CHRIST CHURCH SECONDARY SCHOOL
2025 PRELIMINARY EXAMINATION
SECONDARY FOUR EXPRESS

CANDIDATE NAME						CLASS	/		
CENTRE NUMBER	S					INDEX NUMBER			

CHEMISTRY

6092/02
Paper **2**
19 August 2025
1 hour 45 minutes

Candidates answer on the Question Paper
No additional materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, index number, name and class on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs, or rough working.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided.

Section B
Answer **one** questions.
Write your answers in the spaces provided.

The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page **21**.

The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	
Section A	
Section B	
10	
11	
Total	/80

This document consists of **19** printed pages and **2** blank pages.

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Section A

Answer **all** questions in the spaces provided.

1 A list of substances is provided below.

methane	**copper(II) chloride**	**sulfur dioxide**
sodium oxide	**lead(II) nitrate**	**zinc sulfate**

(a) For the questions below, each substance can be used once, more than once or not at all.

(i) Which substance exists as a simple molecule but can conduct electricity in aqueous state?

…… [1]

(ii) Which substance, when dissolved in water, gives a blue precipitate with aqueous sodium hydroxide?

…… [1]

(iii) Which substance contains an element with an oxidation state of +6?

…… [1]

(iv) Which substance changes the colour of potassium manganate(VII) from purple to colourless?

…… [1]

(b) Sodium oxide is a white solid that melts at 1132 °C. It dissolves in water to form an alkaline solution with effervescence.

(i) Describe the **arrangement** and **movement** of the sodium oxide particles at 1140 °C.

……

……

…… [2]

(ii) Write the chemical equation for the formation of this alkaline solution.

…… [1]

(iii) State the observation you would expect when an aqueous solution of copper(II) chloride is added to the alkaline solution.

…… [1]

[Total: 8]

2 Aqueous thiosulfate, $S_2O_3^{2-}(aq)$, reacts with aqueous iodine according to the equation.

$$I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$$

In a titration, 50.0 cm^3 of 0.1 mol/dm^3 aqueous thiosulfate was added to 40 cm^3 of 0.1 mol/dm^3 aqueous iodine.

(a) Determine the limiting reagent. Show your workings clearly.

[2]

(b) Calculate the percentage yield of iodide ions if only 0.0013 mol of iodide ions were produced at the end of the experiment.

[2]

(c) Explain, in terms of oxidation states, why the aqueous thiosulfate acts as a reducing agent in this reaction..

.....

.....

..... [2]

(d) Explain whether this reaction can be considered a disproportionation reaction.

.....

..... [1]

[Total: 7]

3 Fig. 3.1 shows the apparatus set-up of an experiment that a student performed.

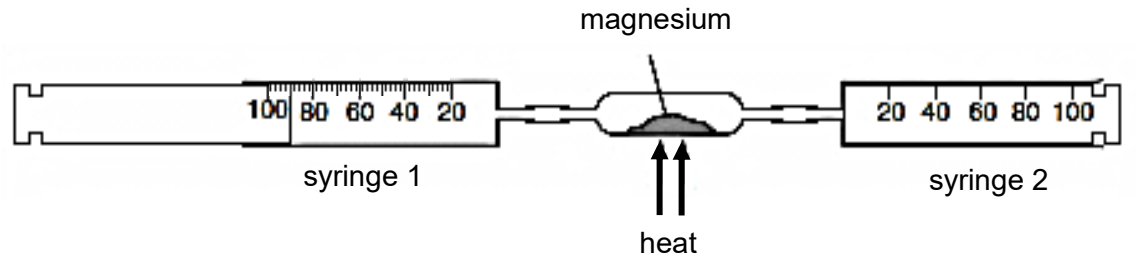


Fig. 3.1

Syringe 1 contains 90 cm^3 of air. The air is forced over heated magnesium into syringe 2. The air is then forced back over the heated magnesium into syringe 1**.**

The process is repeated several times until the volume of gas forced back into syringe 1 is constant. The apparatus is allowed to cool to room temperature.

Fig. 3.2 shows the volume of gas in syringe 1 at the end of the experiment.

