CHRIST CHURCH SECONDARY SCHOOL
2025 PRELIMINARY EXAMINATION
SECONDARY FOUR EXPRESS

CANDIDATE NAME		CLASS	
CENTRE NUMBER	S	INDEX NUMBER	

CHEMISTRY

6092/01

Paper **1**

26 August 2025

1 hour

Candidates answer on the Question Paper
Additional Materials: OTAS Paper

READ THESE INSTRUCTIONS FIRST

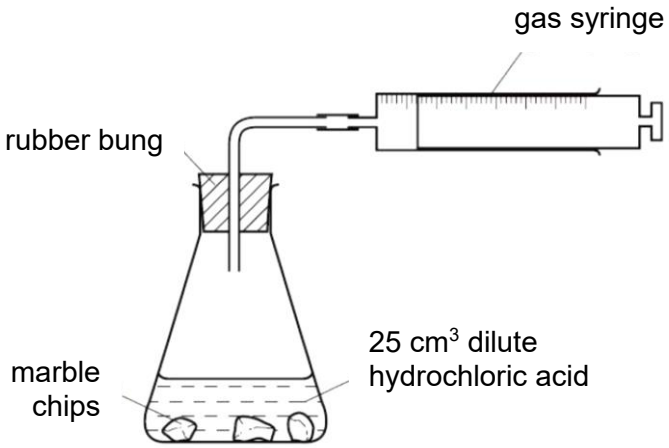
Write your Centre number, index number, name and class on all the work you hand in.
Write in soft pencil on the Multiple Choice Answer Sheet
Do not use staples, paper clips, glue or correction fluid.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Multiple Choice Answer Sheet.

Read the instructions on the answer sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 16.
The use of an approved scientific calculator is expected, where appropriate.

1 The apparatus shown in the diagram below was set up by a student to measure the volume of carbon dioxide gas made when different masses of marble chips were added to 25 cm^3 of dilute hydrochloric acid.



Which other apparatus did he use for his experiment?

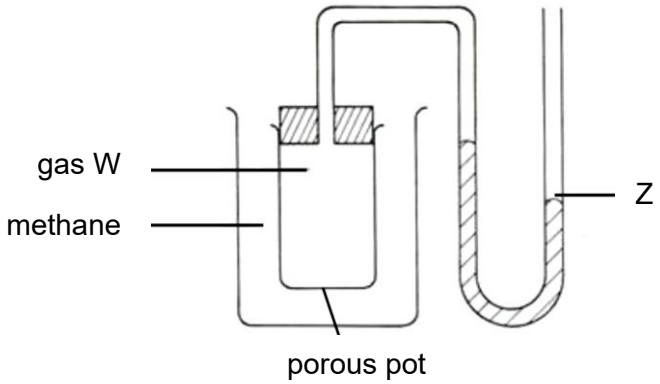
A filter funnel and mass balance

B filter funnel and stopwatch

C measuring cylinder and mass balance

D measuring cylinder and stopwatch

2 Gas W was collected using displacement of air by downward delivery, and then placed in the set-up below. After a short while, the water level in column Z was observed.



Which observations(s) could possibly be made about the water level in column Z?

I Water level increased.
II Water level remained the same.
III Water level decreased, then increased.

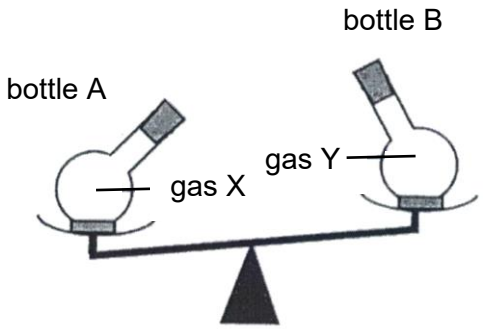
A I only

B II only

C I and II

D II and III

3 Two identical bottles, A and B are filled with gases X and Y respectively. They were then put on a balance at room temperature and pressure. The result is shown below



Which of the following statements is **correct**?

A The number of gas particles in bottle A is greater than the number of gas particles in bottle B.

B The number of moles of gas particles in bottle A is greater than the number of moles of gas particles in bottle B.

C The molar mass of gas particles in bottle A is greater than the molar mass of gas particles in bottle B.

D The molar volume of gas particles in bottle A is greater than the molar volume of gas particles in bottle B.

4 The boiling points of some gases present in air are given in the table below.

gas	nitrogen	oxygen	argon	xenon
boiling point / ^{o}C	-196	-182	-186	-108

A mixture containing liquefied air at -200 ^{o}C is fractionally distilled.

Which one of the following would still remain as a liquid when the temperature is increased by 15 ^{o}C?

A nitrogen and argon

B oxygen and argon

C oxygen and xenon

D argon, oxygen and xenon

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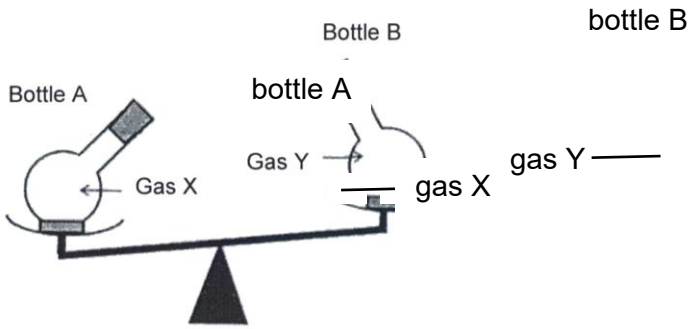

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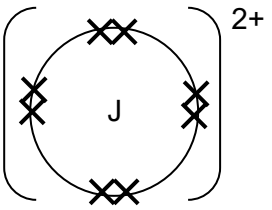
5 J is an element found in the Periodic Table.



Which of the following **cannot** be deduced from the information provided only?

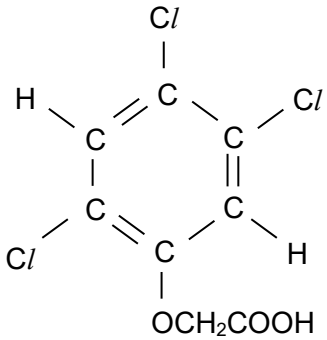
A Element J can likely be found in Group 2 of the Periodic Table.

B Element J has two isotopes that have different physical properties.

C The atomic radius of J is bigger than its ionic radius.

D The ion of J can be attracted to any oppositely charged ion.

6 The figure below shows a molecule of an herbicide called 2,4,5-T which is often used for weed control.



How many pairs of shared electrons are present in one molecule of the herbicide?

A 12 **B** 15

C 20 **D** 23

7 In which of the following molecules are all the outer electrons of the atoms involved in bonding?

A CH_4 **B** CO_2

C NH_3 **D** HCl

8 The table below shows the information about the chlorides of some elements in Period 3 of the Periodic Table.

element	formula of main chloride	bonding present in chloride	pH of resulting solution when dissolved in water
sodium	NaC*l*	ionic	7
magnesium	$MgCl_2$	ionic	7
aluminium	$AlCl_3$	covalent	3
phosphorus	PCl_3	covalent	2
sulfur	S_2Cl_2	covalent	2

What will be the bonding present in the chloride of silicon and the pH value of the resulting solution when the chloride is dissolved in water?

	bonding present in chloride	pH of resulting solution when dissolved in water
A	covalent	2
B	covalent	7
C	ionic	2
D	ionic	7

9 The table below shows some physical properties of substances P, Q, R and S.

substance	melting point / °C	electrical conductivity	
		in solid state	in molten state
P	high	poor	good
Q	high	good	good
R	high	poor	poor
S	low	poor	poor

Which of the following statements is **true** about substances P, Q, R and S?

