NAME:		( )	CLASS:	

YISHUN TOWN SECONDARY SCHOOL

G3

PRELIMINARY EXAMINATION 2025

SECONDARY 4 & 5

G3 SCIENCE (CHEMISTRY)

(5086/3)

DATE : 15 Aug 2025 **DAY : Friday**

DURATION: 1 hr 15 min **MARKS: 65 marks**

READ THIS INSTRUCTIONS FIRST

Write your name, class and register number in the spaces provided at the top of this page.

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

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

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.

You may use an approved calculator.

A copy of the Periodic Table and Colours of Metal Hydroxides are printed on the last two pages.

Section A	
Section B	
TOTAL	

This paper consists of **17** printed pages.

Section A

Answer **all** the questions.

1 Choose from the following substances to answer the questions. [4]

$PbSO_4$	Al_2O_3	$CaSO_4$	$Al(NO_3)_3$
$CuCO_3$	KOH	$ZnCl_2$	$(NH_4)_2SO_4$

Each substance may be used once, more than once, or not at all.

Which substance

(a) gives a white precipitate that dissolves in excess aqueous ammonia. ..... [1]

(b) reacts with both acid and alkali. ..... [1]

(c) reacts with an acid to produce a salt, a gas and water. ..... [1]

(d) gives out a gas that turns damp red litmus paper blue when warmed with sodium hydroxide. ..... [1]

2 The apparatus shown in Fig. 2.1 can be used to separate hexane (boiling point 70°C) and heptane (boiling point 98°C).

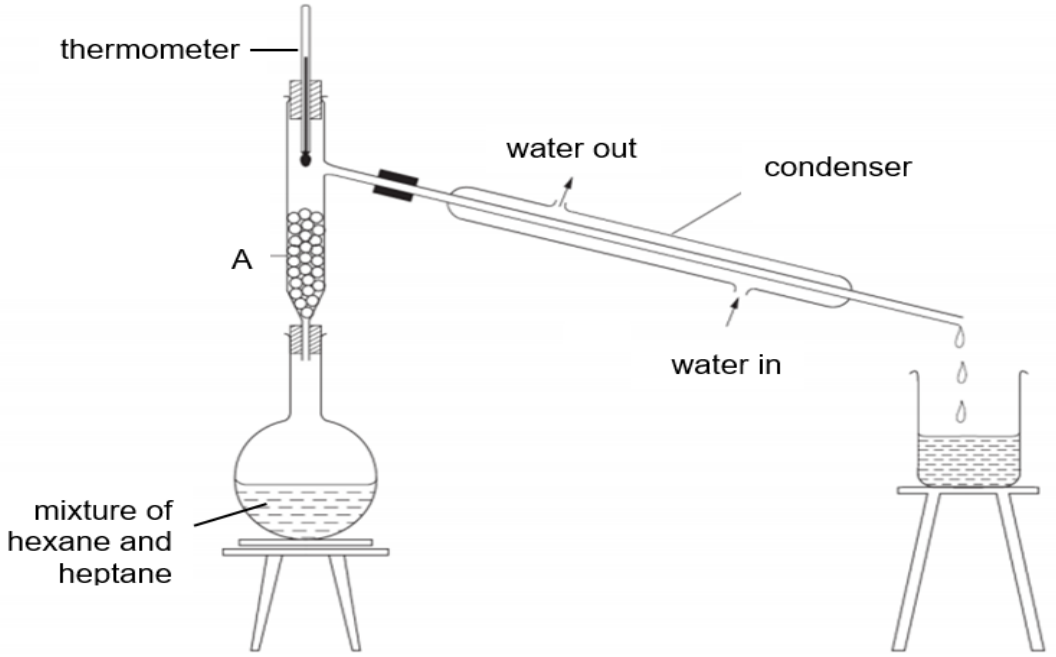


Fig. 2.1

(a) Describe the role of apparatus A. [1]

……

……

(b) Identify the distillate first collected. [1]

……

(c) Describe the changes in the arrangement and movement of particles in hexane when it is heated from 25 ºC to 80 ºC. [2]

arrangement :

……

……

movement :

……

……

3 The atomic radius is a measure of the size of an atom. The ionic radius is a measure of the size of an ion.

The table below shows the information on the atomic and ionic radii of Period 3 elements. Silicon is excluded as it does not form ions.

