2020-2021
S.6 CHEM

PAPER 1B

B

Student name	
Class	
Class number	
Block number	

Good Hope School
Mock Examination 2020-2021

S.6 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 name, class, class number and block number in the space provided on Page 1.

(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.

(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 name, class, class number and block number on EACH of the supplementary answer sheet.

(6) No extra time will be given to candidates for filling in the student information after the 'Time is up' announcement.

Section B : Conventional Questions (84 marks)

Part I

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

1. The table below shows some information of 3 atoms:

	Number of protons	Number of electrons	Number of neutrons
Protium	1	1	0
Deuterium	1	1	1
Oxygen	8	8	16

(a) Explain why protium and deuterium are isotopes.

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

(1 mark)

(b) Deuterium can be represented by D. When a test tube of deuterium gas is ignited, "heavy water" (D_2O) is formed according to the equation below:

$$2\ D_2 + O_2 \rightarrow 2\ D_2O$$

(i) Give ONE expected observation of the reaction.

Give a "pop" sound [1]

(ii) Draw the electron diagram for a D_2O molecule, showing electrons in the outermost shells only.

[1]

(2 marks)

[3 marks]

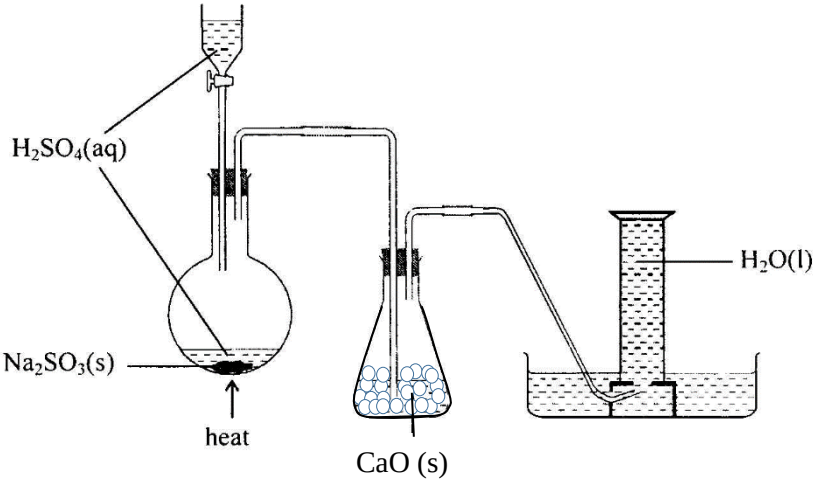
2. Sulphur dioxide can be prepared by reacting sodium sulphite solid with dilute sulphuric acid.

(a) Write the chemical equation for the reaction.

$Na_2SO_3\ (s) + H_2SO_4\ (aq) \rightarrow Na_2SO_4\ (aq) + H_2O\ (l) + SO_2\ (g)$ [1]

(1 mark)

(b) A student suggested to use the set-up below to prepare a dry sample of sulphur dioxide from sodium sulphite solid.



State, with reasons, TWO mistakes in the above set-up and suggest how they could be corrected respectively.

CaO (s) should not be used as SO_2 (g) reacts with CaO(s) [1]. Concentrated sulphuric acid/ anhydrous calcium chloride should be used instead [1].

SO_2 (g) should not be collected over water as SO_2 is highly soluble [1]. SO_2 (g) should be collected by downward delivery / using a syringe [1].

(4 marks)

(c) State the expected observation if sulphur dioxide gas is passed into an aqueous solution of iodine and write an ionic equation for the reaction involved.

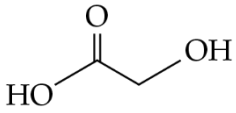
$SO_3^{2-}(aq) + H_2O(l) + I_2\ (aq) \rightarrow SO_4^{2-}(aq) + 2I^-\ (aq) + 2H^+\ (aq)$ [1]

The solution changes from pale yellow/ pale brown to colourless [1]

(2 marks)

[7 marks]

3. Glycolic acid is a weak acid that can be found in some skin-care products. The structure of glycolic acid is shown below:



To be regarded as non-hazardous, the amount of glycolic acid in skin-care products should not exceed 12 g per 100 cm^3.

(a) Glycolic acid is a monobasic acid. Define the term "monobasic acid".