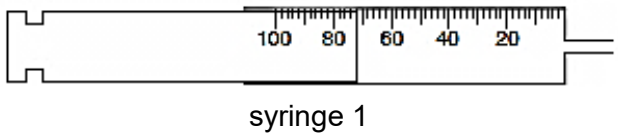


Fig. 3.2

(a) Construct a chemical equation, including state symbols, for the above reaction.

..... [1]

(b) Name the major component of the gas remaining in syringe 1.

..... [1]

(c) Excess magnesium was used for the above reaction. Calculate the mass of magnesium that has reacted by the end of the experiment.

[3]

[Total: 5]

4 The order of reactivity of five metals, copper, **P**, **Q**, **R** and **S** are investigated using a simple cell set-up shown in Fig. 4.1.

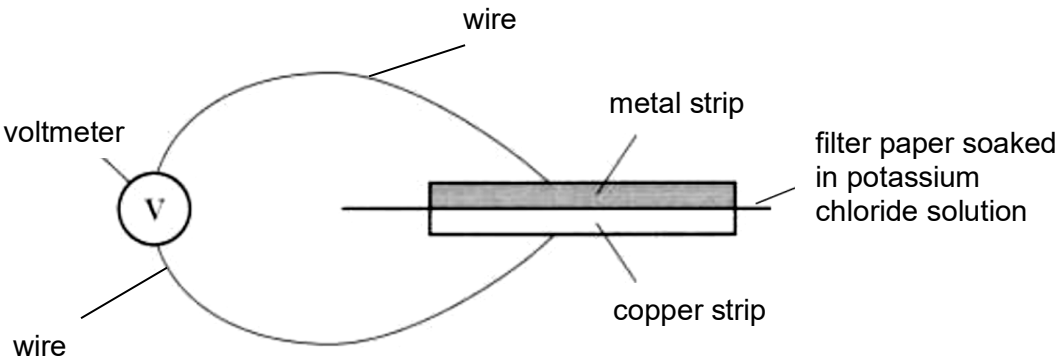


Fig. 4.1

The voltmeter reading is recorded when each metal is being used as the metal strip. The results are summarised in Table 4.1.

Table 4.1

Experiment	metal strip	direction of electron flow	voltage / V
1	P	from **P** to copper	0.52
2	Q	from copper to **Q**	0.33
3	R	from **R** to copper	1.51
4	S	from **S** to copper	1.25

(a) Arrange the five metals in order of decreasing reactivity.

..... [1]

(b) If **R** forms ions of R^+, construct the half equations that took place at the anode and cathode in Experiment 3.

Anode: .....

Cathode: ..... [2]

(c) Describe **two** differences between a simple cell and an electrolytic cell.

.....

.....

.....

..... [2]

[Total:5]

5 Ammonia is industrially manufactured in the Haber process.

(a) Explain, with the help of an equation, why nitrogen and hydrogen are mixed in a ratio of 1 : 3 by volume.

.....

.....

..... [2]

(b) State the ideal conditions that are deployed in the Haber process.

..... [1]

(c) Name a method used to collect ammonia gas in the laboratory and provide a reason for using that method.

.....

..... [2]

(d) Ammonia is used to manufacture nitric acid by first converting ammonia to nitrogen monoxide.

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(l)$$

(i) In terms of the collision between reacting particles, state and explain how the rate changes when the pressure is increased.

.....

.....

.....

..... [2]

(ii) Calculate the volume of gas that can be collected from 440 dm^3 of ammonia at the end of the reaction if the yield is 40%.

[2]

[Total: 9]

6 The chemical composition of glass is known to be silicon (IV) dioxide as shown in Fig 6.1 which is the material used to make wine glasses.

A piece of the wine glass mentioned above is tested for its physical properties using an electric circuit. The light bulb did not light up.

