2024-2025
MOCK EXAM
S.6 CHEM

PAPER 1B

B

Good Hope School
Mock Examination 2024-2025
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) An asterisk (*) has been put next to the questions where one mark will be awarded for effective communication.

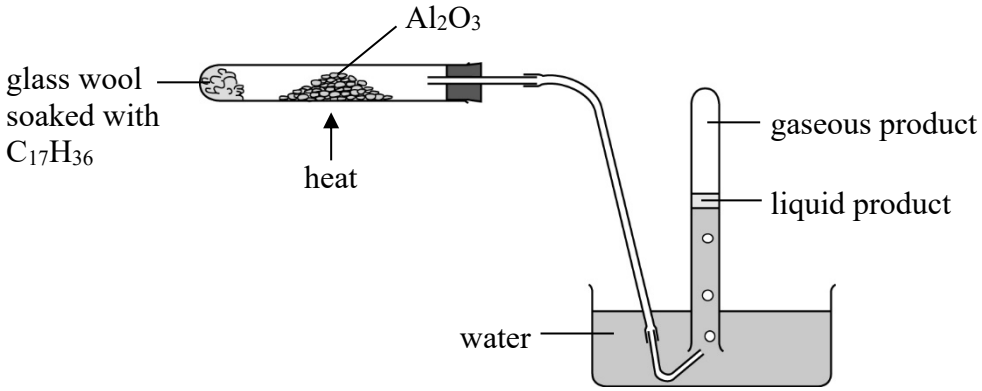
(6) Supplementary answer sheets will be provided on request. Mark the question number box and stick a barcode label on each sheet, and fasten them with string **INSIDE** this Question-Answer Book.

(7) No extra time will be given to 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. A student conducts an experiment with $C_{17}H_{36}$ (a liquid alkane) using the set-up illustrated in the diagram below. An oily liquid layer is observed in the test tube.



(a) Explain why the delivery tube should be removed before turning off the heating. (1 mark)

To avoid sucking-back of water. [1]

Good performance. Some students did not write "water".

(b) Suppose the reaction only produces but-1-ene and another liquid product.

(i) Write a chemical equation for the reaction involved. (1 mark)

$C_{17}H_{36} \rightarrow C_4H_8 + C_{13}H_{28}$ [1]

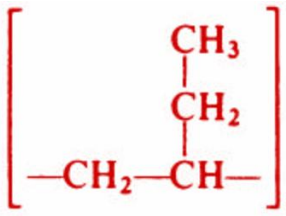
Excellent performance. Some students wrote the wrong states.

(ii) Suggest one importance of this type of reaction in industry. (1 mark)

To produce petrol. / To produce alkenes. / To produce smaller hydrocarbons from larger hydrocarbons. / To convert heavy oil to petrol. [1]

Good performance.

(iii) Draw the structure of the polymer formed from but-1-ene. (1 mark)



[1]

Poor performance. Many students drew the polymer formed by but-2-ene instead.
Many students did not know how to draw the polymer. They drew with 3 repeating units instead.

(c) Pure but-1-ene can be obtained using the same set-up by replacing $C_{17}H_{36}$ with another reagent.

(i) Suggest what reagent can be used. (1 mark)

Butan-1-ol [1]

Poor performance. Some students did not pay attention to the word "pure" and suggested to use another hydrocarbon.

(ii) Name the type of reaction involved. (1 mark)

Dehydration [1] Fair performance.

Answers written in the margins will not be marked.

1. (d) Equal volumes of $C_{17}H_{36}$ and the liquid product are ignited. Which liquid produces a sootier flame? Explain your answer. (2 marks)

$C_{17}H_{36}$ produces a sootier flame.

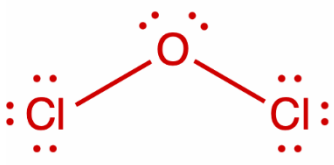
Since $C_{17}H_{36}$ has higher C to H ratio / higher percentage of C by mass. [1]

It undergoes more incomplete combustion. [1]

Fair performance. Some students wrote that it is related to the molecular size.

2. Dichlorine monoxide (Cl_2O) is a brownish yellow gas under room conditions.

(a) (i) Draw the three-dimensional structure of Cl_2O. (1 mark)



Good performance. Some students drew it as linear.