A Substance P contains mobile electrons to conduct electricity when in molten state.

B Substance Q consists of strong electrostatic attractions between oppositely charged particles.

C Substance R consists of weak bonds between the atoms.

D Substance S exists in a simple molecular structure.

10 Which of the following is **true** of graphite and copper?

A They both contain strong forces of attraction between oppositely charged ions.

B They both have giant covalent structure.

C They can conduct electricity in the solid state due to mobile delocalised electrons.

D They have high melting points due to strong covalent bonds.

11 Compound X is made up of two elements, metal Y and non-metal Z. Compound X has a giant lattice structure where each negative ion is surrounded by four positive ions while each positive ion is surrounded by eight negative ions.

Which of the following shows the correct formula of the ions present in compound X, as well as the chemical forumla of compound X?

	cation	anion	chemical formula
A	Y^+	Z^{2-}	Y_2Z
B	Y^{2+}	Z^-	YZ_2
C	Z^+	Y^{2-}	Z_2Y
D	Z^{2+}	Y^-	ZY_2

12 An unknown carbonate, M_2CO_3, is heated and the following reaction takes place.

$$M_2CO_3 \rightarrow M_2O(s) + CO_2(g)$$

Which volume of carbon dioxide, at r.t.p, would be produced if *z* g of M_2CO_3, which has relative molecular mass *y*, is heated?

A $\frac{y}{24z}$ dm^3

B $\frac{24y}{z}$ dm^3

C $\frac{24z}{y}$ dm^3

D $\frac{44z}{y}$ dm^3

13 Red cabbage can be used as a pH indicator. The indicator prepared from red cabbage changes colour according to the following pH ranges shown in the table below.

pH	colour
<7	red
7	purple
8-9	blue
10-11	green
11-13	yellow

Which two solutions could **not** be distinguished using the red cabbage indicator?

A aqueous solutions of ammonia and sodium hydroxide

B aqueous solutions of hydrogen chloride and sulfurous acid

C aqueous solutions of potassium hydroxide and potassium nitrate

D distilled water and limewater

14 The table below shows the results of different experiments conducted on two acids, A1 and A2, of equal concentration.

acids	conductivity of acid solution / arbitrary units	temperature change when excess acid was reacted with 0.1 mol of sodium hydroxide / °C	observation when reacted with 3.0 cm magnesium strip
A1	1000	+6.9	rapid effervescence of a colourless gas
A2	7	+6.7	slow bubbling of a colourless gas

Which of the following deductions can be made about acids A1 and A2?

A A1 is a weak acid while A2 is a strong acid.

B A1 is a strong acid while A2 is a weak acid.

C Both A1 and A2 are weak acids, except that A1 is a dibasic acid.

D Both A1 and A2 are strong acids, except that A2 is a dibasic acid.

15 Zinc carbonate granules were added into a mixture of hydrogen chloride gas dissolved in an organic solution called benzene. No reaction was observed.

Which of the following changes could be made so that the zinc carbonate would react with the hydrogen chloride gas?

A Add more hydrogen chloride gas.

B Change the benzene solvent to water.

C Crush the zinc carbonate into powdered form.

D Heat the reaction mixture.

16 In which reaction is dilute hydrochloric acid **not** behaving as an acid?

A $HCl(aq) + AgNO_3(aq) \rightarrow AgCl(s) + HNO_3(aq)$

B $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

C $2HCl(aq) + CuO(s) \rightarrow CuCl_2(aq) + H_2O(l)$

D $2HCl(aq) + Mg(s) \rightarrow MgCl_2(aq) + H_2(g)$

17 Which of the following statements about the Haber process is **incorrect**?

A At the optimum conditions, the yield of ammonia is 100%.

B Higher pressure produces a higher percentage yield of ammonia.

C Nitrogen is obtained as a raw material from the fractional distillation of liquid air.

D The pressure in the reaction chamber is increased to speed up the reaction.

18 The reaction in the Haber process is represented by the equation below.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92 \text{ kJ}$$

Which of the following statements is **incorrect**?

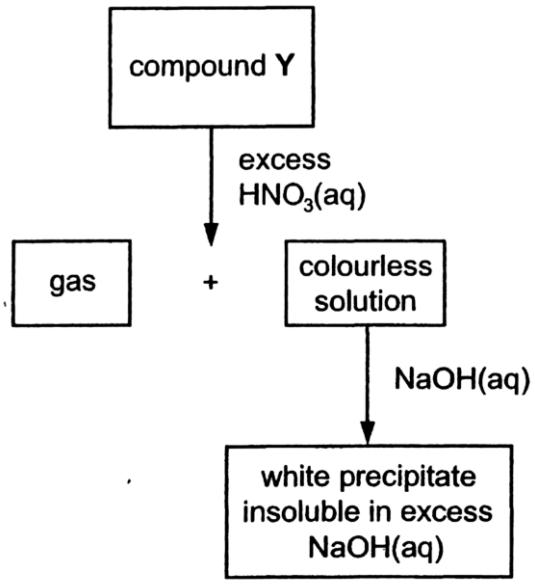
A 92 kJ of heat is given off when 2 moles of ammonia are formed.

B Iron catalyst affects the enthalpy change.

C The process is carried out at a high pressure of 250 atm.

D When 2 moles of nitrogen and 6 moles of hydrogen are used, 4 moles of ammonia will be collected.

19 The scheme shows some reactions of a compound Y.



What could the compound Y be?

A aluminium sulfate

B calcium carbonate

C copper(II) carbonate

D zinc sulfate

20 An excess of sodium hydroxide is added to an aqueous solution of salt L and boiled. Ammonia gas is observed to be produced only after a piece of aluminium foil is added to the hot solution.

What could be salt L?

A ammonium chloride

B ammonium nitrate

C sodium chloride

D sodium nitrate

21 Which of the following ions have the highest concentration in solution when a few drops of aqueous ammonia are added into aqueous copper(II) sulfate?