Monobasic acid refers to an acid molecule which gives one hydrogen ion / an acid which gives one hydrogen ion per molecule upon ionization in water. [1]

(1 mark)

(b) Explain, with the aid of a chemical equation, whether 0.01 M glycolic acid solution has a pH greater than, smaller than or equal to 2.

Glycolic acid ionizes slightly in water and the concentration of $H^+(aq)$ is lower than 0.01 M. Hence, the pH of 0.01 M glycolic acid is greater than 2. [1]

$CH_2OHCOOH(aq) \rightleftharpoons CH_2OHCOO^-(aq) + H^+(aq)$ [1]

(2 marks)

(c) To determine the amount of glycolic acid in a toner, 7.50 cm^3 of the toner is diluted to 100.0 cm^3 using distilled water. Four portions of 25.0 cm^3 of the diluted solution are titrated against 0.150 M potassium hydroxide solution. The average volume of the potassium hydroxide solution required is 21.40 cm^3. Determine whether the toner is hazardous from the titration results.
(Molar mass of glycolic acid = 76.0 g mol^{-1})

Number of moles of KOH used = $0.150 \times \frac{21.40}{1000}$ mol = 3.21×10^{-3} mol [1*]

Number of moles of glycolic acid in 25.0 cm^3 of the diluted solution
= 3.21×10^{-3} mol
Number of moles of glycolic acid in 7.50 cm^3 of the toner
= $3.21 \times 10^{-3} \times \frac{100.0}{25.0}$ mol = 0.01284 mol
Mass of glycolic acid in 7.50 cm^3 of the toner = 76.0×0.01284 g = 0.976 g [1*]
Mass of glycolic acid in 100 cm^3 of the toner
= $0.976 \text{ g} \times \frac{100}{7.5}$ = 13.0 g > 12.0 g ∴the toner is hazardous. [1]

(3 marks)

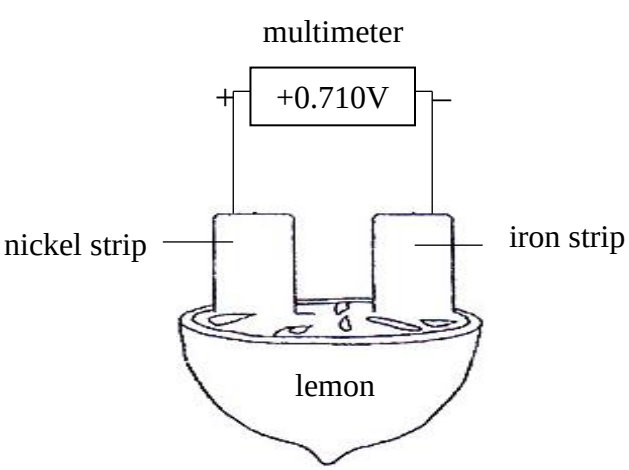
(d) For the titration in (c), the pipette used to transfer the diluted solution is rinsed with water only. Explain how this practice will affect the titration result.

After washing the pipette, some distilled water is left inside the pipette. The diluted toner solution is further diluted and the number of moles of glycolic acid in the conical flask will be smaller than the expected value. [1]
A smaller volume of standard KOH(aq) will be required for the titration. [1]

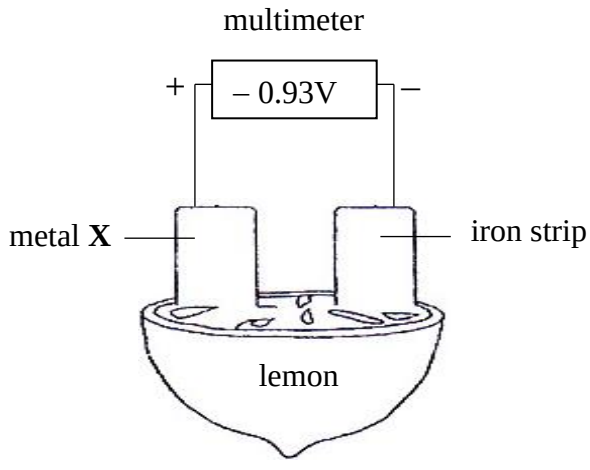
(2 marks)

[8 marks]

4. (a) The following lemon cells are set up to study the reducing power of different metals.



cell 1



cell 2

(i) Arrange nickel, iron and metal **X** in decreasing order of reducing power.