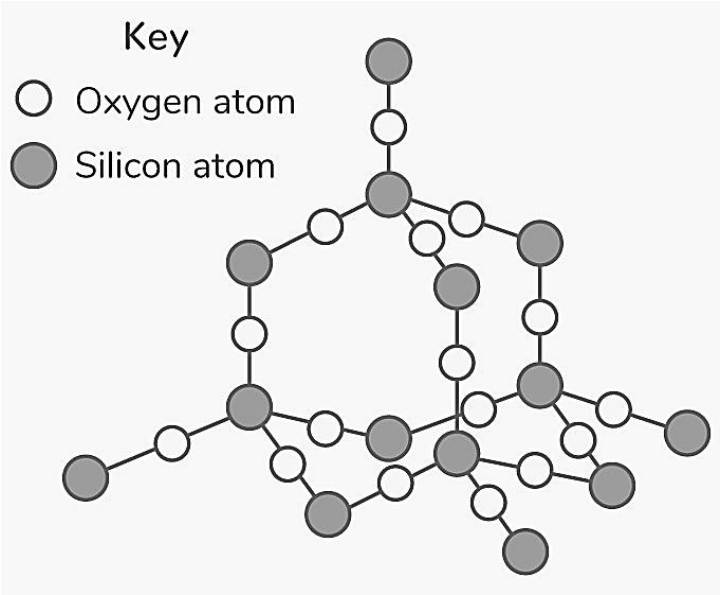


Fig. 6.1

(a) Explain why the light bulb did not light up.

.....

..... [1]

(b) Suggest **two** similarities in the structure of glass and diamond.

.....

.....

.....

..... [2]

(c) Another type of wine glass, shown below in Fig.6.2, can be made by heating a mixture of calcium carbonate, sodium carbonate and sand in a furnace to a high temperature. Its chemical composition is different from the compound found in Fig. 6.1.

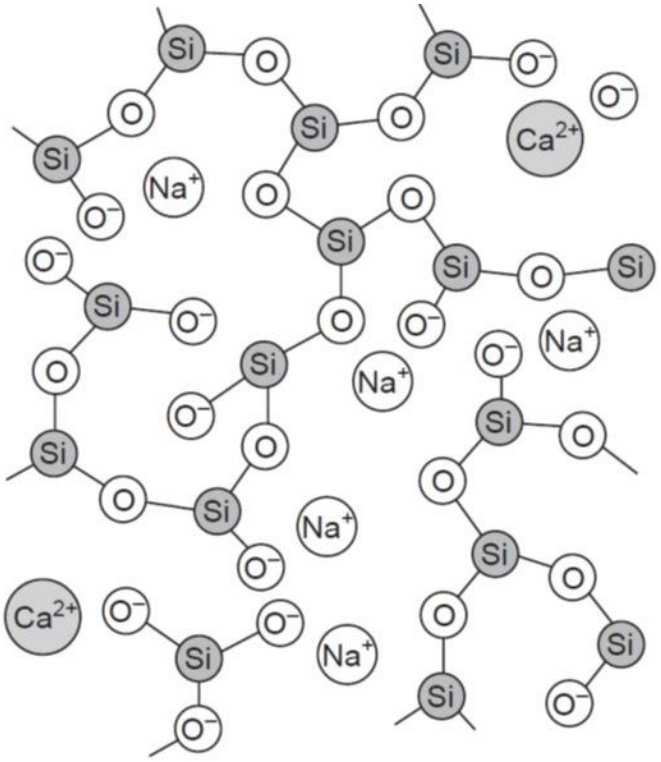


Fig. 6.2

Using the information in Fig. 6.1 and 6.2 to answer the questions below.

(i) Describe two differences between the wine glass from Fig. 6.1 and Fig. 6.2

.....

.....

.....

..... [2]

(ii) Use ideas on structure and bonding to explain why wine glass can conduct electricity when it is melted.

.....

.....

..... [2]

[Total: 7]

7 Various volumes of 1.0 mol/dm^3 sulfuric acid were added to 50.0 cm^3 of barium hydroxide solution. One of the products formed in this reaction is barium sulfate salt. The mixture was continuously stirred using a plastic stirrer and the reaction was monitored by measuring the conductivity of the solution, which is proportional to the number of ions in the solution.

Fig. 7.1 shows the results obtained from the experiment.