A Cu^{2+} **B** NH_4^+

C OH^- **D** SO_4^{2-}

22 Which of the following shows a redox reaction?

A acid reaction with a metal oxide

B displacement reaction

C precipitation reaction using two soluble salts

D titration between acids and alkalis

23 In which of the following pairs of compounds do the two underlined elements have the same oxidation state?

A $\underline{Cr}O_3$ and $K\underline{Cl}O_3$

B $\underline{Cu}Cl_2$ and $\underline{Na}_2CO_3$

C $K\underline{Mn}O_4$ and $K_2\underline{Cr}_2O_7$

D $\underline{Mn}SO_4$ and $\underline{Fe}SO_4$

24 Three electrolysis cells are set up with inert electrodes. The electrolytes used for each cell are listed below.

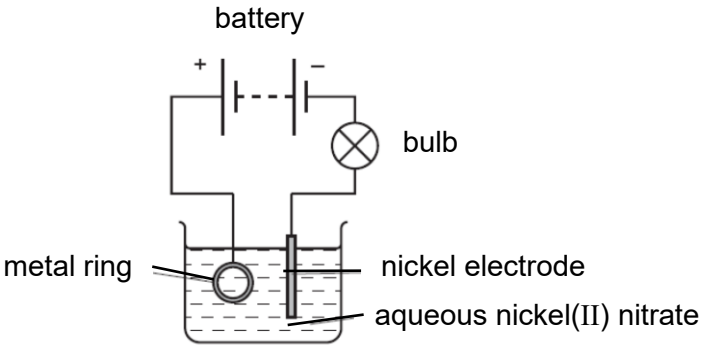
1 concentrated hydrochloric acid
2 molten aluminium bromide
3 aqueous potassium nitrate

Which of the cell(s) above will have a gas formed at **both** its electrodes?

A 2 only **B** 3 only

C 1 and 2 **D** 1 and 3

25 The diagram shows the apparatus used to electroplate a metal ring with nickel.



The experiment did not work.

Which change is needed in the experiment to make it work?

A Add molten nickel(II) nitrate to the electrolyte.

B Increases the temperature of the electrolyte.

C Reverse the connection to the battery.

D Swap the nickel electrode with a platinum electrode.

26 Which of the following statements about Group 17 elements are **true**?

I They form diatomic molecules because they have the same number of valence electrons.

II They have increasing density down the group.

III Their strength as oxidising agents increases down the group.

A I only

B I and II only

C II and III only

D I, II and III

27 Which of the following rows of properties is **correct** for both copper and sodium?

	property	copper	sodium
A	density / g cm^{-3}	8.92	0.97
B	colour	blue	white
C	melting point / °C	810	1083
D	nature of oxide	amphoteric	basic

28 The solid carbonate of three metals W, X and Y are heated, and the results are recorded in the table below.

carbonate of metal	result
W	carbon dioxide produced; solid turns from green to black
X	carbon dioxide produced; solid does not change colour
Y	carbon dioxide not produced; solid does not change colour

The conclusions below were made by a student.

1 Metal W could be used as a catalyst.
2 Metal Y is a stronger reducing agent than metal X.
3 Only the carbonates of metals W and X produce carbon dioxide when added to dilute nitric acid.

Which of the above statements are correct?

A 1 and 2 only

B 1 and 3 only

C 2 and 3 only

D 1, 2 and 3

29 Which of the following metals requires the **least** energy to be extracted from its ore?

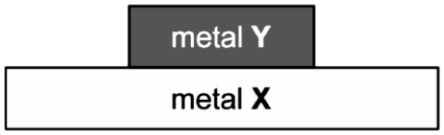
A calcium

B copper

B iron

D lead

30 Metals can be protected against corrosion by sacrificial protection.
The diagram below shows metal X being protected from corrosion by metal Y.

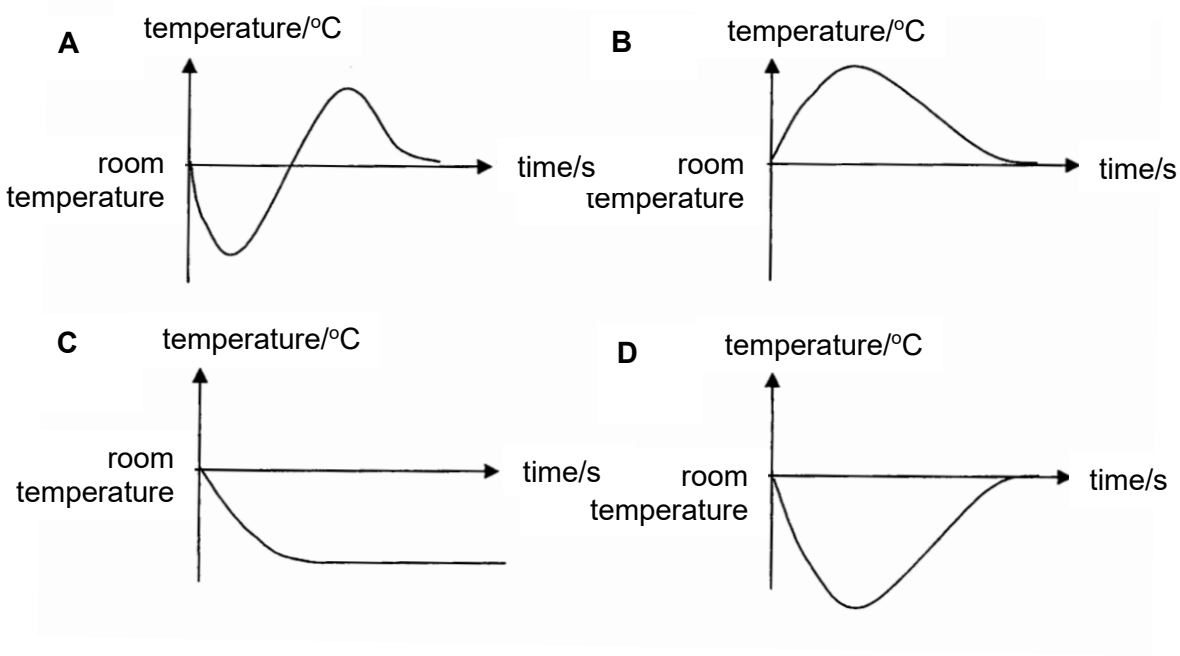


What could be the possible identities of metals X and Y?

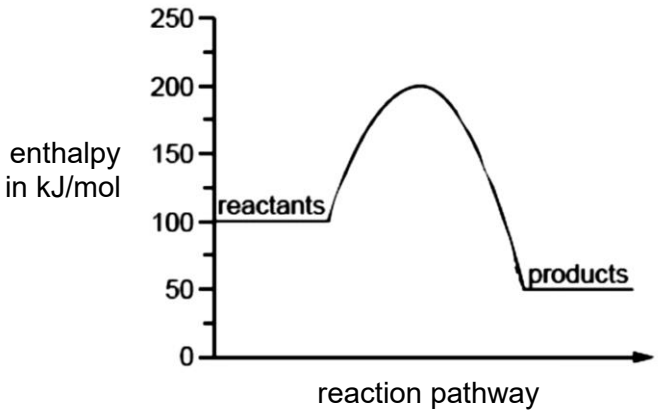
	metal X	**metal Y**
A	copper	gold
B	lead	silver
C	magnesium	iron
D	zinc	calcium

31 The process of dissolving potassium iodide in water is endothermic.

Which of the following graphs shows the temperature changes that occur when potassium iodide is stirred with water until no further change in temperature is observed?



32 The energy diagram below represents the energy changes in a chemical reaction.



What is the enthalpy change of this reaction?