X > Fe > Ni [1]

(ii) For **cell 1**, write the half-equation for the reaction that occurs at the nickel strip.

$2H^+ (aq) + 2e^- \rightarrow H_2 (g)$ [1]

(iii) Would the multimeter reading become more negative, less negative or remain unchanged if the iron strip in **cell 2** is replaced by a copper strip, while the other conditions remain unchanged? Explain your answer.

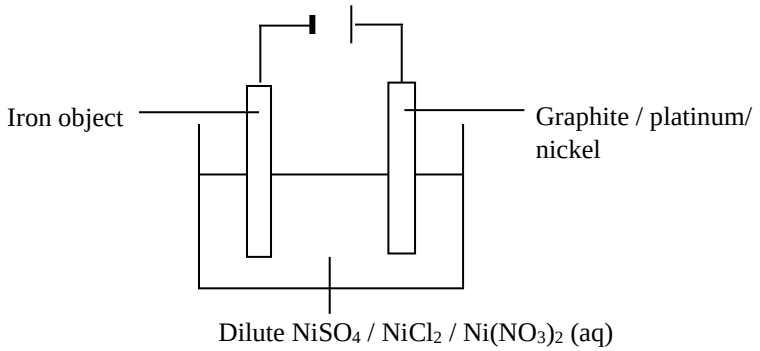
More negative [1]. Copper is less reactivity than iron/ copper loses electrons less readily than iron/ copper occupies a lower position in ECS than iron/ copper is a weaker reducing agent than iron [1]. Therefore, X and Cu are further apart in ECS than X and Fe.

(4 marks)

(b) (i) Explain why nickel-plated iron does not rust easily.

The nickel coating keeps iron away from oxygen and water.[1]

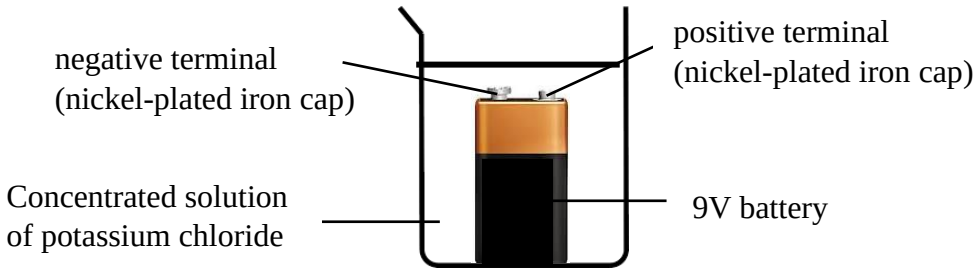
(ii) Draw a labelled diagram of the experimental set-up used in a laboratory for coating a layer of nickel on an iron object by electrolysis.



Correct connection to power supply [1]
Correct electrolyte [1]

(2 marks)

4. (c) The terminal caps of 9-volt batteries are commonly made of nickel-plated iron. In an experiment, a 9V battery is immersed in a concentrated solution of potassium chloride as shown below:



After 30 minutes, some green gel-like precipitate is formed inside the beaker.
With reference to the reactions taking place at the 2 terminals, explain the formation of the green precipitate.

At the negative terminal, H^+ ions are preferentially discharged, leaving behind OH^- (aq). [1]
At the positive terminal, nickel metal loses electrons to become Ni^{2+} (aq)/ iron loses electrons to become Fe^{2+} (aq). [1]
OH^- (aq) which remains in the electrolyte combine with Ni^{2+} (aq)/ Fe^{2+} (aq) to form insoluble $Ni(OH)_2$ / $Fe(OH)_2$ which appears as green precipitate.[1]

(3 marks)

(d) The 9V battery used in part (c) is a zinc-carbon cell. The equation below shows the reaction that occurs in the cell during discharge:

$2\ MnO_2\ (s) + 2\ NH_4Cl\ (aq) + Zn\ (s) \rightarrow Mn_2O_3\ (s) + 2\ NH_3\ (g) + H_2O\ (l) + ZnCl_2\ (aq)$

(i) Deduce, in terms of change in oxidation number, the oxidising agent in a zinc-carbon cell.

Oxidation number of Mn decreases/ changes from +4 to +3. [1]
Therefore MnO_2 (s) is the oxidizing agent. [1]

(ii) Do you agree with the following statement? Explain your answer.
"Nickel-cadmium cells is more environmental friendly than zinc-carbon cell."