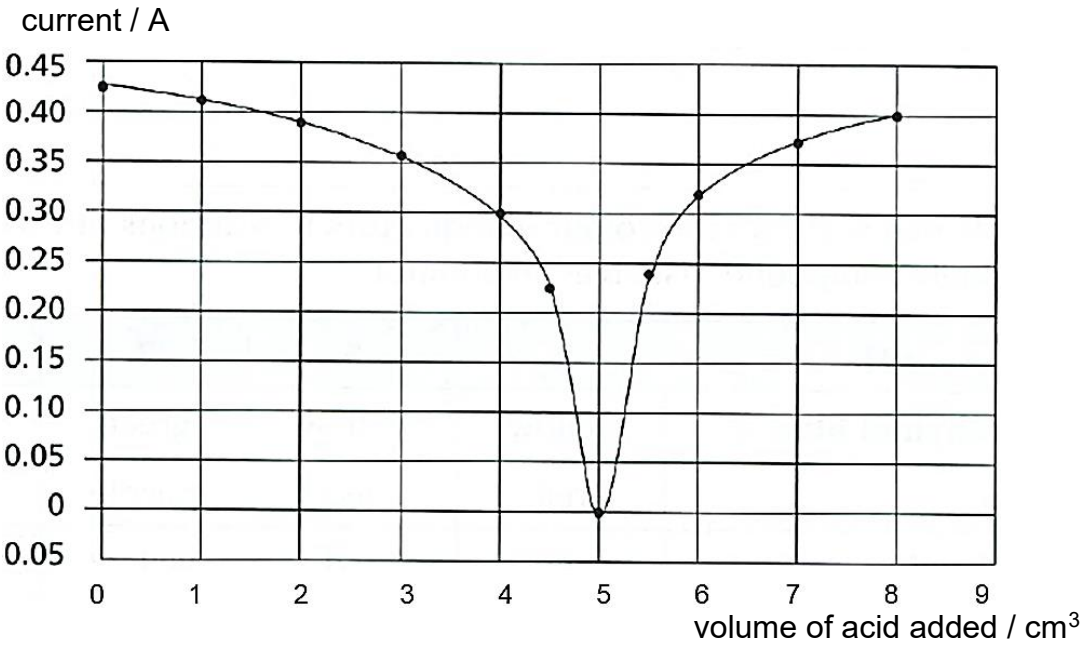


Fig. 7.1

(a) Sulfuric acid is a strong acid. Explain what is meant by 'strong acid'.

.....

..... [1]

(b) Suggest why using an iron stirrer would **not** be suitable for this experiment.

..... [1]

(c) Write the chemical equation for the reaction. Include state symbols in the equation.

..... [2]

(d) Explain the shape of the graph as acid is added.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(e) Based on the results of the graph, calculate the concentration of the barium hydroxide used in mol/dm^3.

[1]

[Total: 9]

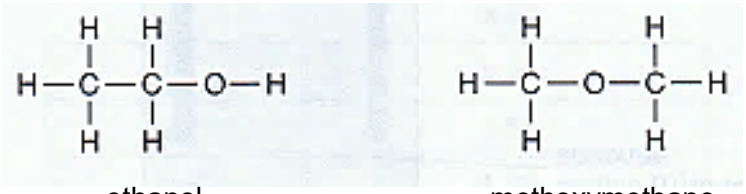
8 Ethers are organic compounds with the general formula R–O–R′, where R and R′ are alkyl groups. They form a homologous series, with each successive member differing by a $–CH_2–$ group. When ethers undergo complete combustion, they produce carbon dioxide and water, releasing energy in the process.

Table 8.1 shows some data about the enthalpy change when 1 mol or 1 g of each ether is completely combusted.

Table 8.1

name of ether	formula	enthalpy change of combustion (kJ/mol)	enthalpy change of combustion (kJ/g)
Methoxymethane (dimethylether)	CH_3OCH_3	-1460	-31.7
Methoxyethane	$CH_3OC_2H_5$	-2107	-35.1
Ethoxyethane (diethylether)	$C_2H_5OC_2H_5$	-2726	

Ethers forms isomers in the form of alcohols. Ethanol is an isomer of methoxymethane.



ethanol methoxymethane

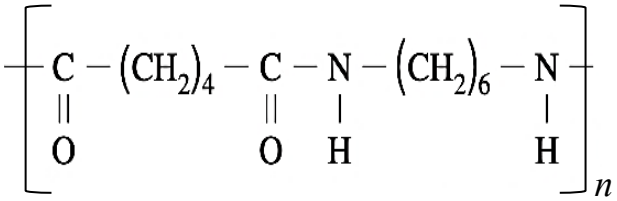
Table 8.2 shows enthalpy changes of combustion for ethanol and methoxymethane.