atom	Na	Mg	Al		P	S	Cl
atomic radius/ nm	0.191	0.160	0.130		0.110	0.102	0.099
electronic structure	2, 8, 1	2, 8, 2	2, 8, 3		2, 8, 5	2, 8, 6	2, 8, 7

ion	Na^+	Mg^{2+}	Al^{3+}		P^{3-}	S^{2-}	Cl^-
ionic radius/ nm	0.102	0.072	0.054		0.212	0.184	0.181
electronic structure							

(a) Complete the table to show the electronic structure of each ion. [2]

(b) **(i)** State one difference between the atomic radii of metals and non-metals. [1]

……

……

(ii) State one difference between the ionic radii of metal ions and non-metal ions. [1]

……

……

(iii) Suggest an explanation for the difference in **(b)(ii)**. [1]

……

……

(c) Argon is also found in Period 3 of the Periodic Table. Explain why there is no value for the ionic radius of argon. [1]

……

……

4 Fig. 4.1 describes some of the substances that result from chemical reactions with solution **R**.

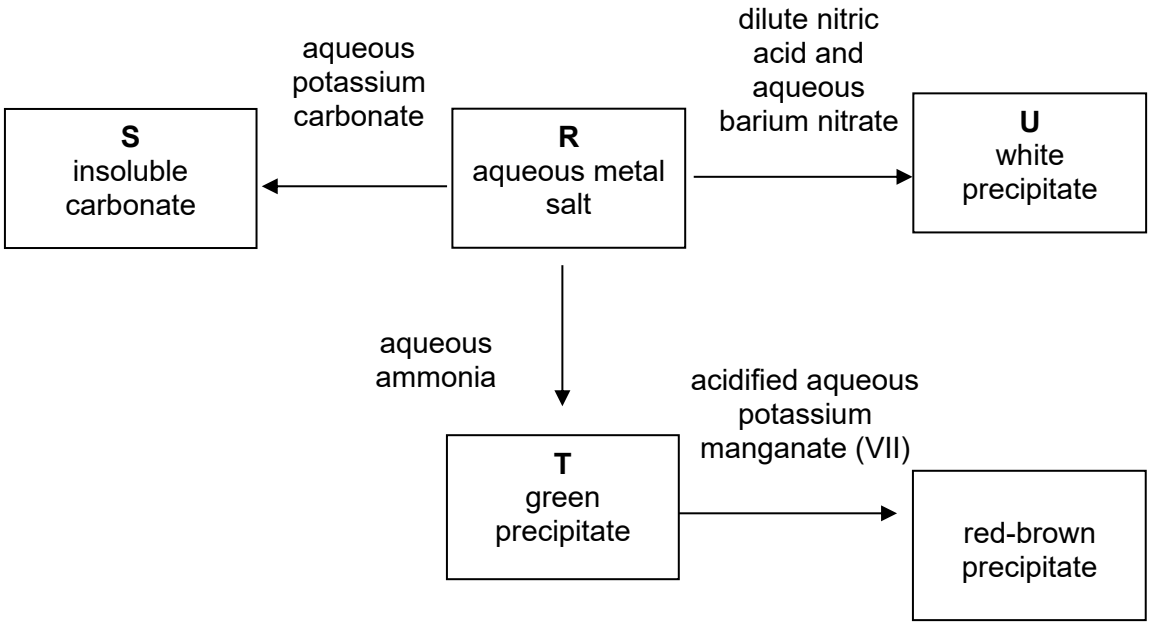


Fig. 4.1

(a) Identify **R, S, T** and **U**. [4]

R …….

S ……..

T …….

U ……..

(b) Write an ionic equation, including state symbols, for the reaction between **R** and aqueous potassium carbonate. [2]

……...

(c) Describe the colour change of acidified potassium manganate (VII) when it was added to **T**. [1]

……...

……...

5 Molten iron may be extracted by reacting iron(III) oxide with aluminium. During the extraction, a large amount of heat is produced. This process is known as the thermite reaction.

The production of molten iron in the thermite reaction is shown in the equation below:

$$Fe_2O_3\ (s) + 2Al\ (s) \rightarrow Al_2O_3\ (s) + 2Fe\ (l)$$

(a) **(i)** Complete the table to show the oxidation states of aluminium and iron before and after the reaction takes place. [2]

element	oxidation state before reaction	oxidation state after reaction
aluminium		
iron		

(ii) Using the information from the table, explain why thermite reaction is a redox reaction. [2]

……

……

……

(b) State, with a reason, the type of energy change that occurs during the extraction of iron in the thermite reaction. [2]

type of energy change: …..……..

reason:

……..……

……..……..