[one of the following]
FOR: Nickel-cadmium cell produces less solid waste as it is rechargeable while zinc-carbon cell is not. [1]
AGAINST: Nickel-cadmium cell poses more hazard to the environment when disposed as cadmium/ compound of cadmium is highly toxic while chemicals in zinc-carbon cell are less hazardous. [1]

(3 marks)

[12 marks]

5. In an experiment, a piece of aluminium foil is put into a beaker of 6M HCl (aq). For the first few minutes, no gas bubbles are observed. Later on, bubbles of colourless gas evolve and the reaction speeds up. Explain, with the aid of chemical equations, the above observations.

There is no observable change at the beginning as the surface of aluminum foil is covered with a layer of Al_2O_3 which acts as a barrier and prevent aluminium from reacting with HCl. [1]
As Al_2O_3 is gradually dissolved by the HCl, Al is then exposed and reacts with HCl to give hydrogen gas, which appears as colourless gas bubbles.[1]
Al_2O_3 (s) + 6HCl (aq) $\rightarrow$ $2AlCl_3$ (aq) + $3H_2O$ (l) [1]
2Al (s) + 6HCl (aq)$\rightarrow$ $2AlCl_3$ (aq) + $3H_2$ (g) [1]

(4 marks)

[4 marks]

*6. Office paper contains calcium carbonate (up to 50 %) as an additive to enhance its brightness, whiteness and opacity. Devise an experiment to estimate the percentage by mass of calcium carbonate in a sample of office paper. Your answer should include treatment of data.

Weigh a piece of office paper [1]
Immerse paper in excess HCl (aq) [1]
When no CO_2 evolves from the mixture, decant acid and wash paper with distilled water [1]
Dry the paper in an oven and weigh the paper again [1]
% by mass of $CaCO_3$ = (change in mass of paper / original mass of paper) x 100% [1]

Weigh a piece of office paper [1]
Immerse in a known volume of standard HCl (excess) [1]
When no more gas bubbles evolve, titrate excess HCl using standard KOH (aq)/ NaOH (aq) [1]
Calculate mass of $CaCO_3$ from titration result [1]
% by mass of $CaCO_3$ = (mass of $CaCO_3$ / original mass of paper) x 100% [1]

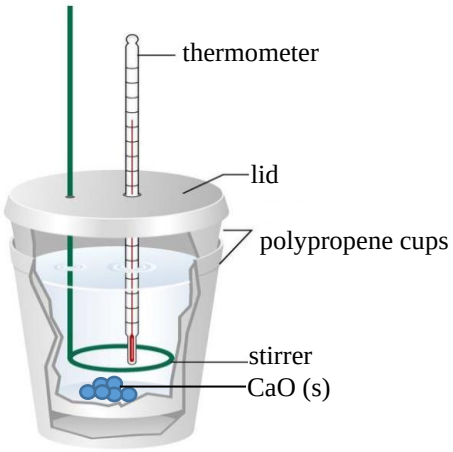
Weigh a piece of office paper [1]
Burn the paper completely (in a crucible) [1]
Weigh the CaO (s) produced [1]
Mass of $CaCO_3$ (s) = (m/56)(100) [1]
% by mass of $CaCO_3$ = (mass of $CaCO_3$ / original mass of paper) x 100% [1]

1 mark for effective communication (only if chemical knowledge got 4-5 M and the answer is complete and easy to understand)

(6 marks)