Table 8.2

isomer	ethanol	methoxymethane
Enthalpy change of combustion (kJ/mol)	-1371	-1460

Unlike alcohols, ethers are generally very resistant to oxidation and do not undergo oxidation reactions easily in typical laboratory conditions. While ethers are often valued for their chemical stability and low reactivity, making them useful as solvents in organic chemistry especially when reactions require inert conditions, alcohols are used in various oxidation reactions and synthesis of organic compounds.

An alcohol **X** was oxidised to produce a substance which is an important component in synthesis of the polymer shown beow.



(a) Write a balanced equation to show the complete combustion of methoxyethane.

…… [1]

(b) Calculate the enthalpy change of combustion when 1 g of ethoxyethane burns.

[2]

(c) Use ideas about breaking and forming bonds to explain why all of the values in the table are negative.

……

……

……

……

…… [2]

(d) Predict the trend of the boiling point of the ethers down the group.

…… [1]

(e) Suggest why the enthalpy changes of combustion for the two isomers of ethanol and dimethylether are different.

……

…… [1]

(f) Draw **two** possible isomers of ethoxyethane.

[2]

(g) Describe the colour changes that would be observed when a few drops of acidified potassium manganate (VII) are added to separate samples of ethoxyethane and its alcohol isomer.

……

…… [1]

(h) Deduce the full structural formula of alcohol **X**.

[2]

[Total: 12]

9 Chlorofluorocarbons (CFCs) have been used in large quantities as solvents and aerosol propellants. One widely used CFCs is CCl_3F.

(a) By means of a "dot and cross" diagram, show the arrangement of the electrons in a CCl_3F molecule. Show only the valence electrons.

[2]

(b) Explain, in terms of bonding and structure, whether CCl_3F would have a high or low boiling point.

……

……

…… [2]

(c) The use of CFCs leads to the depletion of the ozone layer. When CFC compounds are released into the atmosphere, the C - Cl bond would be broken by ultraviolet light, releasing chlorine atoms in a photochemical reaction.

These chlorine atoms would cause ozone to break down in a two-step process.

step 1: $Cl + O_3 \rightarrow ClO + O_2$
step 2: $ClO + O_3 \rightarrow Cl + 2O_2$

(i) State the term that is used to describe ozone and oxygen gas.

…… [1]

(ii) Use the equations above to explain why the presence of one chlorine molecule in the ozone layer will cause a chain reaction.

……

……

…… [2]

(iii) State the harmful effect that a depleting ozone layer would have on us.

…… [1]

[Total: 8]

Section B

Answer **ONE** question from this section.

10 Fig. 10.1 was used to study the rate of reaction between calcium carbonate and dilute hydrochloric acid.

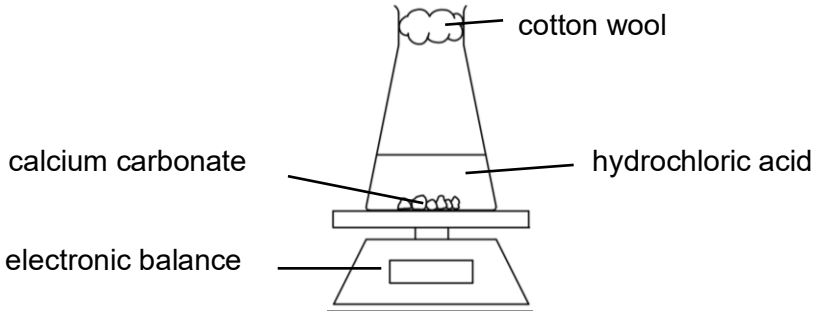


Fig. 10.1

In experiment 1, a fixed mass of calcium carbonate was added to 100 cm^3 of 1.00 mol/dm^3 of hydrochloric acid. The mass of the flask and contents were recorded every 30 seconds until the reaction is complete.

