2022-2023
MOCK EXAM
S.6 CHEM

PAPER 1B

B

Good Hope School
Mock Examination 2022 – 2023
S.6 Chemistry
Paper 1

Section B: Question-Answer Book B

This paper must be answered in English

請在此貼上電腦條碼
Please stick the barcode label here

Student Number						

INSTRUCTIONS FOR SECTION B

(1) After the announcement of the start of the examination, you should first write your Student Number in the spaces provided on Page 1 and stick your labels in the spaces provided on Pages 1, 3, 5 and 7.

(2) Refer to the general instructions on the cover of the Question Paper for Section A.

(3) Answer **ALL** questions.

(4) 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) Supplementary answer sheets will be supplied on request. Mark the question number box and stick a barcode label on each sheet, and fasten them with string **INSIDE** this Question-Answer Book.

(6) Present your answers in paragraphs wherever appropriate.

(7) The diagrams in this section are **NOT** necessarily drawn to scale.

(8) No extra time will be given to students for filling in the Student Number and the question number boxes after the 'Time is up' announcement.

Part I

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

1. The table below shows some information about two atoms of hydrogen:

	Chemical symbol
Protium	$^{1}_{1}H$
Tritium	$^{3}_{1}H$

(a) Explain why protium and tritium are isotopes. (1 mark)

Protium and deuterium have the same number of protons but with different number of neutrons. [1]

(b) Tritium can be represented by T. When a burning splint is put into a test tube of tritium gas (T_2), a reaction occurs as shown in the equation below:

$$2T_2\,(g) + O_2\,(g) \rightarrow 2T_2O(l)$$

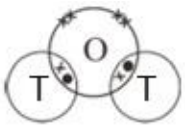
(i) Give ONE expected observation during the reaction. (1 mark)

Give a "pop" sound [1]

Fair performance

Explanation: The chemical properties of isotopes are the same. T2, like H_2, gives "pop" sound with burning splint.

(ii) Draw the electron diagram for a molecule of T_2O, showing electrons in the outermost shells only. (1 mark)



[1]

(iii) 1 mole of $T_2O(l)$ occupies a volume of 18.13 cm^3 at room condition. Calculate the density of $T_2O(l)$. (1 mark)

Mass of 1 mole of $T_2O(l)$ = 16 + 3(2) = 22 g

Density of $T_2O(l)$ = 22/ 18.13 = 1.21 g cm^{-3} [1]

Poor performance.

- Many had no idea about the definition of density/ gave wrong unit of density.
- Many assumed that the molar mass of T_2O is the same as normal water H_2O.

[4 marks]

2. Sodium hydride is a colourless crystalline solid which melts at 800 °C. When molten sodium hydride is electrolysed using graphite electrodes, a shiny deposit is formed on the cathode and a colourless gas is evolved from the anode.

(a) Suggest the type of bonding present in sodium hydride. (1 mark)

Ionic bond [1]

(b) Draw the electron diagram of sodium hydride, showing electrons in the outermost shell(s) only. (1 mark)

[Fair performance]

Common mistake: Wrong number of in hydride ion/ covalent instead of ionic

(c) Write a half-equation for the change that takes place at the anode. (1 mark)

$2H^- \rightarrow H_2 + 2e^-$ [1]

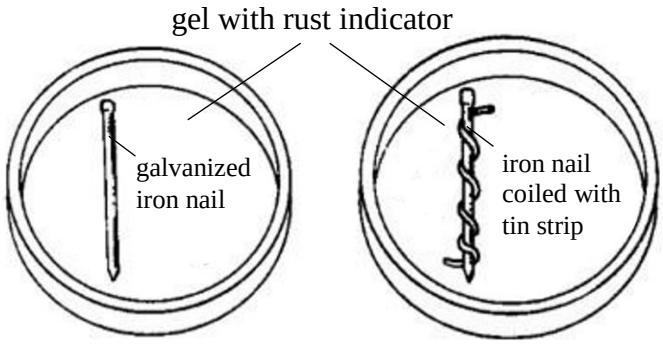
[Poor performance]

Common mistake: many wrote $2H^+ + 2e^- \rightarrow H_2$

[3 marks]

請在此貼上電腦條碼
Please stick the barcode label here

3. Two iron nails are placed in gel with rust indicator containing potassium hexacyanoferrate (III) as shown below and allowed to stand in air for some time.



Petri-dish A Petri-dish B

(a) What would be observed if an iron nail in the above set-up rusts? (1 mark)

Blue colour observed [1]

(b) Explain whether the following iron nails rust:

(i) the nail in petri-dish A (1 mark)

The layer of zinc/ zinc coating on the surface prevents oxygen/ water from contacting with iron. So, no rusting occurs. [1]

[Fair performance]
Common mistake: Many did not state there is a coating of Zn on the surface of iron nail.