(ii) Explain whether Cl_2O is polar. (1 mark)

Cl_2O is V-shaped. The polar O-Cl bonds are not symmetrically arranged and thus the polarities cannot cancel out each other. Therefore it is polar. [1]

Fair performance. Some students wrote the polar bonds cancel out each other.

(b) Explain why HOCl is a liquid but Cl_2O is a gas under room conditions. (1 mark)

HOCl molecules are held by strong hydrogen bonds while Cl_2O molecules are held by weak van der Waals' forces. [1]

Poor performance. Many students thought HOCl has a giant ionic structure.

(c) Write a chemical equation for the reaction involved when Cl_2O is passed into dilute sodium hydroxide solution. (1 mark)

$Cl_2O\ (g) + 2\ NaOH\ (aq) \rightarrow 2\ NaOCl\ (aq) + H_2O\ (l)$ [1]

Poor performance.

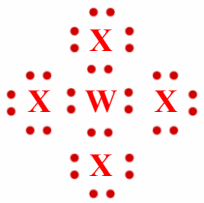
Many students mixeded up with the reaction of Cl_2 dissolving in water, forming Cl^- and OCl^-.

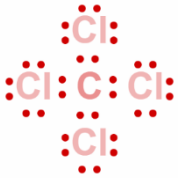
Answers written in the margins will not be marked.

3. Consider the following atomic symbols: $^{12}_{6}\mathbf{W}$ $^{35}_{17}\mathbf{X}$ $^{39}_{19}\mathbf{Z}$

(a) **W** and **X** form a compound **A**, while **X** and **Z** form a compound **B**.

(i) Draw the electron diagram for compound **A**, showing ELECTRONS IN THE OUTERMOST SHELLS only. (1 mark)





Good performance.

(ii) Which compound, **A** or **B**, has a higher melting point ? Explain your answer in terms of structure and bonding. (2 marks)

B has a higher melting point. B has a giant ionic structure and A has a simple molecular structure. [1]

As the attraction between ions in B is strong ionic bond while the attraction between A molecules is weak van der Waals' forces, B has a higher melting point. [1]

Fair performance. Some students did not write the particles involved, or specify the wrong particles.

(b) State and explain the difference between the electrical conductivity of element **Z** and that of compound **B** at room conditions. (2 marks)

Element Z can conduct electricity because there are delocalized electrons in Z. [1]
Compound B cannot conduct electricity because the ions in solid B are fixed / not mobile (and there are no delocalized electrons in solid B) [1]

OR Element Z can conduct electricity while compound B cannot conduct electricity. [1]
It is because there are delocalized electrons in element Z, while the ions in solid B are fixed / not mobile (and there are no delocalized electrons in solid B) [1]

Good performance.

(c) A compound of **X** and oxygen has a relative molecular mass of 67. It contains 47.8% of oxygen by mass. Deduce the molecular formula of the compound.
(Relative atomic mass : O = 16.0) (2 marks)

Number of moles of **X** : number of moles of O = 0.522/35 : 0.478/16 = 1 : 2 [1]

Let molecular formula be $(XO_2)_n$.

$$(35 + 16 \times 2)n = 67$$

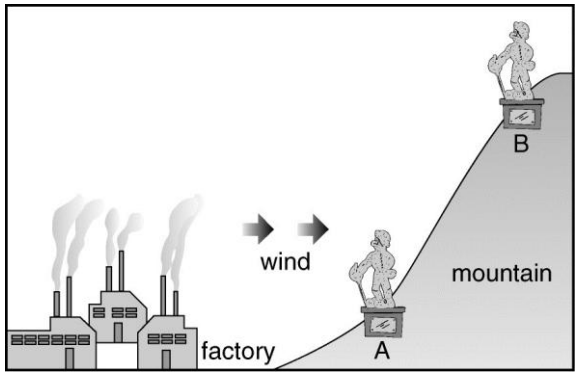
$$n = 1$$

Molecular formula is XO_2 [1]

Good performance.

Answers written in the margins will not be marked.

4. The figure below shows the locations of two statues and a factory which extracts zinc from its ore, zinc blende (ZnS):



The flow diagram below shows how zinc is extracted in the factory:

ZnS $\xrightarrow{\textit{Stage I}}$ compound **X** and acidic gas **Y** are formed $\xrightarrow{\textit{Stage II}}$ Zn

In *Stage I*, the ore is heated strongly in air. A yellow compound **X** which becomes white when cold is formed. Besides, an acidic gas **Y** is evolved and this is emitted to the surroundings from the chimneys.