A +50 kJ

B -50 kJ

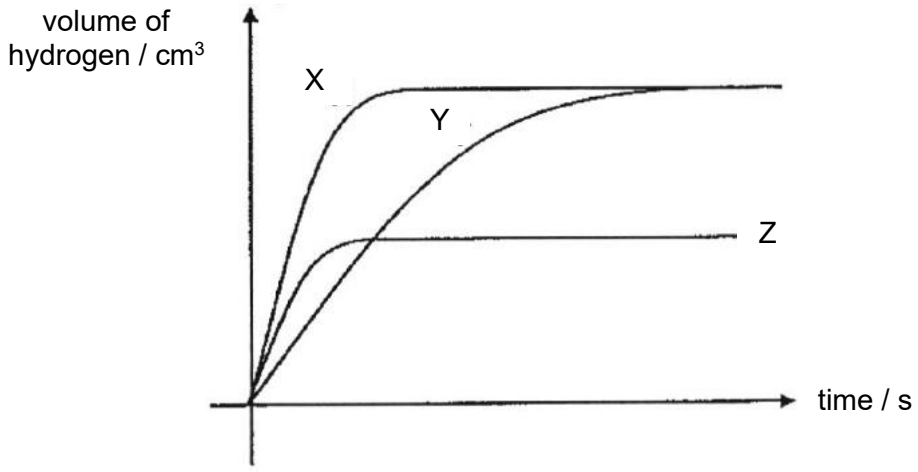
C +100 kJ

D -100 kJ

33 A student performed three experiments to produce hydrogen gas using excess zinc carbonate and dilute sulfuric acid at 30 °C.

experiment	zinc carbonate	dilute sulfuric acid	
	particle size	volume / cm^3	concentration / mol dm^{-3}
1	powdered	20	1.00
2	lumps	40	0.50
3	lumps	10	1.00

Three graphs were plotted for the volume of hydrogen produced against time.



Which graph best represents each of the respective three experiments?

	experiment 1	experiment 2	experiment 3
A	X	Y	Z
B	Y	X	Z
C	Y	Z	X
D	Z	X	Y

34 Which of the following best explains why bioethanol obtained from sugarcane plants is considered renewable?

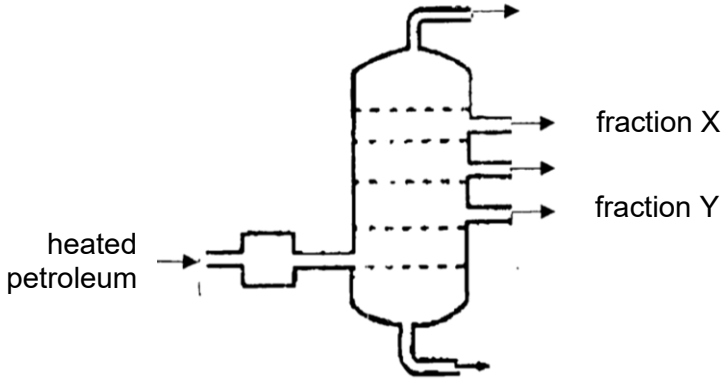
A Sugarcane plants can be harvested after one year.

B Sugarcane plants require carbon dioxide during photosynthesis.

C The sugar from sugarcane plants can be transported from one place to another.

D The sugar from sugarcane plants can undergo fermentation.

35 The diagram shows the fractional distillation of petroleum.

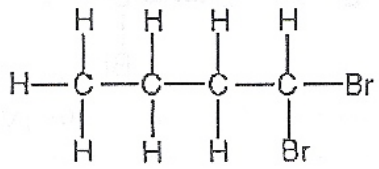


Which statements about fractions X and Y are correct?

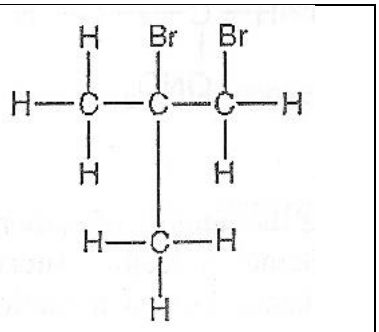
	X is more flammable than Y	X burns with a less sooty flame than Y	X is more viscous than Y
A	yes	no	no
B	yes	yes	no
C	no	yes	yes
D	no	no	yes

36 Which of the following compounds could be formed by the action of bromine on an alkene of formula C_4H_8?

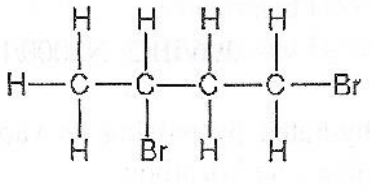
A



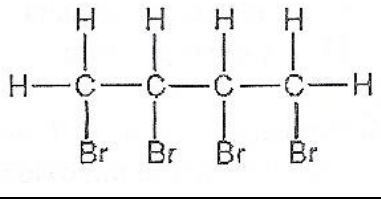
B



C



D



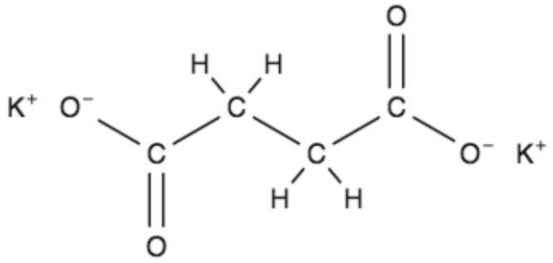
37 Linoleic acid is an unsaturated fatty acid with a M_r of 280. In a reaction, it was measured that 70 g of the fatty acid reacts with 254 g of iodine.

How many double bonds are there in each molecule of linoleic acid?

A 1 **B** 2

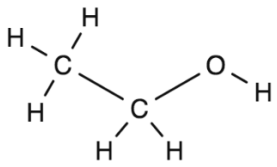
C 3 **D** 4

38 An alcohol was completely oxidised to produce a carboxylic acid. This carboxylic acid was reacted with potassium hydroxide to produce a salt, which has the structural formula displayed below.

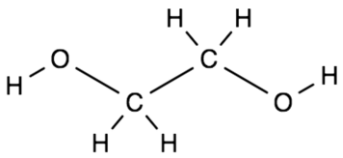


Which of the following represents the structure of the starting alcohol?

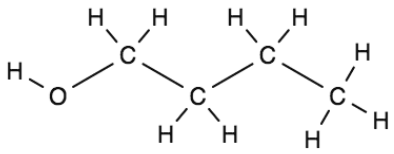
A



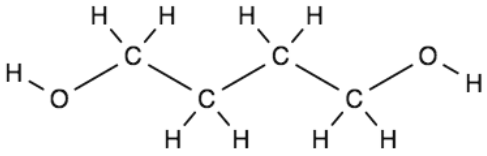
B



C



D



39 Which of the following does **not** change in the polymerisation of ethene to form poly(ethene)?

A boiling point

B density

C empirical formula

D molecular mass

40 Which of the following chemical equations does **not** represent a process that occurs in the catalytic converter of a car?

A $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$

B $2CO + O_2 \rightarrow 2CO_2$

C $2N_2 + O_2 \rightarrow 2N_2O$

D $2NO + 2CO \rightarrow N_2 + 2CO_2$

End of Paper

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 –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

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 –

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}

Answer Scheme

1	C	**2**	A	**3**	C	**4**	C	**5**	B
6	D	**7**	A	**8**	A	**9**	D	**10**	C
11	B	**12**	C	**13**	B	**14**	B	**15**	B
16	A	**17**	A	**18**	B	**19**	B	**20**	D
21	D	**22**	B	**23**	D	**24**	D	**25**	C
26	B	**27**	A	**28**	A	**29**	B	**30**	D
31	D	**32**	B	**33**	A	**34**	A	**35**	B
36	B	**37**	D	**38**	D	**39**	C	**40**	C

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.