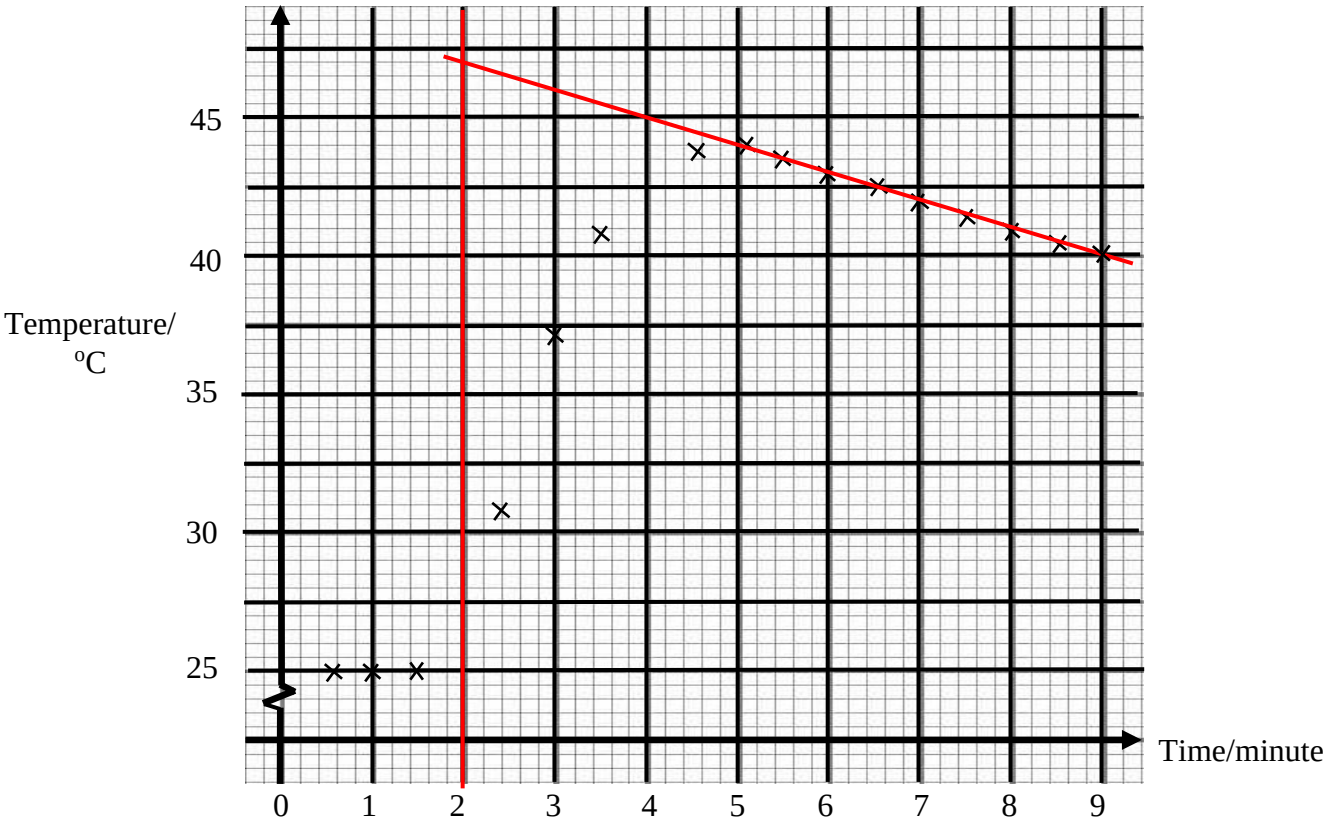
[6 marks]

7. A student carried out an experiment to determine the enthalpy change of reaction of calcium oxide (CaO) with water. The experimental set-up is shown below:



A certain volume of water was placed in a polypropene cup. The temperature of water in the cup was measured with a thermometer at half-minute intervals. Right at the second minute, 3.0 g of CaO(s) was added to the cup. The solution in the cup was then stirred thoroughly and its temperature was measured for an additional 7 minutes.

The recordings of temperature are shown in the graph below:



(a) (i) From the graph, estimate the greatest temperature rise of the solution in the cup. Show your work on the graph.

47 – 25 = 22 °C [1 M + 1 A]

7. (a) (ii) The mass of the solution obtained was found to be 33.5 g. Calculate the enthalpy change of the reaction, in kJ mol^{-1}, under the experimental conditions.
(Heat capacity of the polypropene cup is negligible; specific heat capacity of the solution is 4.2 J g^{-1} K^{-1}; relative formula mass of CaO = 56.1)

No. of moles of CaO(s) used = 3/56.1 = 0.0535 [1]
Heat released = 33.5 x 4.2 x (47 – 25) = 3095.4 J [1]
ΔH = – 3095.4 / 0.0535
= – 57.9 kJ mol^{-1} [1]

(iii) Besides heat loss, suggest another possible source of error in the experiment.