(a) Write a chemical equation for the reaction involved in *Stage I*. (1 mark)

$2\ ZnS\ (s) + 3\ O_2(g) \rightarrow 2\ ZnO(s) + 2\ SO_2(g)$ [1] Fair performance.

(b) In *Stage II*, **X** is heated strongly with a black powder.

(i) Name the process involved. (1 mark)

Carbon reduction [1] Fair performance.

(ii) Write a chemical equation for the reaction involved in *Stage II*. (1 mark)

$2\ ZnO(s) + C(s) \rightarrow 2\ Zn(s) + CO_2(g)$ / $ZnO(s) + C(s) \rightarrow Zn(s) + CO(g)$ [1] Good performance.

(c) (i) Statues A and B are mainly made of iron. Predict and explain which statue rusts more quickly. (2 marks)

Statue A rusts more quickly.

Wind brings sulphur dioxide to Statue A / Statue A is closer to the factory. [1]

The acidic sulphur dioxide forms an acid with moisture/ dissolves in water in the air. [1]

Acidic gas / acid rain / acidic rainwater speeds up the rusting of iron.

Fair performance. Many students did not mention the formation of acid rain.

(ii) Suggest ONE method to slow down the corrosion of the statues. Explain briefly. (1 mark)

Plate a metal layer on the statues to prevent iron contacting with water and oxygen.

/ Paint the statue to prevent iron contacting with water and oxygen.

/ Installing scrubber in the chimneys of the factory to reduce the amount of sulphur dioxide emitted (accept other explanations) [1] Good performance.

Answers written in the margins will not be marked.

5. A chemist carried out an experiment to determine the percentage by mass of nitrogen in a sample of nitrogenous fertilizer. The experiment consisted of three stages:

Stage 1 4.65 g of the sample were dissolved in distilled water and then made up to 250.0 cm^3.

Stage 2 25.0 cm^3 of this solution were heated with 25.0 cm^3 of 0.250 mol dm^{-3} sodium hydroxide solution until no more ammonia gas was evolved.

Stage 3 The resulting solution was titrated against 0.20 mol dm^{-3} hydrochloric acid. 16.20 cm^3 of the acid was required to reach the end point.

(a) Briefly describe how the 250.0 cm^3 solution was made up in *Stage 1*. (2 marks)

Transfer the solution into a 250.0 cm^3 volumetric flask. [1]

Wash the beaker, glass rod and the filter funnel with distilled water and pour all the washings into the flask.

Add distilled water to the flask until the meniscus reaches the graduation mark. [1]

Stopper the flask and invert several times to mix the solution well.

Good performance. Some students did not write about the meniscus.

(b) Write an ionic equation for the reaction involved in *Stage 2*. (1 mark)

$NH_4^+(aq) + OH^-(aq) \rightarrow NH_3(g) + H_2O(l)$ [1]

Good performance.

(c) Suggest a suitable indicator for the titration in *Stage 3*, and state the expected colour change at the end point. (1 mark)

Methyl orange. – From yellow to orange. **OR** Phenolphthalein. – From pink to colourless. [1]

Good performance. Some students wrote the end point of the phenolphthalein is pink.

(d) Calculate the percentage by mass of nitrogen in the fertilizer.
(Relative atomic masses : H = 1.0, N = 14.0) (3 marks)

Number of moles of HCl = 0.2 x 0.0162 = 0.00324 mol [1]

Number of moles of NaOH reacted with fertilizer = 0.25 x 0.025 – 0.00324 = 0.00301 mol [1]

Mass of N in fertilizer = 0.0301 x 14 = 0.421 g

Percentage by mass of N in fertilizer = 0.421 / 4.65 = 9.06% [1]

Good performance. Many students calculated wrongly the mass of N in fertilizer e.g. 0.0301 x (14 x 2). They thought N must be in the form of N_2 or NH_3.