(c) Calculate the mass of aluminium needed to produce 1000 g of molten iron. [2]

mass : …… g

6 Fluorine, chlorine and bromine are found in group 17 of the Periodic Table.

(a) State one physical property trend of group 17 elements. [1]

……..……

……..……

(b) Fig. 6.1 shows the experiment when a sample of fluorine gas is passed over potassium iodide powder under strong heat.

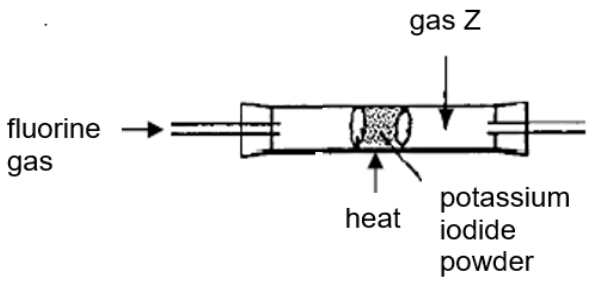


Fig. 6.1

(i) Identify gas Z. [1]

gas Z …….....

(ii) Explain the chemistry involved when fluorine gas is passed over potassium iodide powder under strong heat. [1]

……

……

……

……..

7 **(a)** Sodium burns in air to form a white solid of sodium oxide.

(i) Draw a 'dot-and-cross' diagram to show the arrangement of all electrons in sodium oxide. [2]

(ii) Explain, in terms of electrons, how sodium reacts with oxygen. [1]

……

……

(b) Nitrogen trifluoride, NF_3, is a compound used in the manufacture of LCD displays and other microelectronics.

(i) Draw a 'dot-and-cross' diagram to show the arrangement of valence electrons in a molecule of nitrogen trifluoride. [2]

(ii) With reference to structure and bonding, explain why nitrogen trifluoride exists in the gaseous state at room temperature. [2]

……

……

……

……

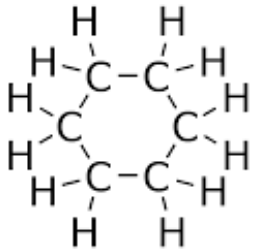
(iii) Nitrogen trifluoride is a greenhouse gas. Describe one potential impact of increased levels of greenhouse gases in our atmosphere. [1]

……

……

……

8 Cyclohexane is a colourless liquid. The structure of cyclohexane is shown below.



(a) Write a balanced chemical equation for the complete combustion of cyclohexane. [1]

……

(b) Cyclohexane reacts with chlorine in the presence of sunlight.

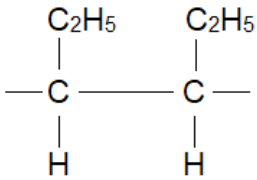
(i) Name the type of reaction. [1]

……

(ii) Give the chemical formula of the organic product of this reaction. [1]

……

(c) Compound **X** has the same molecular formula as cyclohexane. Compound **X** can be made to form a polymer **Y**. The repeat unit of **Y** is shown below.



(i) Draw the structural formula of compound **X**. [1]

(ii) Compound **X** reacts with aqueous bromine to give compound **Z**. [1]
What is the molecular formula of compound **Z**?

……

9 Vodka is an alcoholic drink which is made by a two-step process.

Step 1	Fermenting cereal grains or potatoes in water.
Step 2	Concentrating the ethanol content from an alcohol solution.

(a) **(i)** If the main sugar content present in the fermentation process is glucose, $C_6H_{12}O_6$, write down the balanced chemical equation for the fermentation process. [2]

……

(ii) Explain whether the rate of fermentation process can be increased by placing cereal grains in water at 80 ºC. [1]

……

……

(iii) What is the name of the physical separation method used in the second step to concentrate the ethanol content from an alcohol solution? [1]

……

(iv) If the ethanol obtained at the end of the two-step process is not bottled fast enough and is left to stand in air for a while, it will turn sour. Draw the **full** structural formula of the molecule responsible for this sour taste. [1]

(b) Quality control can be done by taking samples during each of the steps to measure for alcohol content or impurities. Name the pieces of apparatus most suitable to complete the following laboratory actions:

(i) measure exactly 6.35 cm^3 of acid into a beaker. [1]

……

(ii) add 25 cm^3 of alcohol solution to each of several beakers quickly. [1]

……

(iii) collect and measure the volume of carbon dioxide gas. [1]

……

(c) The alcohols are a homologous series of organic compounds having the same functional group. State two other general characteristics of alcohols in the same homologous series. [2]

……

……

……

……

Section B

Answer **one** question.