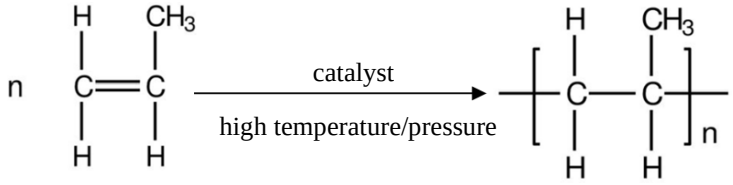
The reaction is not conducted under standard conditions / the CaO sample is impure / the reaction is incomplete [1].

(6 marks)

*(b) The cup used in the experiment is made of polypropene. Describe how polypropene can be produced from crude oil using appropriate chemicals and processes.
Write the chemical equations for the reactions involved.

Chemical knowledge:

- Separation of crude oil gives naphtha, heavy oil, fuel oil etc. by fractional distillation / oil refinery.
- Cracking of naphtha/heavy oil/fuel oil etc. gives a mixture of smaller molecules including propene.
- A balanced chemical equation for cracking:
C_7H_{16} → $CH_3CH{=}CH_2 + C_4H_{10}$
(Accept hydrocarbons with 5 or more carbon atoms e.g. C_5H_{12})
- Fractional distillation of the above reaction mixture to obtain propene.
- Addition polymerization using propene as monomers under suitable reaction conditions (high temperature and pressure, in the presence of catalyst) / write a chemical equation showing the addition polymerization of propene and stated with reaction conditions.



- 1 mark is given for effective communication only if the chemical knowledge got 4-5 marks and the answer is complete and easy to understand.

(6 marks)

[12 marks]

8. (a) Explain the following decreasing order of the boiling points of three substances:

$NH_4F > CH_3NH_2 > CH_3F$

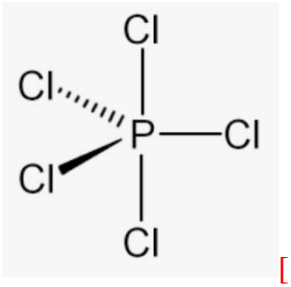
CH_3NH_2 and CH_3F have simple molecular structures while NH_4F has a giant ionic structure [1].

The ionic bonds between NH_4^+ ions and F^- ions are much stronger than the intermolecular forces (hydrogen bonds and the van der Waals' forces). Boiling point of NH4F is thus the highest. [1]

Hydrogen bonds exist among CH_3NH_2 molecules are stronger than van der Waals' forces exist among CH_3F molecules. Boiling point of CH_3NH_2 is thus higher than that of CH_3F. [1]

(3 marks)

(b) Draw a three-dimensional diagram to represent the molecular shape of PCl_5.



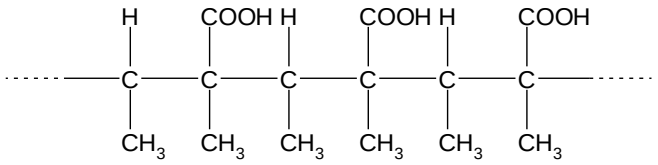
[1]

(1 mark)

[4 marks]

Part II

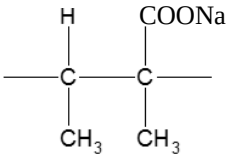
9. (a) Part of the structure of polymer **Y** is shown below:



(i) Polymer **Y** can be formed from the polymerisation of compound **X**. State the systematic name of compound **X**.

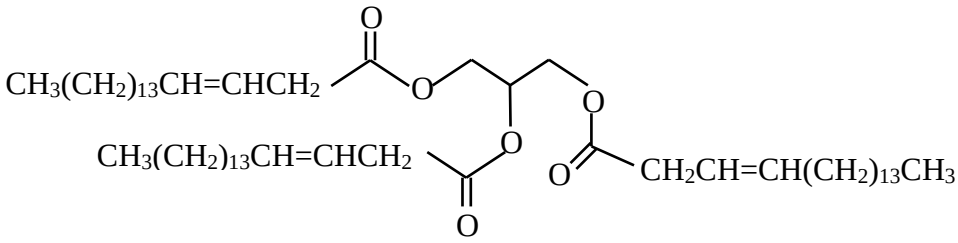
2-methylbut-2-enoic acid [1]

(ii) It is known that the reaction of polymer **Y** with $NaHCO_3(aq)$ forms polymer **Z** which can absorb water better. Draw the repeating unit of **Z**.

 [1]

(2 marks)

(b) The following structure represents an unsaturated fat **F** which is a component of a vegetable oil:



(i) State the reagents needed for converting **F** into a saturated fat **S**.