(e) Suggest ONE assumption in the calculation of percentage by mass of nitrogen. (1 mark)

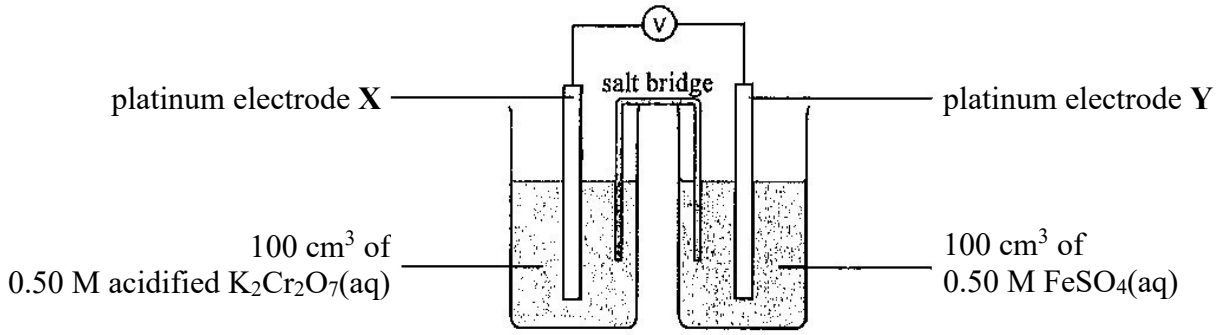
Assume NH_4^+ is the only source of nitrogen in the sample. [1]

Accept: there is no other impurities in the fertilizer that react with NaOH(aq).

Poor performance. Many students simply put down no impurities.

Answers written in the margins will not be marked.

6. The diagram below shows the experimental set-up of a chemical cell :



(a) Suggest one function of a salt bridge. (1 mark)

A salt bridge completes the circuit by providing ions / to balance the charges in the two half cells / to keep the solutions electrically netural. [1]

Excellent performance.

(b) State, with explanation, the expected observation around the electrodes after the experiment has been conducted for some time.

(i) electrode **X** (2 marks)

The solution turns from orange to deep green [1]

as $Cr_2O_7^{2-}$ is reduced to Cr^{3+}. [1]

Fair performance. Many students did not explain.

(ii) electrode **Y** (2 marks)

The solution turns from pale green to yellow [1]

as Fe^{2+} is oxidized to Fe^{3+}. [1]

Fair performance. Many students did not explain. Many students wrongly thought OH^- is preferentially discharged. Fe^{2+} is a stronger RA than OH^- and the concentration of OH^- is very low.

(c) Explain what would happen to the pH value of the half-cell containing $K_2Cr_2O_7$ solution. (1 mark)

pH increases as H^+ is converted to H_2O / is consumed during the reduction of $Cr_2O_7^{2-}$ to Cr^{3+} [1]

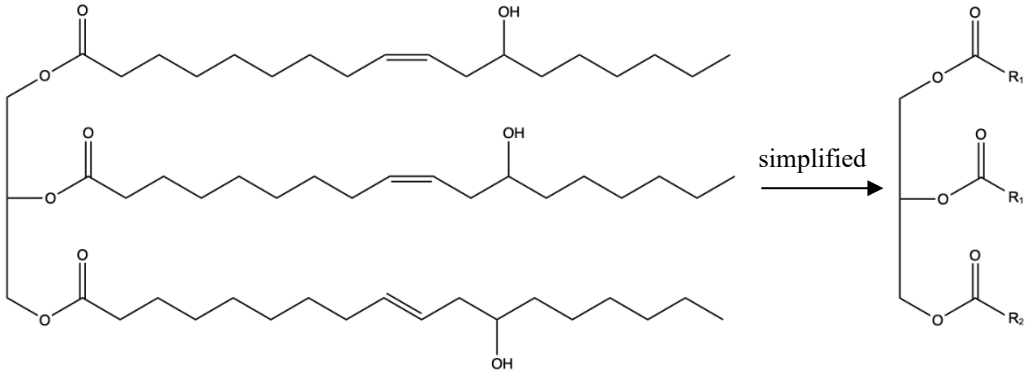
Poor performance. Some students answered no change. They did not realize H^+ is consumed in the reaction.

(d) Explain why the voltage of the cell increases when 0.50 M acidified $K_2Cr_2O_7$(aq) is replaced by 0.50 M acidified $KMnO_4$(aq). (1 mark)

MnO_4^- is a stronger oxidizing agent thant $Cr_2O_7^{2-}$ [1]

Good performance.