BLANK PAGE

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.

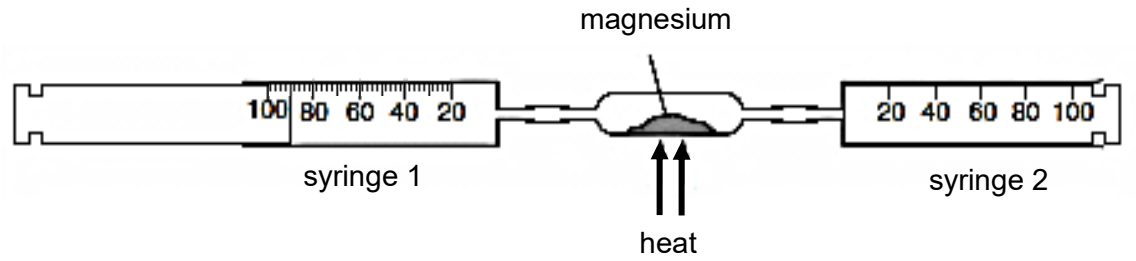


Fig. 3.1

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.

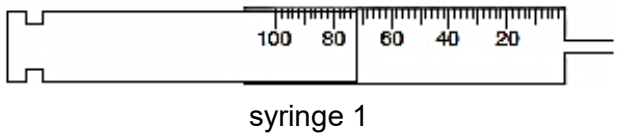


Fig. 3.2

(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.

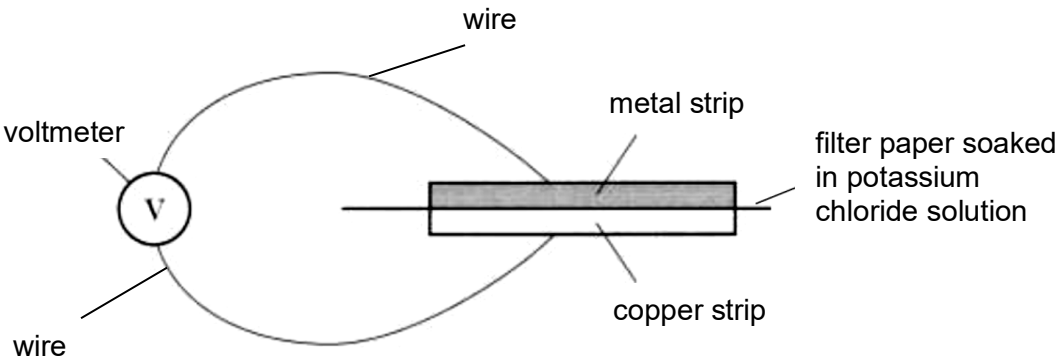


Fig. 4.1

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.

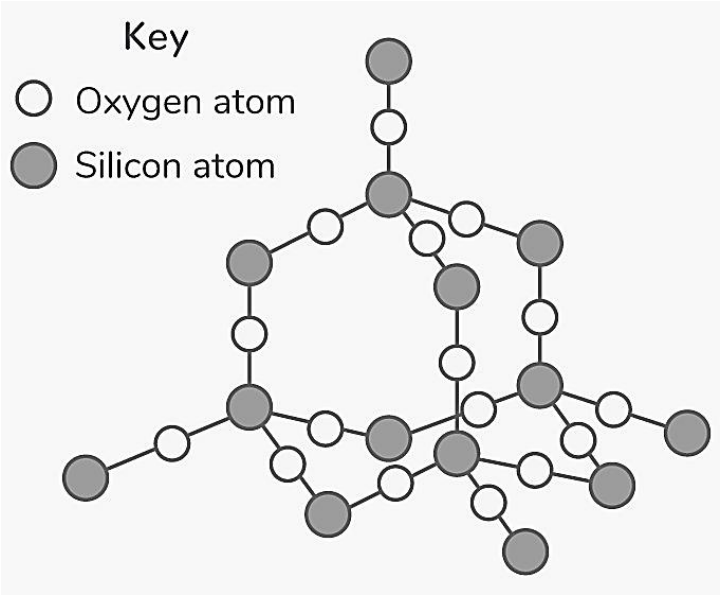


Fig. 6.1

(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.

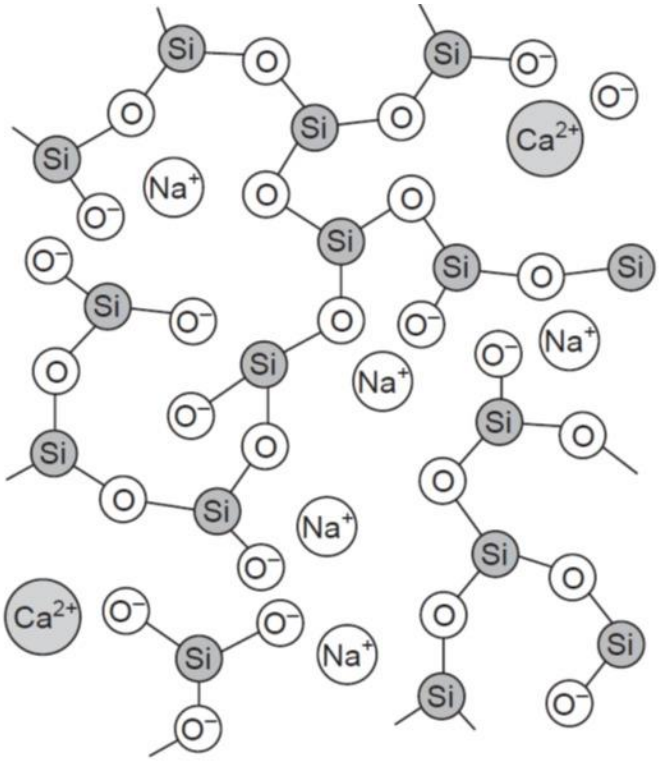


Fig. 6.2

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.