(ii) the nail in petri-dish B (1 mark)

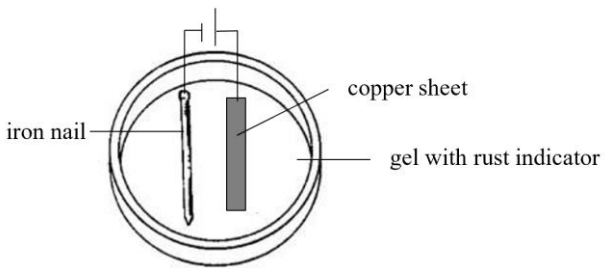
Tin is less reactive than iron/ iron loses electrons more readily than tin, rusting occurs. [1]

(c) Suggest an advantage of galvanization over painting for rust prevention. (1 mark)

Even if the zinc coating is scratched off, zinc still protects iron from rusting by sacrificial protection/ zinc corrodes instead of iron as it is more reactive than iron/ loses electrons more readily than iron. However, if the painting is scratched off, the iron object starts to rust. [1]

(d) Draw a labelled diagram to show how an iron nail can be protected from rusting using the following materials.

- petri-dish
- gel with rust indicator
- electrical wires
- battery
- iron nail
- copper sheet



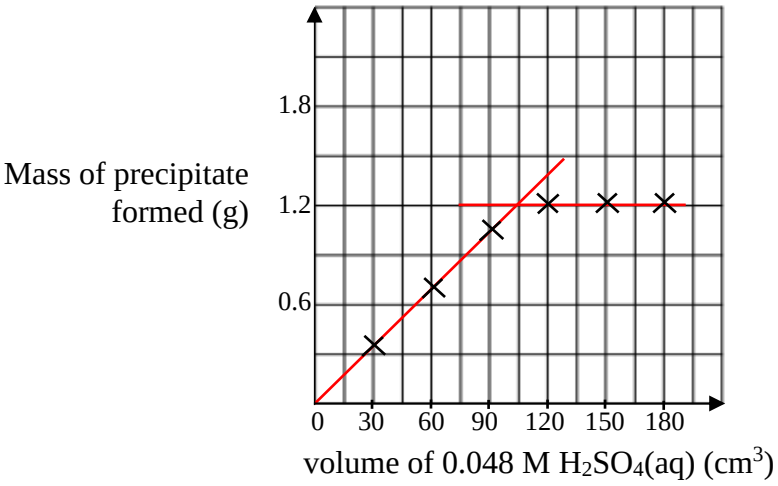
[Fair performance]
Common mistakes:
- Incomplete circuit
- Wrong connection to the battery.

(1 mark)

[1 mark for connecting the negative terminal of the battery to the iron nail]

[5 marks]

4. An experiment was performed to determine the percentage by mass of $Ba(OH)_2$ in a solid sample. 32.50 g of the impure $Ba(OH)_2(s)$ was dissolved in water and diluted to 500.0 cm^3 in apparatus **X**. Different volumes of 0.048 M $H_2SO_4(aq)$ were added to six beakers each containing 25.0 cm^3 of the diluted $Ba(OH)_2(aq)$. The white precipitate obtained in each beaker was filtered, dried and weighed. The mass of the precipitate obtained and the corresponding volume of $H_2SO_4(aq)$ added were plotted in the graph below.



(a) What is apparatus **X**? (1 mark)

Volumetric flask* [1]

(b) Write an equation for the reaction involved in the experiment. (1 mark)

$Ba(OH)_2 + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2H_2O(l)$ [1]

(c) Why is it necessary to rinse the precipitate with distilled water before drying? (1 mark)

To remove soluble impurities adhere on the surface of the precipitate. [1]

(d) Explain why the amount of precipitate formed remains constant for the last three samples. (1 mark)

All $Ba^{2+}(aq)$/ $Ba(OH)_2(aq)$ has been used up/ precipitated/ reacted [1]

(e) (i) By sketching on the graph above, deduce the volume of the $H_2SO_4(aq)$ needed to completely react with 25.0 cm^3 of the diluted $Ba(OH)_2(aq)$. (1 mark)

volume of $H_2SO_4(aq)$ needed = 105 cm^3

Common mistake: Many did not extrapolate the 2 straight lines to deduce the point at which the reaction just completes.