7. **X** is a major component of castor oil. The structure of **X** is shown below:



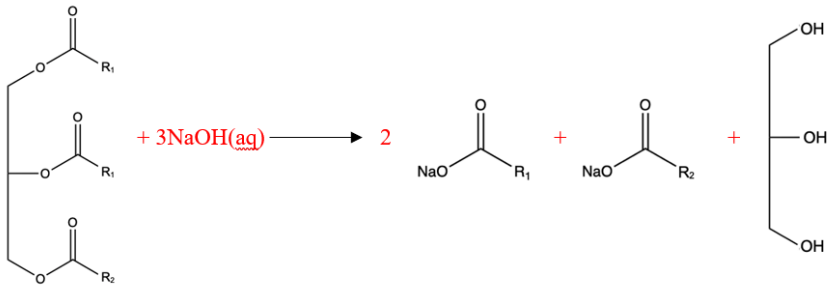
(a) State the reagents and condition necessary for converting **X** into a saturated fat. (1 mark)

Hydrogen, platinum / palladium / nickel, heat [1]

Poor performance. Many students did not specify "heat" is involved.

(b) Soapy detergents can be made from **X** using concentrated sodium hydroxide solution.

(i) Write a chemical equation for the reaction involved. (1 mark)



Poor performance. Many students did not write the right stoichiometry "3" for NaOH. Some students did not realize R_1 is different from R_2. Many students had the wrong functional groups on the products after hydrolysis. Some students put water as one of the products.

(ii) Describe how solid soap can be obtained from the reaction mixture. (1 mark)

Add concentrated NaCl(aq).

Fair performance. Many students put concentrated NaOH(aq) instead or simply use filtration.

(c) Explain the cleansing action of the soapy detergents. (3 marks)

Any THREE of the following:

- It reduces the surface tension so that water can spread and wet the surfaces. / It is a wetting agent so water can spread and wet the surfaces. [1]
- The hydrocarbon tails of the detergent anions dissolve in grease while the ionic heads dissolve in water. [1]
- Water molecules attract the hydrophilic heads, lifting up the grease from the surface into water. [1]
- By stirring, tiny grease droplets, which carry negative charges, form. Repulsion of the negatively charged droplets prevents them from joining together. The greasy suspension can be washed away easily. [1]

Fair performance. Some students did not specify what causes the repulsions of the grease droplets.

Answers written in the margins will not be marked.

8. Describe what you would observe when a copper coin is put into concentrated nitric acid. Write a chemical equation for the reaction involved. (2 marks)

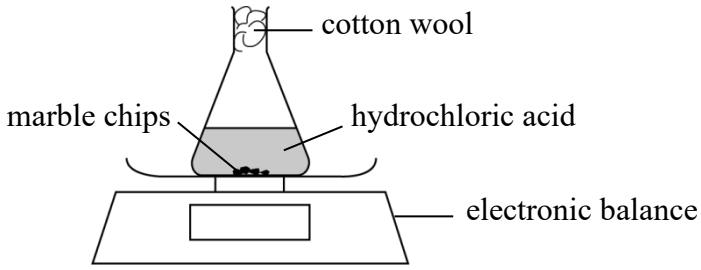
The copper coin dissolves. / The solution turns green / blue. / Some brown fumes are given off. [1]

$Cu(s) + 4HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2NO_2(g) + 2H_2O(l)$ [1]

ACCEPT $Cu(s) + 2NO_3^-(aq) + 4H^+(aq) \rightarrow Cu^{2+}(aq) + 2NO_2(g) + 2H_2O(l)$

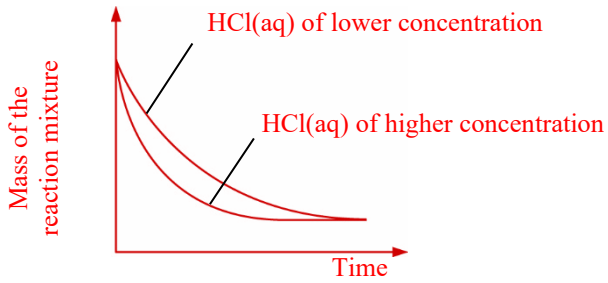
Fair performance. Many students did not know how to write the chemical equation. Some thought H_2 gas is given out.