10 Magnesium ribbon reacts with dilute sulfuric acid in the apparatus shown in Fig.10.1.
A gas is produced and collected in the gas syringe.

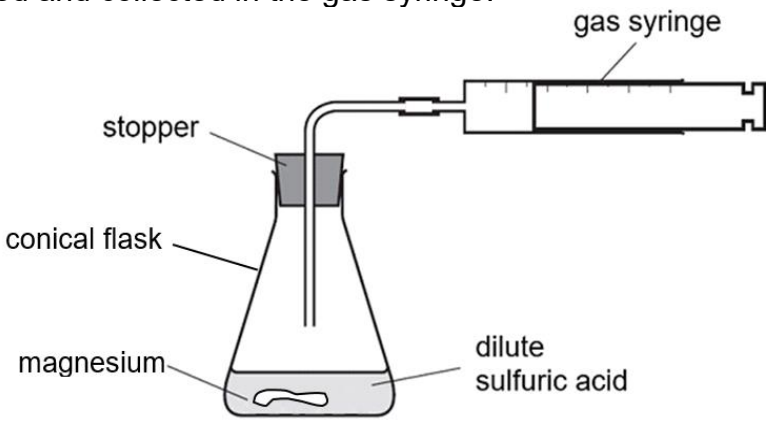


Fig. 10.1

(a) Write a chemical equation for the reaction between magnesium and sulfuric acid. [1]

……

(b) Describe a test to confirm the identity of the gas produced. [2]

……

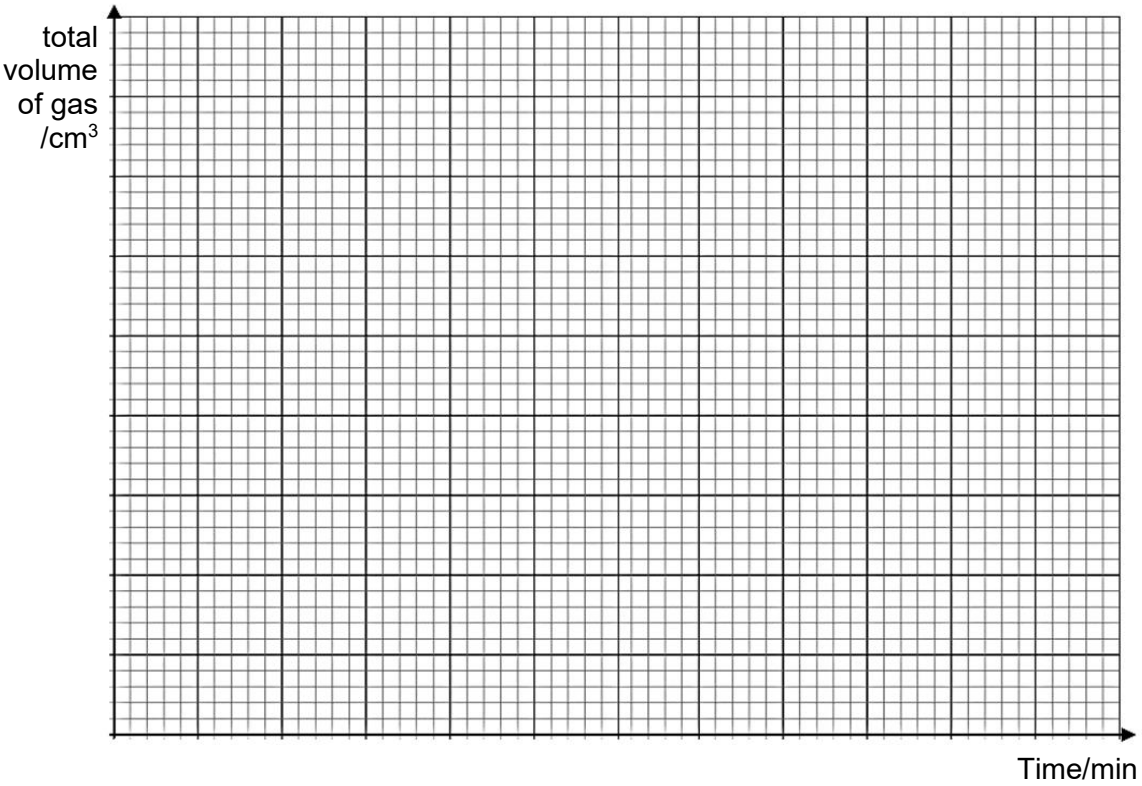
……

(c) A student measured the total volume of gas produced over 6 minutes.
Table 10.2 shows the results obtained.