Hydrogen in the presence of Ni / Pd / Pt [1]

(ii) **S** can be used to make soap. Give the structural formula of the soap formed from hydrolysis of **S** in NaOH(aq).

$CH_3(CH_2)_{13}CH_2CH_2CH_2COONa$ or $CH_3(CH_2)_{16}COONa$ [1]

(iii) A small piece of soap is added to a test tube containing a mixture of oil and water. The test tube is then shaken thoroughly. State and explain what would be observed.

When the soap is added to the mixture, the hydrophilic heads of the detergent anions dissolve in water and the hydrophobic hydrocarbon tails dissolve in the oil [1].
When shaking the mixture, negatively charged oil droplets form and repel each other, forming an emulsion [1].

(4 marks)

[6 marks]

10. (a) C_2H_6 reacts with Br_2 under sunlight to form C_2H_5Br. Write chemical equations to illustrate the initiation step and propagation steps involved in the reaction mechanism.

Initiation step: $Br_2 \rightarrow 2\ Br\cdot$ [1]
Propagation steps: $Br\cdot + C_2H_6 \rightarrow \cdot C_2H_5 + HBr$ [1]
$\cdot C_2H_5 + Br_2 \rightarrow C_2H_5Br + Br\cdot$ [1]

(3 marks)

(b) Compound **A**, C_4H_8, reacts with concentrated hydrochloric acid to give compound **B**, C_4H_9Cl, as the only product. Compound **A** exists in two isomeric forms with the same structural formula. Compound **B** reacts with warm sodium hydroxide solution to give compound **C**, $C_4H_{10}O$. When compound **C** is heated under reflux with methanoic acid and concentrated sulphuric acid, a sweet-smelling compound **D**, $C_5H_{10}O_2$, is formed.

(i) Give the structures of **C** and **D**.

C: $CH_3CH(OH)CH_2CH_3$ [1]
D: $HCOOCH(CH_3)CH_2CH_3$ [1]

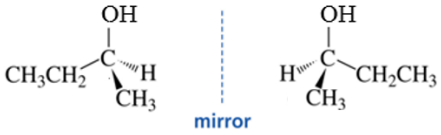
(ii) (I) What kind of isomerism does **A** exhibit?

Cis-trans isomerism [1]

(II) Give the structures of the two isomeric forms of **A**.

[1 mark for two correct diagrams]

(iii) **C** exists in two isomeric forms. Draw the possible structures of the isomeric forms of **C**.



[1 mark for two correct diagrams]

(5 marks)

[8 marks]

11. (a) At 700 °C, the equilibrium constant K_c for the reaction below is 0.05 mol dm^{-3}.

$$C(s) + H_2O(g) \rightleftharpoons H_2(g) + CO(g) \qquad \Delta H < 0$$

A 2.0 dm^3 sealed container, which is maintained at 700 °C, initially contains 5.0 mol of C(s), 4.0 mol $H_2O(g)$, 0.8 mol $H_2(g)$ and 0.8 mol CO(g).

(i) For this system under the initial conditions, calculate its reaction quotient. Predict and explain the direction of the shift of equilibrium position.

$Q_c = [H_2][CO]/[H_2O]$
$= (0.4)\ (0.4) / (2)$
$= 0.08$ mol dm^{-3} [1]
Since $Q_c > K_c$, the equilibrium position shifts to the left [1].

(ii) Calculate the equilibrium concentration of CO(g) when the equilibrium is attained at 700 °C.

	C(s)	$H_2O(g)$	$H_2(g)$	CO(g)
Initial [mol]	/	2	0.4	0.4
Equilibrium [mol]	/	2 + x	0.4 – x	0.4 – x

$K_c = [H_2][CO]/[H_2O]$
$0.05 = (0.4 - x)\ (0.4 - x) / (2 + x)$ [1*]
$x = 0.078$
Equilibrium $[CO(g)] = 0.4 - 0.078 = 0.322$ mol dm^{-3} [1]

(4 marks)

(b) Deduce the effect on K_c if the above equilibrium mixture is subjected to each of the following changes:

(i) Increase in temperature of the system.

An increase in temperature favours endothermic reaction (i.e. the backward reaction), hence shifting the equilibrium position to the left. K_c thus decreases [1].