9*. With reference to the set-up in the diagram below, explain how you would conduct an experiment to investigate the effect of hydrochloric acid concentration on the rate of carbon dioxide production. Sketch a labelled graph to represent the expected results of the experiment. (6 marks)



Effective Comunication [1]

- Measure the mass of the reaction mixture at regular time intervals. [1]
- Repeat the experiment with hydrochloric acid of a different concentration [1]
- Other conditions (size of the marble chips / volume of hydrochloric acid used / temperature of the reaction mixture) are kept the same. [1]



- Correct curves [1]
- Correct labels [1]

Poor performance. Many students completely misunderstood the whole question and explained the shape of the curve instead. Some proposed to use a gas syringe to follow the progress of reaction. Many students

END OF PART I

Answers written in the margins will not be marked.

PART II

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

10. Using manganese as an example, suggest TWO characteristic properties of transition metals. (2 marks)

Any TWO of the following:

- Transition metals form coloured ions in aqueous solution. For example, $Mn^{2+}(aq)$ is very pale pink / $MnO^{4-}(aq)$ is purple. [1]
- Transition metals exhibit variable oxidation states in their compounds. For example, the oxidation states of manganese in Mn^{2+} and MnO^{4-} are +2 and +7 respectively. [1]
- Transition metals and their compounds show catalytic properties. For example, manganese(IV) oxide is used as a catalyst in the decomposition of hydrogen peroxide solution. [1]

Fair performance.

Many students did not specify the oxidation number should be of the **element** (Mn) in a compound e.g. oxidation number of **Mn** in MnO_2

Some students wrongly gave the example of Mn being the catalyst for the decomposition of hydrogen peroxide.

11*. Outline a method to prepare pure solid calcium carbonate, starting with some solid calcium chloride. In your answer you should include the names of the reagent(s) needed and describe the experimental setup(s) used, such as separation method(s) employed. (4 marks)

Dissolve some solid calcium chloride in distilled water in a beaker. [1]

Add sodium carbonate solution until it is in excess, solid calcium carbonate would be formed. [1]

Obtain the calcium carbonate by filtration, rinse the solid residue with little distillewater and dry between filter papers. [1]

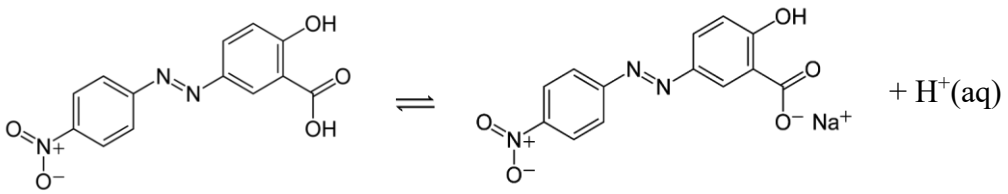
Effective communication [1]

Fair performance.

Many students did not write the step to dissolve the solid calcium chloride in distilled water.

Some students suggested using CO_2, the yield will not be high because 1 mole of CO_2 has a volume of 24 dm^3.

12. The equation below shows the ionization of Alizarine Yellow in water:



HB (Yellow) $\rightleftharpoons$ **B^-** (Red)

At 25°C, the equilibrium constant K_c for the ionization is 11.0 **mol dm^{-3}**.

~~(a)~~ Write an expression for K_c. (1 mark)

$$K_c = \frac{[H^+(aq)][B^-(aq)]}{[HB(aq)]} \quad [1]$$

(b) A sample solution of Alizarin Yellow has a pH of 12.1.

~~(i)~~ Calculate the ratio of the concentration of **B^-**(aq) to that of **HB**(aq) in the sample. (2 marks)

$$[H^+(aq)] = 10^{-12.1}$$
$$= 7.94\times10^{-13} \text{ mol dm}^{-3} [1]$$
$$\frac{(7.94\times10^{-13})[B^-(aq)]}{[HB(aq)]} = 11.0$$
$$\frac{[B^-(aq)]}{[HB(aq)]} = 1.38\times10^{13} [1]$$

(ii) State and explain if there is any colour change when dilute hydrochloric acid is added gradually to the sample. (2 marks)

When HCl(aq) is added, the concentration of H^+(aq) increases and the equilibrium position shifts to the left. [1]

The solution changes from red to yellow / orange. [1]

Good performance. Some students did not mention about the concentration.

