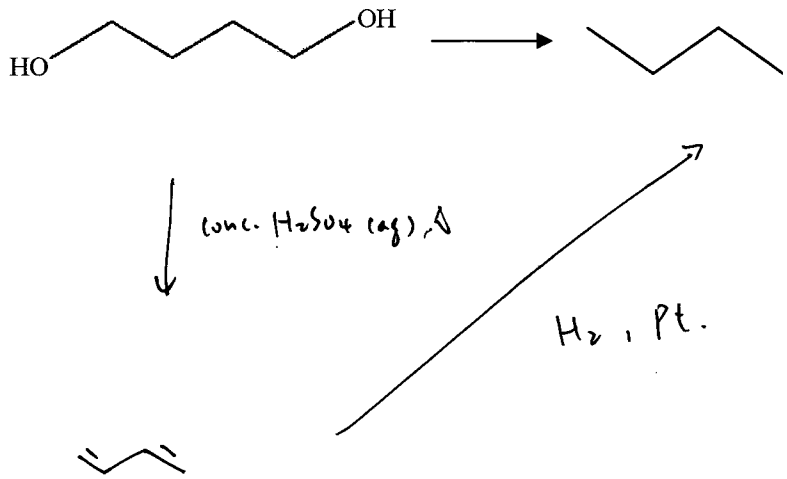
12. Outline a synthetic route, with NO MORE THAN THREE STEPS, to accomplish the following conversion. For each step, give the reagent(s), reaction conditions (as appropriate) and structure of the organic product.



(3 marks)

Answers written in the margins will not be marked.

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)

- As MgO and Al_2O_3 are insoluble in water, no products are form when MgO ~~and~~ or Al_2O_3 are added to water.
- As Na_2O is added to water, it forms sodium hydroxide solution, which is an alkali and can undergo neutralisation with acid
- As Cl_2O is added to water, it forms hypochloric acid, which is an acid and can undergo neutralisation with alkali.

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.

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)

Level 5 Exemplar 2
Paper 2

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

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.

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

試題編號 Question No.

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

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.

a(ii) As it uses ~~toxic~~ to ~~gas~~ catalyst

b) As it uses toxic CO gas.

iii) The surface area to volume ratio of the catalyst is increased such that the catalytic efficiency of catalyst is also increased.

c) As the catalyst may be poisoned by impurities that its catalytic efficiency decreased.

iii) glass bottle

b i) water.

ii i) ~~oxygen~~ chlorine

c) As the concentration of NaCl is very high that Cl^- ions are more preferentially discharged than OH^- ions

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

c) As H^+ ions are discharged as H_2 gas and leave the solution, most of the ~~+~~ ions left in the solution is OH^- ions. Due to high concentration of OH^- ions, some Na^+ ions are diffused to the right hand side of the membrane to form NaOH. Since the membrane is only permeable to Na^+ ions, ~~No~~ no chloride is diffused through the ~~main~~ membrane ~~brown~~ and the NaOH(aq) formed does not contain NaCl.

iv) ~~bleach~~ NaOCl.

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每題另起新頁作答。
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(i) The rate of reaction when the reaction has just started.

(ii) Since the concentration of H^+ ions is so high that the change in H^+ concentration of ions is negligible. The concentration of H^+ ions more or less remains constant.

(iii). $r_0 = k' [S_2O_3^{2-}(aq)]^a$

$\log r_0 = a \log [S_2O_3^{2-}(aq)] + \log k'$.

a = slope = $\dfrac{(-1.1) - (-1.5)}{(-1.84) - (-2.24)}$

$= 1$.

∴ order of reaction with respect to $S_2O_3^{2-}(aq)$ is 1

(iv). $\log \dfrac{k_1}{k_2} = -\dfrac{E_a}{2.3R} \left(\dfrac{1}{T_1} - \dfrac{1}{T_2} \right)$.

$\log \dfrac{1}{1.9} = -\dfrac{E_a}{2.3(8.31)} \left(\dfrac{1}{25+273} - \dfrac{1}{35+273} \right)$.

$E_a = 48.9 \text{ kJ mol}^{-1}$.

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a i) Pump both gas into $K_2Cr_2O_7/H^+_{(aq)}$ separately, only $SO_{2(g)}$ turns the solution from orange to green.

ii). $CH_3CH_2CHO_{(l)}$ contains a peak at m/z = 29 but $CH_3COCH_{3(l)}$ does not.

iii). anhydrous sodium sulphate since only anhydrous sodium sulphate does not react with ethyl butanoate, while concentrated H_2SO_4 and solid sodium hydroxide, which can absorb water to become $NaOH_{(aq)}$, can (let the ester) can undergo hydrolysis.

(maximum mass of Y can be dissolved in 50cm³ deionised water=)

b i) $3.04 \div 100 \times 50 = 1.52g$

$\therefore$ $1.52g > 1.4g$

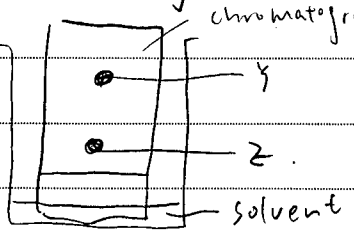
$\therefore$ All of Y in solid sample should have dissolved.

ii). To remove the water-insoluble charcoal and the impurities on it.

iii) crystallisation

iv) Some Y may ~~not~~ be ~~crystalised and collected but~~ be lost during washing.

v 1).



2) Since Y has a greater Rf value than Z, it can move faster with the mobile phase, so Y is collected first.

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(c)(i) At the end pt., all MnO_4^- and Fe^{2+} are reacted to form brown Fe^{3+} ions and pale pink Mn^{2+} ions. As end pt. is reached, the colour intensity of Mn^{2+} is higher than Fe^{3+}, so it changes colour from pale yellow to pale pink.

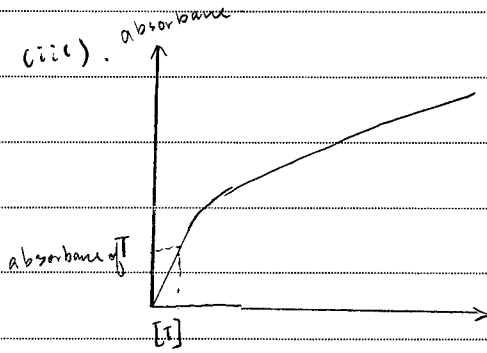
(ii) No. of mol of MnO_4^- reacted $= 0.0041 \times \frac{32.35}{1000} = 1.32635 \times 10^{-4}$ mol

No. of mol of Fe^{2+} present in solution S $= 1.32635 \times 10^{-4} \times 5$

$= 6.63178 \times 10^{-4}$ mol

concentration of Fe^{2+} ions $= 6.63178 \times 10^{-4} \div \left(\frac{25}{1000}\right) = 0.0265$ mol dm^{-3}

(iii).



As the absorbance is only directly proportional to concentration of W when the concentration is very small. By comparing the ~~abs~~ absorbance of very diluted T to the graph, the concentration of T can be more accurately known.

Concentration of W can be given by [T] ×100.

(iv). First by diluting S until the concentration is low enough. React the diluted S with the colourless organic reagent to form W. Measure the absorbance of the newly formed W. Calculate the concentration of W from diluted S by: $\frac{\text{absorbance}_1}{[W_1]} = \frac{\text{absorbance}_2}{[W_2]}$. Multiply the [W] measured by 100, $[Fe^{2+}]$ in S can be determined.

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