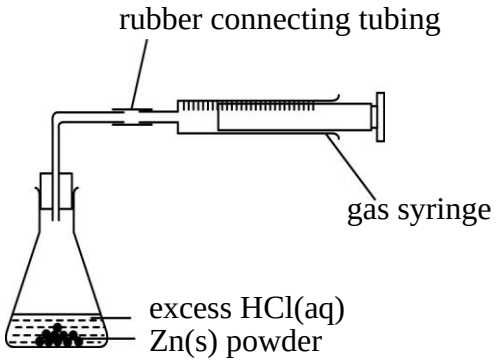
(ii) Removal of $H_2O(g)$ from system.

K_c remains unchanged because K_c is independent of concentration / is dependent on temperature only. [1]

(2 marks)

[6 marks]

12. To follow the progress of reaction between Zn(s) and HCl(aq), a student added 0.35 g of Zn(s) powder into a conical flask containing excess HCl(aq) and measured the volume of gaseous product formed at regular time intervals.

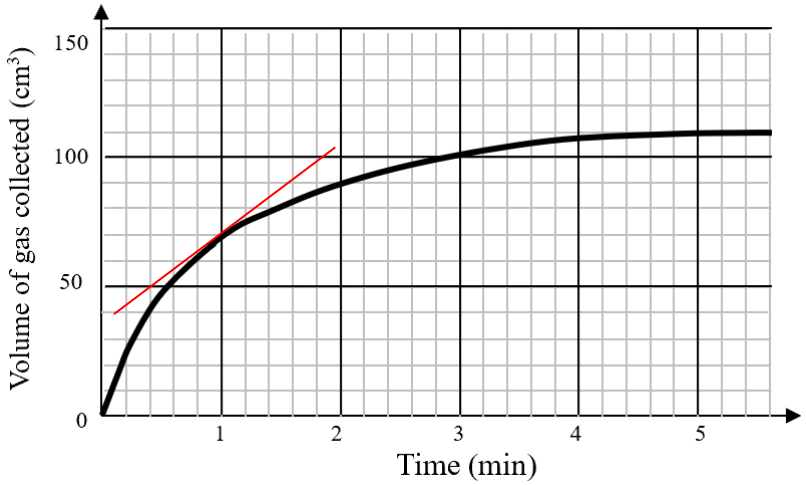


(a) Calculate the theoretical volume of gas collected under room temperature and pressure.
(Molar volume of gas at room conditions = 24.0 dm^3)
(Relative atomic mass: Zn = 65.4)

$Zn + 2HCl \rightarrow ZnCl_2 + H_2$
No. of moles of H_2 = 0.35 / 65.4= 5.35×10^{-3} [1*]
Volume of H_2 = $5.35 \times 10^{-3} \times 24 \times 1000 = 128\ cm^3$ [1]

(2 marks)

(b) The graph below shows the experimental results:



(i) Determine the instantaneous rate of formation of the gaseous product at the 1st minute.

Instantaneous rate = (90-50) / (1.6-0.4) = 33.3 $cm^3\ min^{-1}$

(ii) What is the instantaneous rate of consumption of $H^+(aq)$ ions at the 1st minute?

Instantaneous rate = 2 x 33.3 = 66.6 $cm^3\ min^{-1}$

(2 marks)

12. (c) Suggest how the effect of surface area of solid reactant on the rate of reaction can be studied using the experimental set-up on P.14.

Use same mass of Zn of different sizes to perform the experiment while other conditions of the experiment should be kept unchanged. [1]

(1 mark)

(d) Another student suggested to measure the mass of the reaction mixture using electronic balance at different time to follow the progress of the reaction. Comment on her suggestion.

This method is not workable because H_2 is light in weight/ has a small molecular mass [1]. The loss of H_2 gas does not cause a significant change in mass of the reaction mixture over a period of time.

(1 mark)

(e) There is a view saying that zinc is NOT a transition metal. Explain, with examples, to support this view.

Zinc only form ions/ compounds with fixed oxidation number. Oxidation number of Zn in compounds ZnO, $ZnSO_4$ is always +2. [1]
All compounds of zinc (ZnO, $ZnSO_4$, $Zn(OH)_2$) are not coloured/ aqueous solution of ion of zinc is colourless. [1]

(2 marks)

[8 marks]

END OF SECTION B

END OF PAPER

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)