(c) It is found that at high temperatures, K_c increases. Deduce whether the forward reaction is exothermic or endothermic. (1 mark)

As K_c increases, the forward reaction is favoured. As an increase in temperature favours endothermic reaction, the forward reaction is endothermic. [1]

Fair performance. The question is about deduction. Students need to provide explanation.

Answers written in the margins will not be marked.

13. Propene is a gaseous hydrocarbon with molecular formula C_3H_6.

(a) Suggest why the enthalpy change of formation of $C_3H_6(g)$ CANNOT be determined directly by experiment. (1 mark)

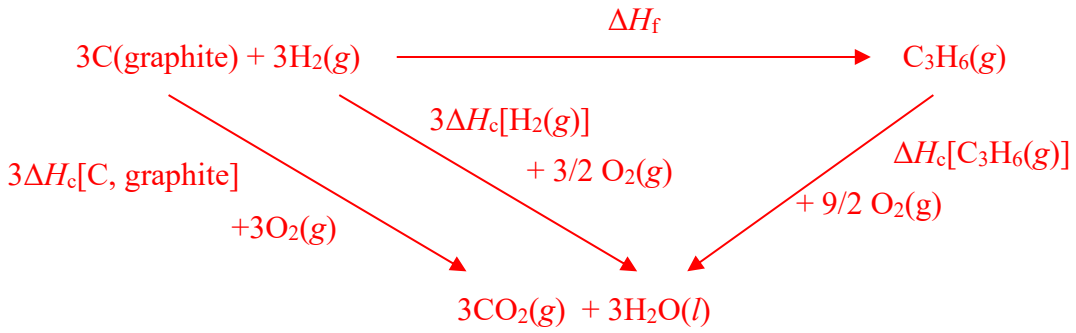
The reaction between carbon and hydrogen does not only give propene. [1]

OR There will be side reactions. / Side products will be formed./
carbon and hydrogen have no reactions under room conditions.

Good performance.

(b) The enthalpy change of formation of $C_3H_6(g)$ can be determined based on the enthalpy changes of combustion ΔH_c of $C_3H_6(g)$, C(graphite) and $H_2(g)$ by the construction of an enthalpy change cycle.

(i) Draw, with labels, this enthalpy change cycle. (2 marks)



Poor performance. Many students did not specify the state symbols and had the wrong stoichiometry.

Answers written in the margins will not be marked.

13. (b) (ii) The standard enthalpy change of combustion $\Delta H_c^{\ominus}$ of $C_3H_6(g)$, C(graphite) and $H_2(g)$ are given below : (2 marks)

	$\Delta H_c^{\ominus}$ / kJ mol^{-1}
$C_3H_6(g)$	−2058
C(graphite)	−394
$H_2(g)$	−286

Calculate the standard enthalpy change of formation $\Delta H_f^{\ominus}$ of $C_3H_6(g)$.

standard enthalpy change of formation of $C_3H_6(g)$

= [3(–394) + 3(–286)] – (−2058) [1]

= +18 kJ/mol [1]

Fair performance. Quite a few students had a negative value. Some students missed out the "+" sign. Students should not just rely on the enthalpy change cycle to do the calculations.

(c) Assuming that all of the heat evolved in burning 21.0 g of propene is transferred to 10.0 kg of water, calculate the increase in temperature of water. (3 marks)
(Specific heat capacity of water = 4.18 J g^{-1} K^{-1})

Heat released = 21.0 g / 42.0 g × 2058 kJ /mol = 1029 kJ = mcΔT [1]

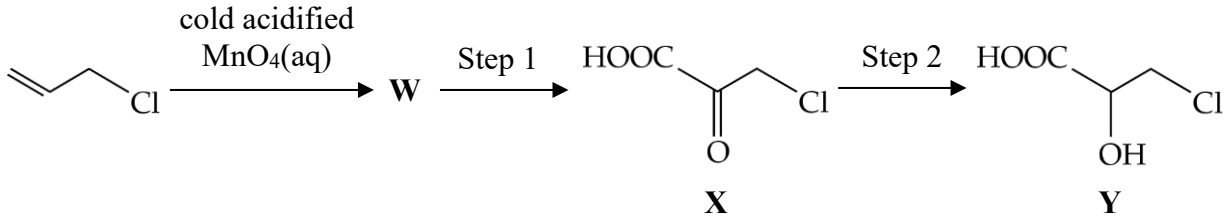
1029 kJ = (10.0 kg)(4.18 $Jg^{-1}K^{-1}$)(ΔT) [1]

ΔT = 24.6°C [1]

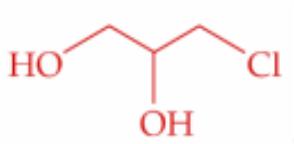
Poor performance. Many students used the wrong quantity, instead of standard enthalpy change of **combustion** of $C_3H_6(g)$, they have used the standard enthalpy change of **formation** of $C_3H_6(g)$ from the last question.