time / min	total volume of gas / cm^3
0	0
1	60
2	80
3	95
4	98
5	100
6	100

Table 10.2

(i) Plot these points on the grid below and draw a best fit curve. [2]



(ii) Explain why there was no increase in the volume of gas produced after 5 minutes. [1]

……

……

(iii) Magnesium ribbon is replaced by zinc ribbon. Explain whether the time taken to collect 10 cm^3 of gas will be shorter or longer. [1]

……

……

(iv) Another experiment was carried out using a heated magnesium ribbon. Sketch a possible graph, for this experiment, on the above grid. Label the graph with **'2'**. [1]

(v) Using collision theory of reacting particles to explain the rate of the reaction in experiment 2. [2]

……

……

……

11 Most metals exist in the form of ores. An ore is a compound of the metal mixed with large amounts of earth and rock. The position of a metal in the reactivity series affects the ease of extraction of the metal from its ore.

Potassium, magnesium and iron are found in the reactivity series.

(a) State the methods of extraction for potassium and iron. [2]

potassium ……

iron ……..

(b) Name one metal that occurs freely in nature as an uncombined metal. [1]

……..……

(c) Potassium plays a key role of increasing crop yields and overall quality of crops. Fig. 11.1 shows how the rate of uptake of potassium ions vary with soil pH.

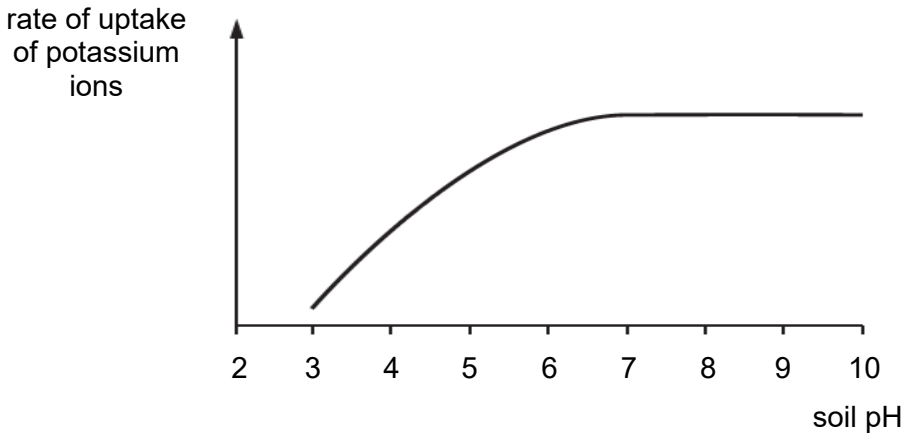


Fig. 11.1

(i) Describe how the rate of uptake of potassium ions changes with soil pH. [1]

……..……

……..

(ii) Explain why adding excess calcium hydroxide into the soil is not useful for improving the quality of crops. [2]

……

……

……

(d) Many metal ores contain carbonates of a metal. The amount of carbonate can be determined by reacting the ore with an acid. [4]

You are provided with two metal ores **A** and **B**. Both contain copper(II) carbonate.

Describe a laboratory investigation that can be used to decide which metal ore, **A** or **B**, contains more copper(II) carbonate. Include all the measurements you would make.

……

……

……

……

……

……

……

……

……

Colours of Some Common Metal Hydroxides

aluminium hydroxide	white
calcium hydroxide	white
copper (II) hydroxide	light blue
iron (II) hydroxide	green
iron (III) hydroxide	red-brown
zinc hydroxide	white

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)

2025 4E5N Science Chemistry Prelim Paper Answers

Paper 1

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
B	C	A	B	D	C	A	D	C	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
D	B	A	C	B	C	C	D	C	A