(ii) Hence, calculate the number of moles of $H_2SO_4(aq)$ for complete reaction. (1 mark)

$(105/1000)(0.048) = 5.04 \times 10^{-3}$ [1]

(f) Determine the percentage by mass of $Ba(OH)_2$ in the solid sample. (2 marks)

[Relative atomic masses: H = 1.0; O =1 6.0; Ba = 137.3]

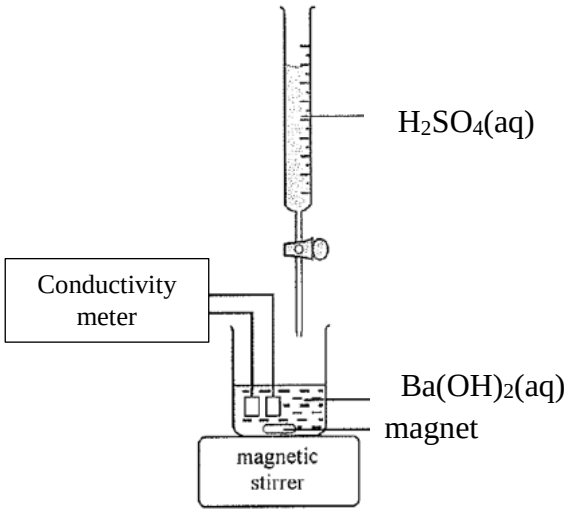
Mass of $Ba(OH)_2$ in the impure sample: $(5.04 \times 10^{-3})(20)[(137.3+(16+1)(2)] = 17.267$ g [1]

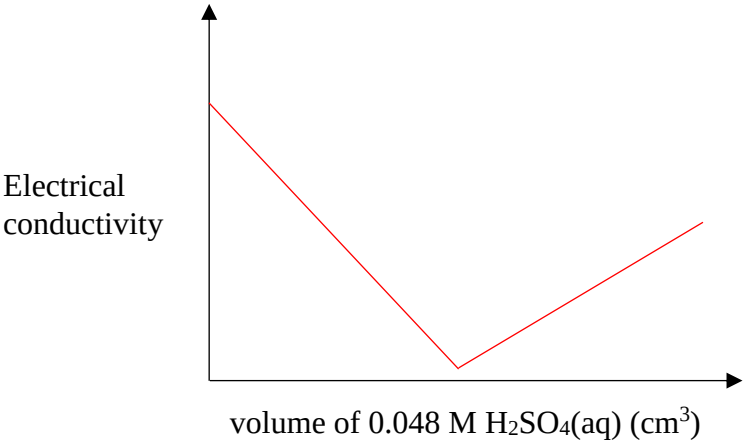
percentage by mass of $Ba(OH)_2 = (17.267 / 32.50)(100\%) = 53.13$ % [1]

[Fair performance]

Common mistake: Many were not aware that the number of moles of $Ba(OH)_2$ in 500.0 cm^3 of the solution is 20 times that in 25.0 cm^3

(g) An alternative method to determine the volume of H_2SO_4(aq) for complete reaction with $Ba(OH)_2$(aq) is by measuring the change in electrical conductivity of the resulting mixture using the apparatus shown below:





Sketch, in the graph above, to show the variation of electrical conductivity with the volume of H_2SO_4 (aq) added. Explain your answer. (3 marks)

[1 for the trend of variation]

Mobile ions are used up to form non-conducting $BaSO_4$ (s) / H_2O (l). Concentration of mobile ions drops, hence leads to a drop in conductivity. [1]
After the equivalence point, the increase in conductivity is due to the increase in concentration of H^+ (aq) and SO_4^{2-} (aq)/ presence of excess H^+ (aq) and SO_4^{2-} (aq) [1].

Common mistake:

Did not explain in terms of "concentration" of mobile ions

[11 marks]

*5. Three unlabelled reagent bottles each contains one of the white solids below:

$MgCl_2(s)$ $ZnCl_2(s)$ $Mg(NO_3)_2(s)$

Outline how you would carry out tests to distinguish these three solids. (6 marks)

Dissolve the solids separately in water. [1]
Add acidified silver nitrate solution to each of the solutions [1]
Only $Mg(NO_3)_2$ does not form precipitate [1]
Add NH_3/ NaOH to each of the solutions obtained until in excess. [1]
Only $ZnCl_2$ forms white precipitate which redissolves in excess alkali/ only $MgCl_2$ forms white precipitate which does not dissolve in excess alkali. [1]

Communication mark [1]

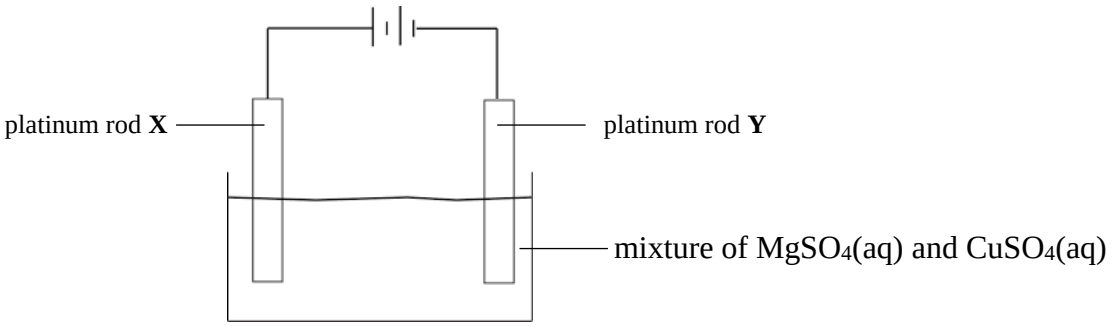
Common mistakes:
Zn^{2+} forms insoluble $Zn(OH)_2$ with NH_3/ NaOH. Some students wrote "precipitate of $ZnCl_2$", "$ZnCl_2$ dissolves in the precipitate" which imply misconceptions.