Answers written in the margins will not be marked.

14. Consider the following conversion of carbon compounds:



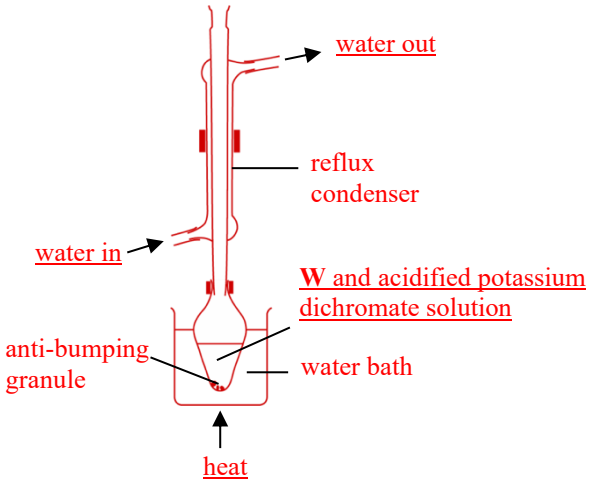
(a) Draw the structure of **W**. (1 mark)



[1]

Fair performance. Some students drew the two -OH groups on the same carbon.

(b) The oxidation of **W** is carried out in Step 1. Draw a labelled diagram for the set-up used for the reaction. Your diagram should include the reagents needed. (2 marks)



Correct labels [1]; Correct drawing [1]

Fair performance. Many students drew the pear-shaped flask and the reflux condenser as one piece of glassware. Some drew the neck. When drawing the diagrams, only the cross-section should be drawn.

(c) State the reagent(s) for Step 2. (1 mark)

$NaBH_4$, (H_2O) [1]

Good performance.

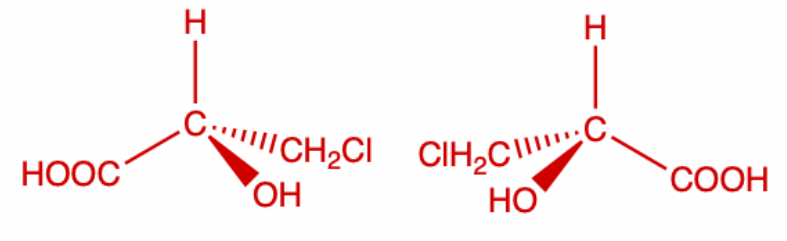
14. (d) Compound **Y** exists as a pair of stereoisomers.

(i) Define the term "stereoisomers". (1 mark)

Stereoisomers are compounds in which atoms are joined in the same order but have a different spatial arrangement. [1]

Poor performance.

(ii) Draw the two stereoisomers of **Y**. (2 marks)



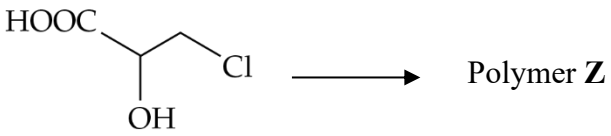
Good performance. Some drew the CH_2Cl as "Cl".

(iii) Describe the difference in the optical activity between the two stereoisomers. (1 mark)

They can rotate the plane of plane-polarized light (by the same extent, but) in opposite directions. [1]

Good performance.

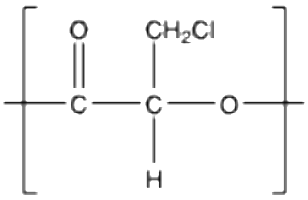
(e) **Y** can undergo polymerization to form polymer **Z**.



(i) Name the type of polymerization involved. (1 mark)

Condensation polymerization [1] Excellent performance.

(ii) Draw the repeating unit of the polymer **Z** formed. (1 mark)



[1]

Poor performance. Students to check for the ester linkage in their drawing and the atoms bonded to a carbon.

END OF PART II

END OF PAPER

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)