In all the experiments mentioned in this question, the acid is the excess reagent.

The results were plotted as shown in Fig. 10.2.

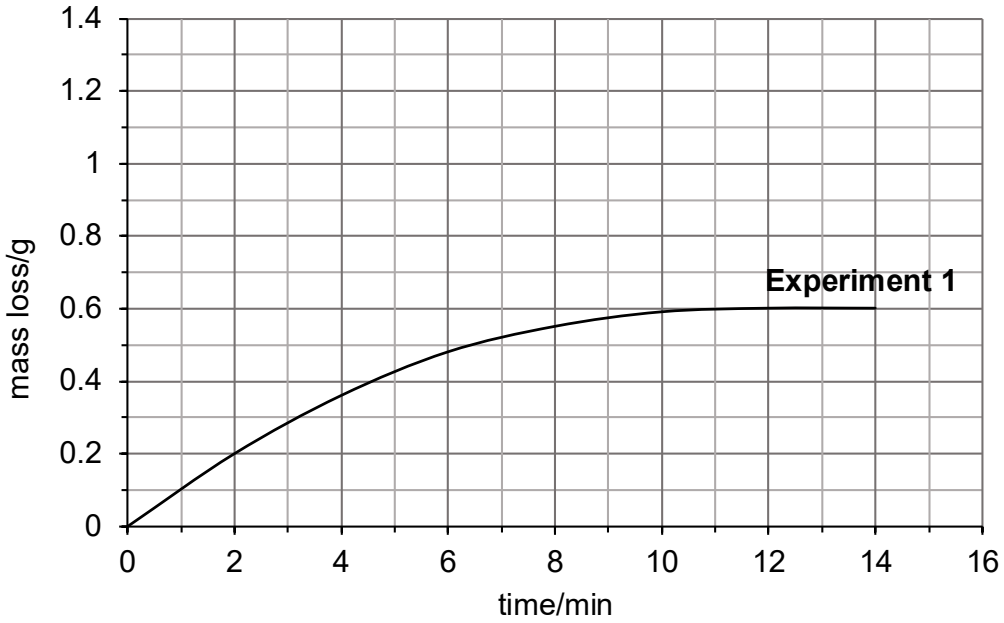


Fig. 10.2

(a) Explain why a decrease in mass was observed.

……

…… [1]

(b) State **two** observations that would indicate that the reaction has reached completion.

……

……

…… [2]

(c) **(i)** The experiment was repeated using the same mass of calcium carbonate but added to 100 cm^3 of 1.00 mol/dm^3 of sulfuric acid.

Sketch the curve that would be obtained using the same grid in Fig. 10.2 and label it Experiment 2.

[1]

(ii) Using ideas about reacting particles, explain the shape of your curve in **(c)(i)**.

……

……

……

…… [2]

(iii) The experiment was repeated using twice the mass of zinc carbonate added to 100 cm^3 of 1.00 mol/dm^3 of sulfuric acid.

Sketch the curve that would be obtained using the same grid in Fig. 10.2 and label it Experiment 3.

[1]

(d) A separate experiment, Experiment 4, was carried out using lead(II) carbonate and 100 cm^3 of 1.00 mol/dm^3 of sulfuric acid. However, the reaction stopped suddenly after a very small mass loss was observed.

(i) Explain why the reaction stopped suddenly.

……

…… [1]

(ii) Name the method and the reagent that can be added to sulfuric acid to prepare a pure and dry sample of the salt that was formed in Experiemnt 4.