Remarks:
Should state the observations at different stages: white precipitate is first formed, which then redissolves in excess.

[6 marks]

請在此貼上電腦條碼
Please stick the barcode label here

6. A mixture of $MgSO_4(aq)$ and $CuSO_4(aq)$ is electrolysed in an electrolytic cell using platinum electrodes as shown in the diagram below:



(a) Write the half-equation for the change that occurs at platinum rod **X**. (1 mark)

$4OH^-(aq) \rightarrow O_2(g) + 2H_2O(l) + 4e^-$ [1]

(b) Write the half-equation for the change that occurs at platinum rod **Y**. (1 mark)

$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ [1]

(c) State an observable change, if any, in the solution during the electrolysis. (1 mark)

The solution turns from blue to colourless/ the blue solution turns paler/

Colourless gas bubbles form at rod X. [1]

(d) Would there be any change in observation in the electrolyte if copper electrodes are used instead of platinum electrodes? Explain your answer. (2 marks)

- The copper anode dissolves/ loses electrons to give $Cu^{2+}(aq)$ meanwhile $Cu^{2+}(aq)$ ion is discharged at the cathode [1]. Concentration of $Cu^{2+}(aq)$ remains the same, hence colour intensity of the solution remains unchanged too/ there is no observable change in the electrolyte [1]. OR
- The copper anode dissolves to give $Cu^{2+}(aq)$ / loses electron instead of $OH^-(aq)$, no gas bubbles are formed at rod X.

[Fair performance]
Common mistake: Discharge refers to removal of charge (changing from an ion into an electrically neutral species). During electrolysis, Cu atom at the anode loses electrons to become Cu^{2+}, hence it is wrong to write "Cu is discharged at anode".

[5 marks]

7. (a) Write an ionic equation for the reaction between $VO_3^-(aq)$ and Zn(s) in an acidic medium to give $V^{2+}(aq)$. (1 mark)

$2VO_3^-(aq) + 3Zn(s) + 12H^+(aq) \rightarrow 2V^{2+}(aq) + 3Zn^{2+}(aq) + 6H_2O(l)$ [1]

(b) Identify the oxidizing agent involved in the reaction. Explain your answer in terms of oxidation number. (1 mark)

$VO_3^-(aq)$ is the oxidizing agent [1] as the oxidation number of V/ vanadium decreases/ changes from +5 to +2. [1]

Common mistakes:

- "V" as the O.A.
- Many wrote oxidation number changes from +5 to +2 without specifying the element concerned.

[2 marks]

8. (a) Dimethyl ether, CH_3OCH_3, can be synthesized from methanol as follows:

$2CH_3OH(l) \rightarrow CH_3OCH_3(l) + H_2O(l)$

Relevant enthalpy changes of formation for this reaction are given in the table below:

Compound	ΔH_f^{θ} / kJ mol^{-1}
$CH_3OH(l)$	-239
$CH_3OCH_3(l)$	-184
$H_2O(l)$	-286

Calculate the standard enthalpy change of reaction, ΔH_r^{θ}, for the synthesis of dimethyl ether from methanol. (2 marks)

$2(-239) + \Delta H_r^{\theta} = (-184) + (-286)$ [1]

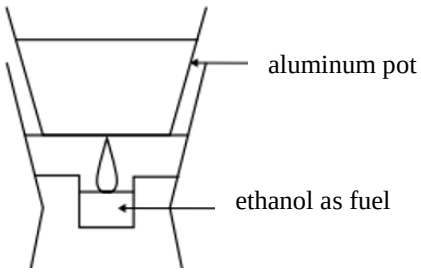
$\Delta H_r^{\theta} = (-184) + (-286) - 2(-239) = +8$ kJ mol^{-1} [1]

Common mistake:
"+" sign is missing/ did not multiply -239 kJ mol^{-1} by 2 [1]

(b) Explain why combustion is exothermic in terms of the breaking and formation of covalent bonds. (1 mark)

The total energy released in the bond formation process is larger than the total energy absorbed in the bond breaking process. [1]

(c) Ethanol (C_2H_5OH) is a common fuel used in camping stove. The structure of a stove is given below:



Consider the following information:

Aluminium pot	150 g
Specific heat capacity of aluminium	0.910 Jg^{-1}K^{-1}
Specific heat capacity of water	4.18 Jg^{-1}K^{-1}
Standard enthalpy change of combustion of ethanol	-1364 kJ mol^{-1}