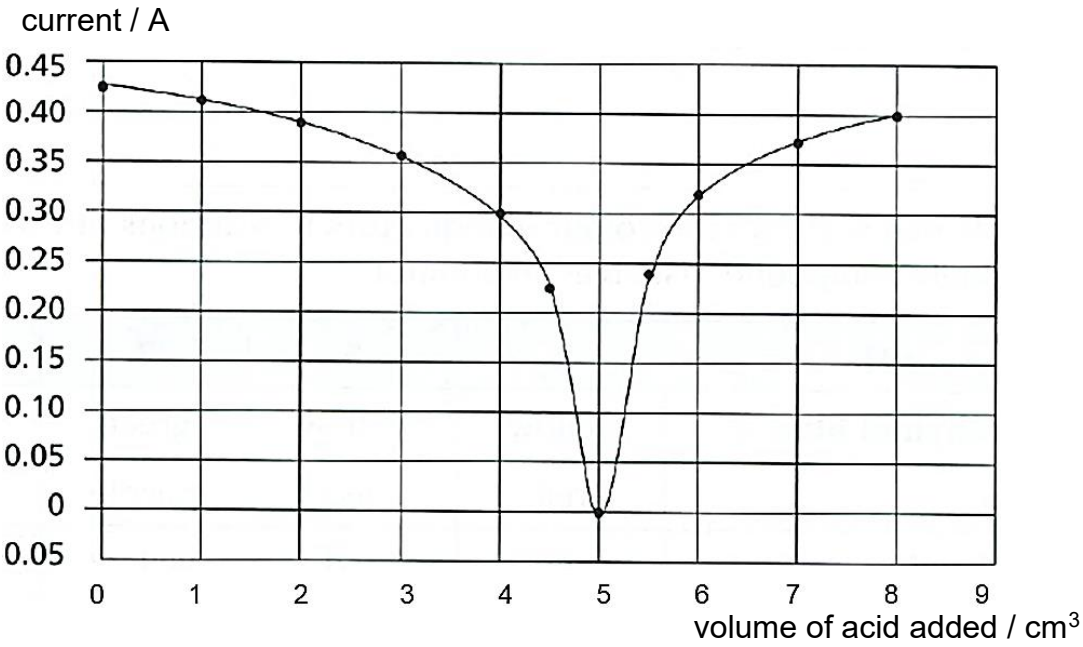


Fig. 7.1

(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]

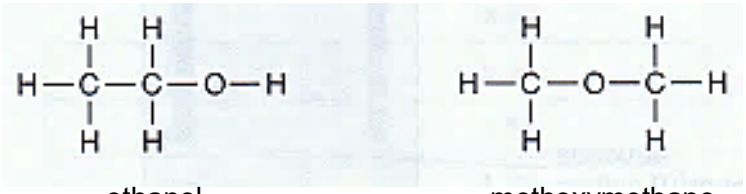
8 Ethers are organic compounds with the general formula R–O–R′, where R and R′ are alkyl groups. They form a homologous series, with each successive member differing by a $–CH_2–$ group. When ethers undergo complete combustion, they produce carbon dioxide and water, releasing energy in the process.

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

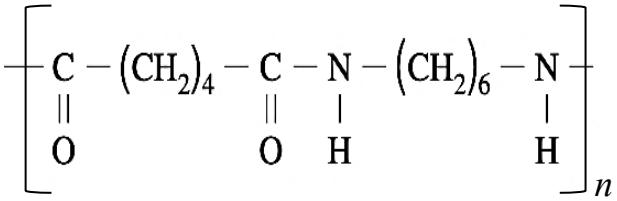
Table 8.2 shows enthalpy changes of combustion for ethanol and methoxymethane.

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.

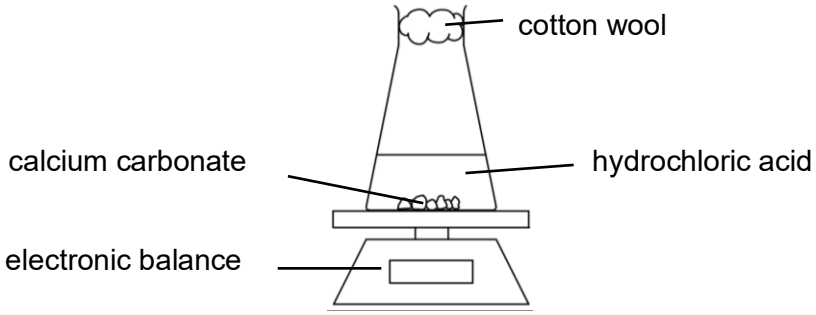


Fig. 10.1

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.

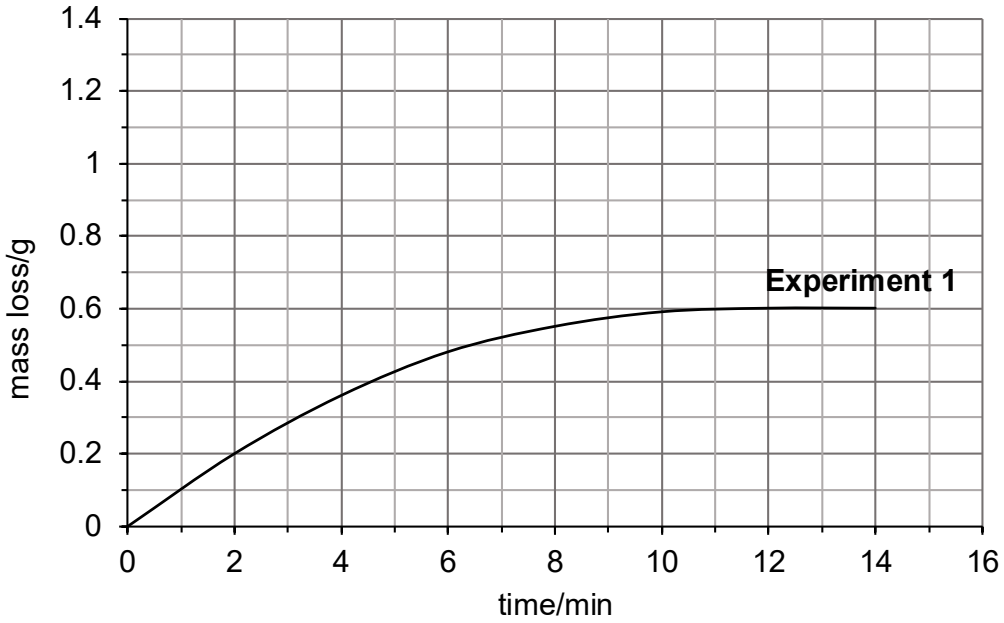


Fig. 10.2

(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.