……

…… [2]

[Total: 10]

11 The structures of some polymers are shown in Fig. 11.1 below.

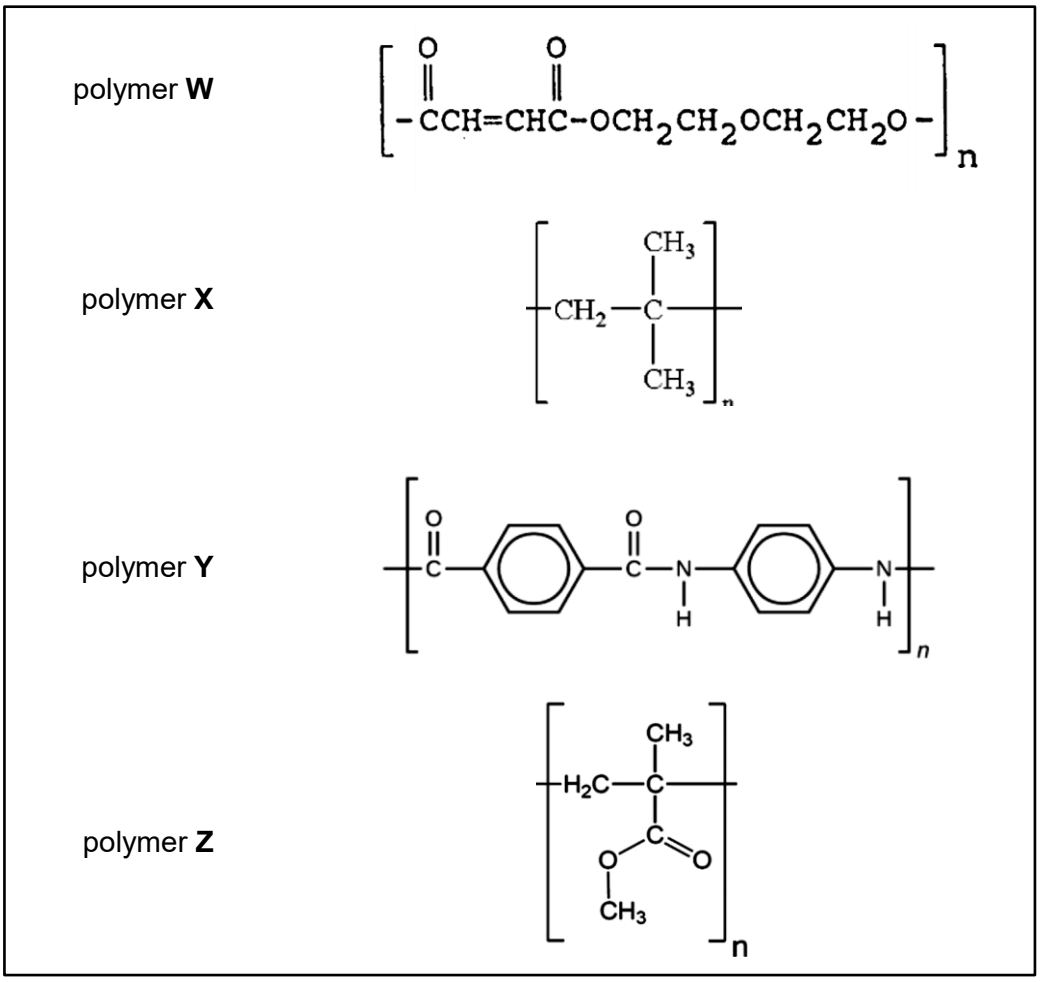


Fig. 11.1

(a) Describe a test to distinguish polymer **W** from polymer **X**.

……

…… [1]

(b) Draw the **full** structural forumla of the monomers that react to form polymer **W**.

[2]

(c) A sample of polymer **X** contains molecules with an average relative molecular mass of 14 000.

How many carbon atoms are there in an average molecule of the polymer?

[2]

(d) "One of the monomers that react to form polymer **Y** must be an alcohol."

Do you agree with the statement? Explain your answer.

……

…… [1]

(e) Polymer **Z** is formed by monomer **A**.

(i) Draw the structural formula of the monomer **A**.

[1]

(ii) Monomer **A** can be formed by reacting an acid and an alcohol under suitable conditions. Name the alcohol that is used.

…… [1]

(f) Some polymers are non-biodegradable.

Explain why being non-biodegradable can be considered both an advantage and a disadvantage.

……

……

……

…… [2]

[Total: 10]

END OF PAPER

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The Periodic Table of Elements

Group																	
1	2											13	14	15	16	17	18
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89 – 103 actinoids	104 Rf Rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

The Avogadro constant, $L = 6.02 \times 10^{23}$ mol^{-1}