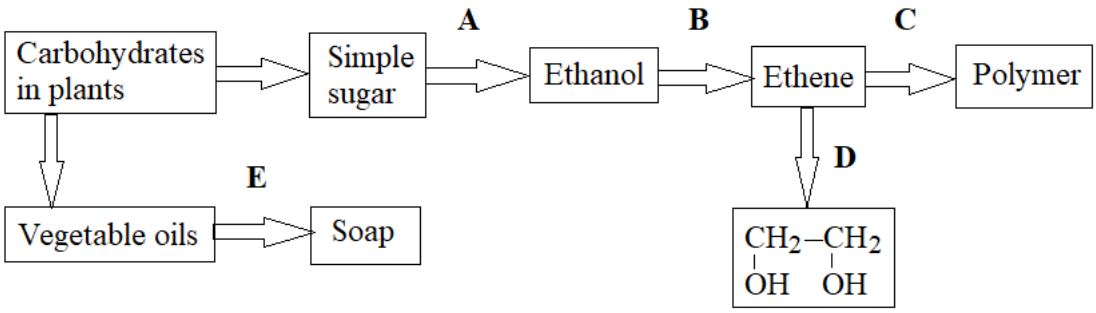
Calculate the minimum mass of ethanol needed to heat 550 g of water from 20 ^{o}C to 100 ^{o}C using the camping stove.
[Relative atomic masses: H = 1.0; C = 12.0; O = 16.0] (3 marks)

Heat released $= m_w c_w \Delta T + m_{Al} c_{Al} \Delta T$
$= 550\ (4.18)(100-20) + 150\ (0.91)(100-20)$
$= 194\ 840$ J [1]
No. of moles of ethanol needed = 194 840 / 1364000 = 0.1428 [1]
Mass of ethanol needed = 0.143 x (12x2+6+16) = 6.57 g [1]
[Poor performance]
Common mistakes:

- Did not determine heat absorbed by the aluminium pot
- Wrongly calculated the total heat absorbed as (550+150) (4.18+0.910)(100-20) J
- Wrongly calculated no. of moles as 194 840 J/ 1364 kJ. They didn't recognize that the units are not consistent.

[6 marks]

9. Consider the following flow chart:



(a) Name process **E**. (1 mark)

E: Saponification* [1] [Not accept: alkaline hydrolysis]

(b) (i) State the reagent required for process **D**. (1 mark)

Cold dilute acidified potassium permanganate solution [1]

(ii) Give the systematic name of the product formed by process **D**. (1 mark)

Ethane-1,2-diol* [1]

(c) (i) State the reagent and condition required for process **E**. (1 mark)

Reagent: concentrated sodium hydroxide solution / concentrated potassium hydroxide solution

Condition: boiling / heating

[both reagent and condition correct – 1]

(ii) Explain why an emulsion is formed when a small amount of soap is added to a test tube containing a mixture of water and a few drops of oil with shaking. (3 marks)

The structure of soap consists of hydrophobic hydrocarbon tail and hydrophilic ionic head. [1+1]

Upon shaking, the oil breaks up into tiny oil droplets. Repulsion of the negatively charged oil droplets prevent them from joining together again. [1] Thus, an emulsion is formed.

(d) State one disadvantage of the polymer formed in process **C**. (1 mark)

It is non-biodegradable and hence pollutes the environment upon disposal. [1]

[Poor performance]

[8 marks]

10. Petrol is a common fuel for motor car. Combustion of petrol emits poisonous air pollutants such as carbon monoxide into the atmosphere.

(a) Suggest how petrol can be obtained from petroleum and explain, from molecular level, the working principle of the method. (3 marks)

Fractional distillation of petroleum [1]

Petroleum fractions have different boiling points and can be separated from each other by fractional distillation. [1]

The longer the carbon chain, the higher the boiling point. [1]

[Do NOT accept cracking]

Common mistake:

- Did not relate the difference in boiling point to the molecular sizes of hydrocarbons.

Explanation: Cracking is carried out on heavy fraction, not petroleum which is a mixture of various hydrocarbons of different chain lengths. In other words, fractional distillation must be performed before cracking.

(b) Octane is a component in petrol. Write a chemical equation to show how carbon monoxide can be formed from the combustion of octane. (1 mark)

$2C_8H_{18} + 17O_2 \rightarrow 16CO + 18H_2O$ [1]

(c) Suggest a method to reduce the emission of carbon monoxide from petrol-driven motor cars. Support your answer with an appropriate equation. (2 marks)

Install a catalytic converter in the exhaust system of the motor car. [1]

$2CO(g) + 2NO(g) \rightarrow N_2(g) + 2CO_2(g)$ / $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$ [1]

Common mistake:

Equation is not balanced.