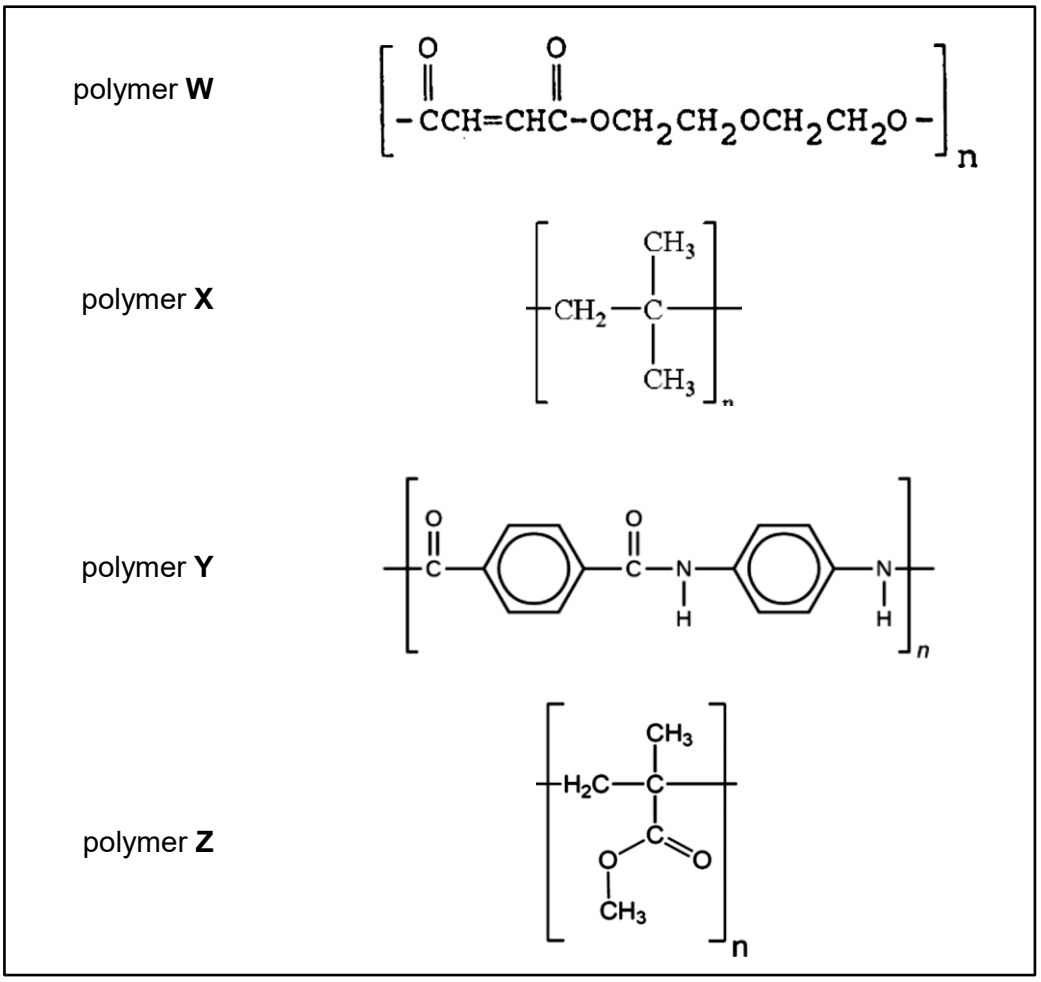


Fig. 11.1

(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.).

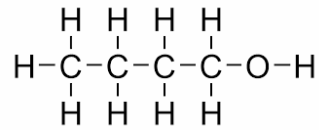
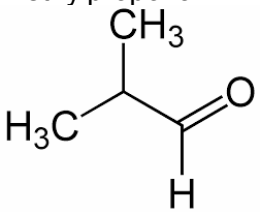
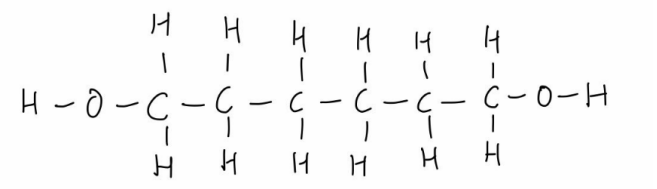
The Avogadro constant, $L = 6.02 \times 10^{23}$ mol^{-1}

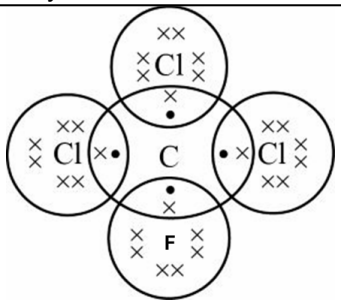
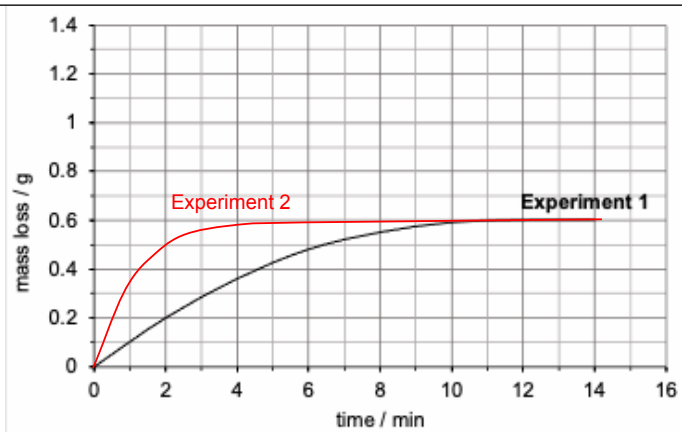
Marking Scheme

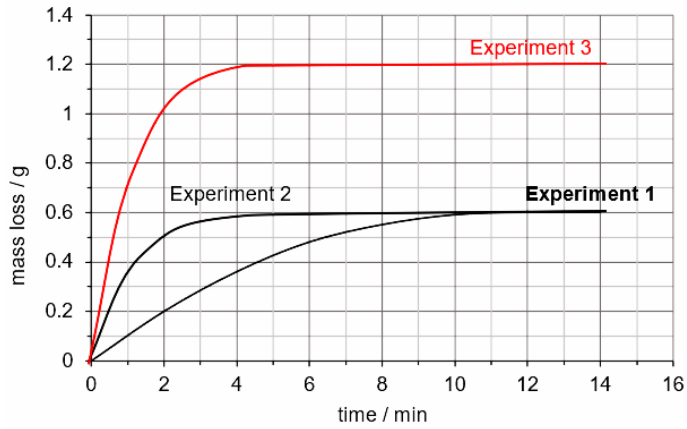
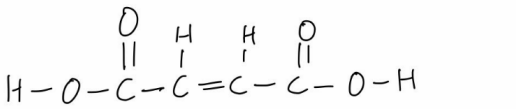
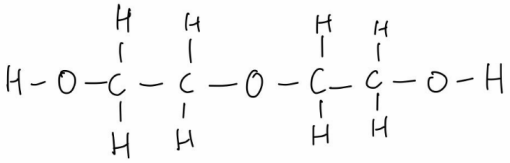
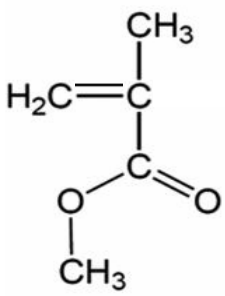
1	**a**	**i**	sulfur dioxide	1
		ii	copper (II) chloride	1
		iii	zinc sulfate	1
		iv	sulfur dioxide	1
	b	**i**	Arrangement: particles closely packed in an unorderly manner Movement: particles able to slide past each other	2
		ii	$Na_2O + H_2O \rightarrow 2NaOH$	1
		iii	Blue precipitate formed	1
2	**a**		No. of moles of $S_2O_3^{2-}$ = x 0.1 = 0.005 mol No of moles of I_2 = x 0.1 = 0.004 mol [1] Mole ratio of $S_2O_3^{2-}$: I_2 → 2 : 1 0.005 mol of $S_2O_3^{2-}$ requires 0.0025 mol of I_2 to react [1] Thus, the limiting reactant is $S_2O_3^{2-}$ [1]	3
	b		Mole ratio of $S_2O_3^{2-}$: I^- → 1 : 1 No. of moles of I^- = 0.005 mol [1] % yield = x 100 % = 26.0% [1] [Accept ECF from (a)]	2
	c		The oxidation state of iodine decreases [1] from 0 in I_2 to −1 in I^- [1] Accept answer where student show thiosulfate being oxidised and link it back to the characteristic of a reducing agent.	2
	d		No. Different elements are being reduced and oxidised at the same time.	1
3	**a**		$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$ [Reject: state symbols not written or incorrect]	1
	b		Nitrogen.	1