[6 marks]

PART II

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

11. An experiment was performed for a reversible reaction involving $Cl_2(g)$, $H_2O(g)$, $HCl(g)$ and $O_2(g)$ in a closed container of a fixed volume of 2.0 dm^3 at a constant temperature. The equation for the reaction is as follows:

$$2Cl_2(g) + 2H_2O(g) \leftrightharpoons 4HCl(g) + O_2(g)$$

(a) Write an expression for the equilibrium constant K_c for the reaction. (1 mark)

$K_c = [HCl(g)]^4 [O_2(g)] / [Cl_2(g)]^2 [H_2O(g)]^2$ [1]

(b) With reference to the table below, calculate **x**. Hence, calculate the equilibrium constant K_c for the reaction at that temperature. (3 marks)

	$Cl_2(g)$	$H_2O(g)$	$HCl(g)$	$O_2(g)$
Initial number of moles	0.16	0.08	0.16	0.08
Number of moles at equilibrium	**x**	0.14	0.04	0.05

x = 0.16 + (0.14 – 0.08) = 0.22 [1]

$K_c = (0.04/2)^4 (0.05/2) / (0.22/2)^2 (0.14/2)^2$ [1]

$= 6.7465 \times 10^{-5}$ mol dm^{-3} [1]

[Poor performance]

Common mistakes:

- Many substituted "no. of moles" of reactants and products into the Kc expression instead of their concentration in mol dm^{-3}.
- Wrong or missing unit.

(c) When the above equilibrium is heated, the colour of the mixture fades. Deduce whether the above reaction is endothermic or exothermic. (2 marks)

When temperature increases, less $Cl_2(g)$ is formed and the equilibrium position shifts to the right. [1]

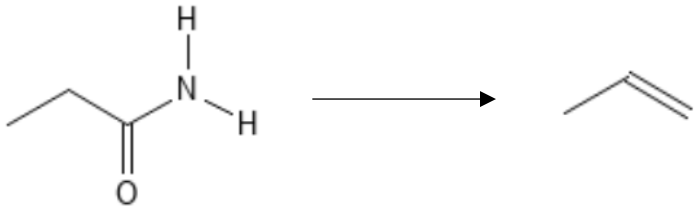
As increase in temperature favors endothermic reaction, thus the forward reaction is endothermic. [1]

[Fair performance]

Common mistake: Many did not state "increase in temperature favors endothermic reaction."

[6 marks]

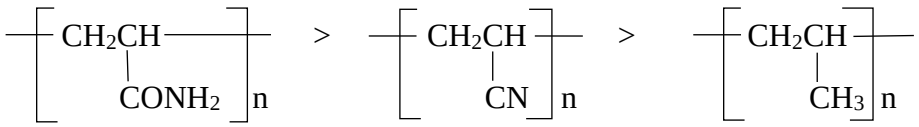
12.(a) Outline a synthetic route, with no more than three steps, to accomplish the following conversion. For each step, give the reagent(s), reaction conditions (as appropriate) and the structure of the organic product.



(3 marks)

Step 1: 1. NaOH(aq), heat 2. H^+(aq) OR H^+(aq), reflux Product: CH_3CH_2COOH [1]
Step 2: 1. $LiAlH_4$, dry ether 2. H^+(aq) Product: $CH_3CH_2CH_2OH$ [1]
Step 3: Al_2O_3, heat OR conc. H_2SO_4, heat [1]

(b) Account for the descending order of tensile strength of the following three polymers:



polymer **X** > polymer **Y** > polymer **Z**

(2 marks)

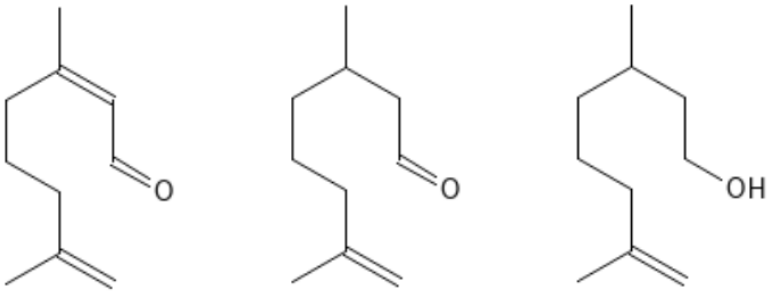
The polymer chains of **X** are attracted by hydrogen bond (due to the presence of -$CONH_2$ group) while those of **Y** and **Z** are attracted by van der Waals' forces. Hydrogen bond is stronger than van der Waals' forces. [1]
Y is polar while **Z** is not, thus the van der Waals' forces between the polymer chains of **Y** is stronger than those between **Z**. [1]

[Poor performance]

Common mistakes
- Many wrote N-H is hydrogen bond which implies misconception. H-bond exists among different chains while N-H bond is a covalent bond which is much stronger than H-bond.
- Many did not state and compare the type of intermolecular forces in different polymers.

[5 marks]

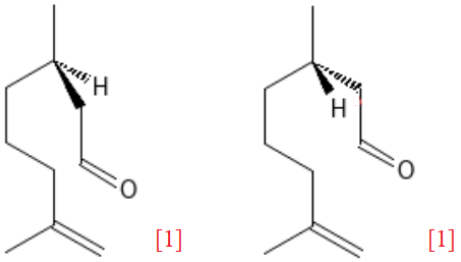
13. The flavours in citrus fruits are mainly due to the presence of compounds **P**, **Q** and **R**.



P **Q** **R**

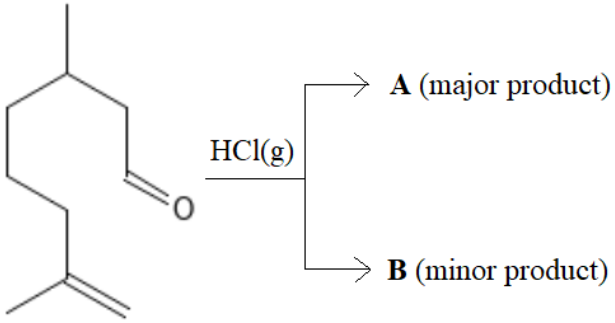
(a) State the type of isomerism that occurs in **Q** but not in **P**. Draw the two structures which illustrate this isomerism in **Q**. (3 marks)

Enantiomerism* [1]



[1] [1]

(b) **Q** reacts with HCl(g) to give major product **A** and minor product **B**, as predicted from the Markovnikov's rule.



Q

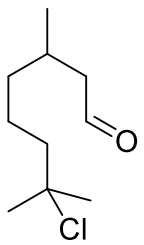
(i) State the Markovnikov's rule. (1 mark)

In the addition reaction of hydrogen halide and an alkene, the hydrogen atom of hydrogen halide is added to the carbon atom of the carbon-carbon double bond that attached with a greater number of hydrogen atoms. [1]

[Poor performance]

Common mistake: "C=C" is missing

(ii) Draw the major product **A**. (1 mark)



[1]

(c) Describe how compound **R** can be converted to compound **Q**. (1 mark)

Heat compound **R** with acidified potassium dichromate solution. [1]

[reflux set-up should not be used.]

[6 marks]

*14. Na_2O, Al_2O_3 and SO_2 are added into water separately. Give, and explain, the approximate pH of each of the reaction mixtures. Chemical equations are NOT required. (4 marks)

Na_2O reacts with water to form sodium hydroxide solution with a pH greater than 7. [1]

Al_2O_3 is insoluble in water and does not react with water. Hence the pH of the mixture is 7. [1]

SO_2 reacts with water to form sulphurous acid with a pH smaller than 7. [1]

Effective communication [1]

[Poor performance]

Common mistake:

- Many did not state the products formed when the oxides are put in water.

[4 marks]

15. An experiment was carried out to investigate the rate of the decomposition of hydrogen peroxide in the presence of manganese(IV) oxide:

$$2H_2O_2(aq) \xrightarrow{MnO_2(s)} 2H_2O(l) + O_2(g)$$

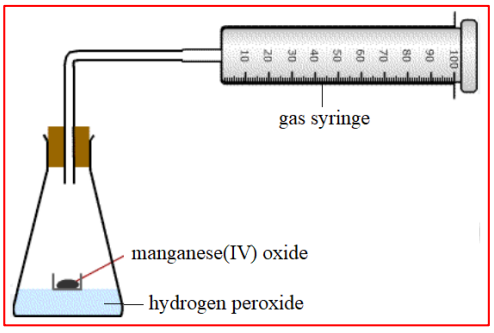
(a) Explain why only a small amount of manganese(IV) oxide is needed for the reaction. (2 marks)

Manganese(IV) oxide acts as a catalyst [1] and is readily regenerated as the reaction proceeds. / remains chemically unchanged at the end of the reaction. [1]

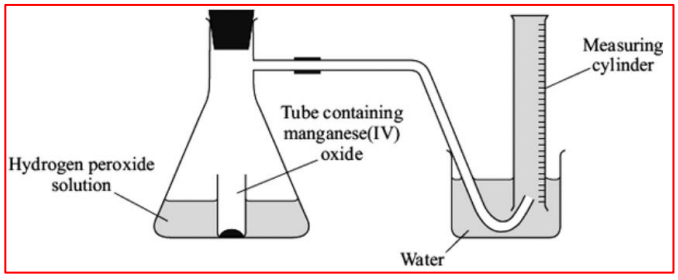
Common mistake:

Some wrote catalyst remains chemically unchanged "throughout "the reaction which implies misconception.