	c	volume of O_2 reacted = 90 – 72 = 18 cm^3 number of moles of O_2 reacted = (18/1000) / 24 = 0.00075 mol [1] From the balanced chemical equation, 2 mol of Mg reacts with 1 mol of O_2. Hence, 0.0015 mol of Mg will react with 0.00075 mol of O_2. [1] Mass of Mg reacted = 0.0015 x 24 = 0.036 g [1] [Accept: ECF from (a)]		3
4	**a**	Most Least R, S, P, Copper, Q		1
	b	Anode: $R(s) \rightarrow R^+(aq) + e$ Cathode: $Cu^{2+}(aq) + 2e \rightarrow Cu(s)$ [Reject: state symbols not written or incorrect.]		2
	c	Any two: • Electrical energy is not supplied but produced through chemical reactions in a simple cell. • Electrons move spontaneously from the anode to the cathode. • The anode is the negative terminal in a simple cell.		2
5	**a**	$N_2 (g) + 3H_2 (g) \rightleftharpoons 2NH_3 (g)$ [1] From the equation, 1 mole / volume of N_2 reacts with 3 moles / volumes of H_2. [1]		2
	b	Temperature: about 450 °C Pressure: about 250 atm Catalyst: finely divided iron [1] for all 3 conditions		3
	c	Method: upward delivery [1] Reason: ammonia is less dense than air [1]		2
	d	**i**	When pressure increases, particles come closer together. [1] Frequency of effective collisions increases; rate of reaction increases.[1]	2
		ii	Since ammonia and nitrogen monoxide are gases, Volume ratio of NH_3 : NO → 1 : 1 Theoretical volume of NO = 440 dm^3 [1] 40% = x 100 % x = 176 dm^3 [1]	2

6	**a**		Silicon(IV) dioxide is a <u>covalent compound</u> and with <u>no mobile charge carriers</u>.	1
	b		They both have a macromolecular structure. [1] They both have atoms in a rigid tetrahedral arrangment. [1]	2
	c	**i**	Any two • Silicate contains only covalent bonds while wine glass contains both covalent and ionic bonds. • Silicate has a regular arrangement while wine glass has an irregular arrangement. • In silicate, each silicon atom is bonded to three oxygen atoms but in wine glass, each silicon atom can be bonded to one or more oxide ions. • Silicate contains no ions but wine glass has calcium and sodium ions.	2
		ii	The strong electrostatic forces of attraction between the ions are overcome when the glass is melted. [1] The ions become free to move about / act as mobile charge carriers to conduct electricity [1].	2
7	**a**		A strong acid is a substance that <u>ionises/dissociates completely in water to produce high concentration of hydrogen ions/ H^+ ions.[1]</u>	1
	b		The iron stirrer would react with the sulfuric acid immediately.	1
	c		$Ba(OH)_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2H_2O(l)$ 1m – correct balanced equation 1m – correct state symbols	2
	d		The <u>conductivity was high</u> at the start as there were <u>free moving mobile barium and hydroxide ions [1].</u> As more sulfuric acid was added, <u>the ions are being removed from the solution</u> when they <u>combine with the hydrogen and sulfate ions</u>. Hence, the <u>number of free moving mobile ions in the solution decreases [1]</u>. When a total of 5 cm^3 of sulfuric acid was added, only the insoluble barium sulfate salt and water are present. There are <u>no free moving mobile ions in the solution at that time [1]</u>, Hence, conductivity of the solution is zero. When excess acid was added, the conductivity of the solution increases as there is an <u>increase in the number of free moving mobile ions from the sulfuric acid [1].</u>	4
	e		= = concentration of barium hydroxide, M_b = =<u>0.100 mol/dm^3</u> [Accept ECF from (c)]	1

8	**a**	$CH_3OCH_3 + 3O_2 \rightarrow 2CO_2 + 3H_2O$	1
	b	M_r of diethylether = 74 [1] Enthalpy change of combustion in kJ/g = Enthalpy in kJ/mol / M_r = -2726 / 74 = -36.8 kJ/g [1]	2
	c	The overall enthalpy change is calculated by the difference between the energy absorbed during bond breaking and the energy released during bond forming. [1] In the combustion reaction of these products, there is more energy released from bond forming than energy absorbed for bond breakling. [1]	2
	d	Increase	1
	e	The <u>types of bonds</u> in the molecules that need <u>to be overcome are different</u> so different amount of energy are needed when these bonds are broken.	1
	f	Butanol  Methylproponal  [Accept: hydroxyl group on any carbon]	1
	g	The potassium manganate (VII) solution will be decolourised / turn from purple to colourless in the sample with the alcohol. The potassium manganate (VII) solution will remain purple in the sample with ethoxyethane	1
	h	 1m – correct hydroxyl groups 1m – correct carbon backbone	2
9	**a**		2

		 1m – shared electrons; 1m – unshared electrons [Minus 1m if legend not shown.]		
	b	CCl_3F is a simple molecule [structure] with weak intermolecular forces of attraction [bonding] [1] that require a low amount of energy to overcome [1]. Hence, it would have a low boiling point.		2
	d	**i**	Allotropes	1
		ii	The ClO particle that is produced in step 1 reacts with an ozone molecule in step 2 to produce another Cl atom. [1] This Cl atom is then able to start step 1 again / to be reused in step 1 / used again for step 1 [1] and react with more ozone molecules.	2
		<u>Excessive UV radiation/light</u> that prevents risk of skin cancer will not be absorbed.		1
10	**a**	Calcium carbonate reacts with hydrochloric acid to form carbon dioxide gas. The mass loss is due to the <u>carbon dioxide gas being liberated.</u>		1
	b	Any 2: • Reading on the electronic balance remains unchanged. • There would be no more zinc carbonate left in the reaction mixture • No more effervescence is observed.		2
	c	**i**		1
		ii	In the same concentration and volume, sulfuric acid <u>has twice the number of hydrogen ions</u> as compared to hydrochloric acid. [1] <u>Concentration of reactant particles increases, increase frequency of effective collision</u>, rate of reaction increases. Since calcium carbonate is the limiting reagent, total mass loss remains at 0.6 g. [1]	2

		iii		1
	d	**i**	The lead(II) sulfate produced <u>forms an insoluble layer on the surface of the lead (II) carbonate</u>, preventing further reaction with the acid.	1
		ii	Precipitation method [1] Lead(II) nitrate [1]	2
11	**a**		<u>Add aqueous bromine</u> to the polymers seperately. Aqueous bromine will <u>decolourise</u> in the sample with polymer W.	1
	b		 	2
	c		n = 14000 / [(4x12)+(8x1)] = 250 [1] No. of carbon atoms = 250 x 4 = 1000 [1]	2
	d		No. Polymer Y is a polyamide which does not require an alcohol / which requires a diacid and diamine.	1
	e	**i**		1
		ii	Methanol	1

	f	Disadvantage: Polymer can only be disposed off by burying in landfills which will lead to land or air pollution.[1] Advantage: Polymer is durable and resistant to corrosion in daily use. [1]	2