(b) Draw the set-up that can be used to measure the volume of oxygen gas liberated during the reaction. (2 marks)

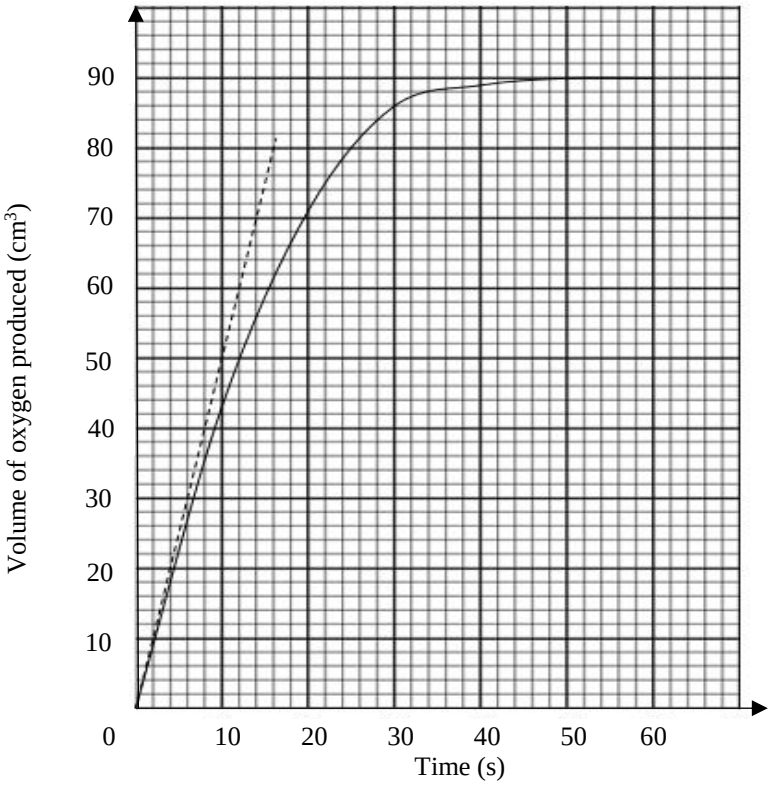


/



[1M – reaction set-up; 1M – means of measuring gas volume]

(c) The curve in the graph below shows the volume, measured at room temperature and pressure, of the oxygen gas liberated in the first minute of the experiment. The dotted line in the graph is the tangent to the curve at the start of the reaction.



With reference to the graph above, calculate the initial rate of the reaction with respect to the volume of oxygen gas liberated. (1 mark)

Initial rate = 60 / 12 = 5 cm^3 s^{-1} [1]

(d) Suggest another factor that can also cause an increase in rate of decomposition under the same temperature. Explain your answer at molecular level. (2 marks)

Increase the concentration of hydrogen peroxide [1]

As the concentration of hydrogen peroxide increases, the hydrogen peroxide particles collide more often. This increases the frequency of effective collisions and hence the rate of reaction. [1]

Also accepts using $MnO_2(s)$ in powder form instead of granular form [1]

Powdered $MnO_2(s)$ provides a larger contact surface area and allow more particles to undergo the reaction via alternative pathway of lower Ea. This increases the frequency of effective collisions . Reaction rate increases. [1]

[Fair performance]

Common mistake:

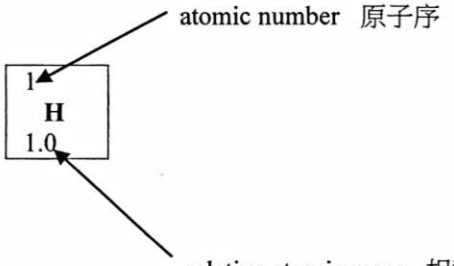
Many suggested increase in gas pressure would increase the reaction rate. Since this reaction does not involve gaseous reactants, change in gas pressure has little effect on reaction rate.

[7 marks]

END OF SECTION B
END OF PAPER

PERIODIC TABLE 周期表

GROUP 族



I	II											III	IV	V	VI	VII	0
																	2 **He** 4.0
3 **Li** 6.9	4 **Be** 9.0											5 **B** 10.8	6 **C** 12.0	7 **N** 14.0	8 **O** 16.0	9 **F** 19.0	10 **Ne** 20.2
11 **Na** 23.0	12 **Mg** 24.3											13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	18 **Ar** 40.0
19 **K** 39.1	20 **Ca** 40.1	21 **Sc** 45.0	22 **Ti** 47.9	23 **V** 50.9	24 **Cr** 52.0	25 **Mn** 54.9	26 **Fe** 55.8	27 **Co** 58.9	28 **Ni** 58.7	29 **Cu** 63.5	30 **Zn** 65.4	31 **Ga** 69.7	32 **Ge** 72.6	33 **As** 74.9	34 **Se** 79.0	35 **Br** 79.9	36 **Kr** 83.8
37 **Rb** 85.5	38 **Sr** 87.6	39 **Y** 88.9	40 **Zr** 91.2	41 **Nb** 92.9	42 **Mo** 95.9	43 **Tc** (98)	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba** 137.3	57 * **La** 138.9	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.9	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 ** **Ac** (227)	104 **Rf** (261)	105 **Db** (262)													

*	58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 152.0	64 **Gd** 157.3	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0	71 **Lu** 175.0
**	90 **Th** 232.0	91 **Pa** (231)	92 **U** 238.0	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)