Paper 3

1	(a)	$ZnCl_2$	[1] each
	(b)	Al_2O_3	
	(c)	$CuCO_3$	
	(d)	$(NH_4)_2SO_4$	

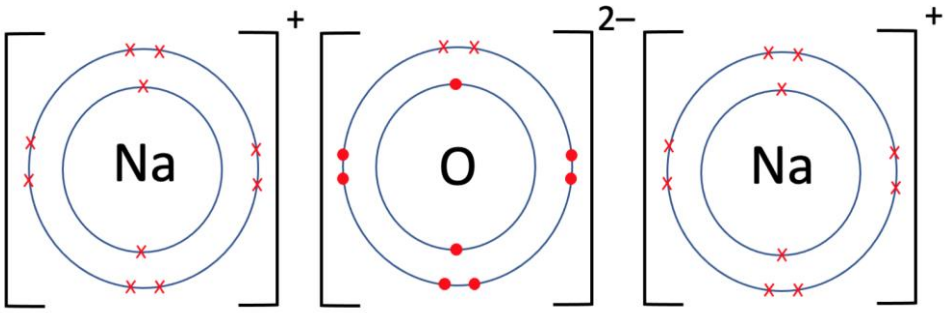
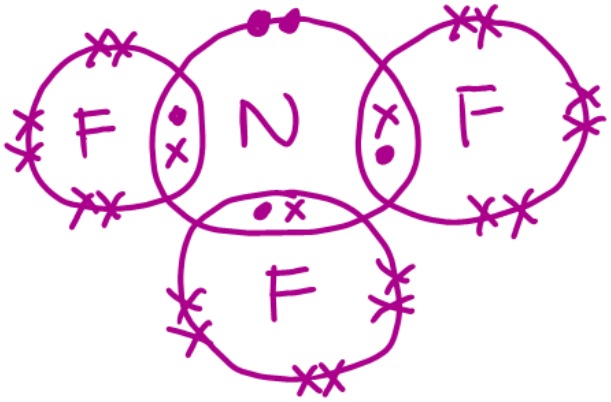
2	(a)	To provide **cooling surface** for cooling and **condensing the vapour** of liquid back into distillation flask.	[1]
	(b)	hexane	[1]
	(c)	Arrangement: Changes from **closely packed** in a **disorderly** arrangement to **far apart** in **random** arrangement Movement: Changes from **rolling and sliding past** one another to moving **randomly at high speeds**	[1] [1]

3	(a)	Na^+, Mg^{2+}, Al^{3+} : 2,8 P^{3-}, S^{2-}, Cl^- : 2,8,8 **Every 3 correct: [1]**		[2]
	(b)	(i)	Atomic radii of non-metal atoms are smaller than metal atoms.	[1]
		(ii)	Ionic radii of metal ions are smaller than non-metal ions.	[1]
		(iii)	Metal ions have less electron shells than non-metal ions.	[1]
	(c)	Argon has a **fully-filled valence** shell of electrons / stable octet structure so it does not need to **lose or gain electrons** to form ion.		[1]

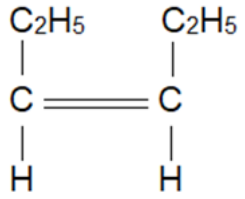
4	(a)	R : iron(II) sulfate / $FeSO_4$ S : iron(II) carbonate / $FeCO_3$ T : iron(II) hydroxide / $Fe(OH)_2$ U barium sulfate / $BaSO_4$	[4]
	(b)	$Fe^{2+}(aq) + CO_3^{2-}(aq) \rightarrow FeCO_3(s)$ 1 mark for correct equation 0.5 mark for correctly balanced 0.5 mark for correct state symbols	[2]
	(c)	**Purple** acidified potassium manganate(VII) turns **colourless.**	[1]

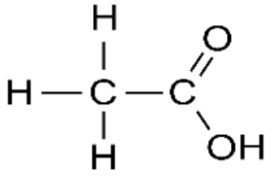
5	(a)	(i)	<table><tr><td>element</td><td>oxidation state before reaction</td><td>oxidation state after reaction</td></tr><tr><td>aluminium</td><td>**0**</td><td>**+3**</td></tr><tr><td>iron</td><td>**+3**</td><td>**0**</td></tr></table>		[1] for every 2 correct
		(ii)	**Al is oxidised** when the oxidation state of Al is increases from 0 in Al to +3 in Al_2O_3. [1] **Fe_2O_3 is reduced** when the oxidation state of Fe decreases from +3 in Fe_2O_3 to 0 in Fe. [1]		[2]
	(b)	Exothermic [1] A lot of heat is released.[1]			[2]
	(c)	No. of moles of Fe = 1000/6 = 17.857 Mole ratio Fe : Al 1 : 1 Mass of Al 17.857 x 27 = 482 g (3sf)			[1] [1]

6	(a)	Melting and boiling point increase down the group. / Colour intensity increases down the group. / Density increases down the group.		[1]
	(b)	(i)	Iodine gas/ I_2	[1]
		(ii)	Fluorine is **more reactive** than iodine so fluorine displaces iodine **from potassium iodide**, producing potassium fluoride and iodine gas.	[1]

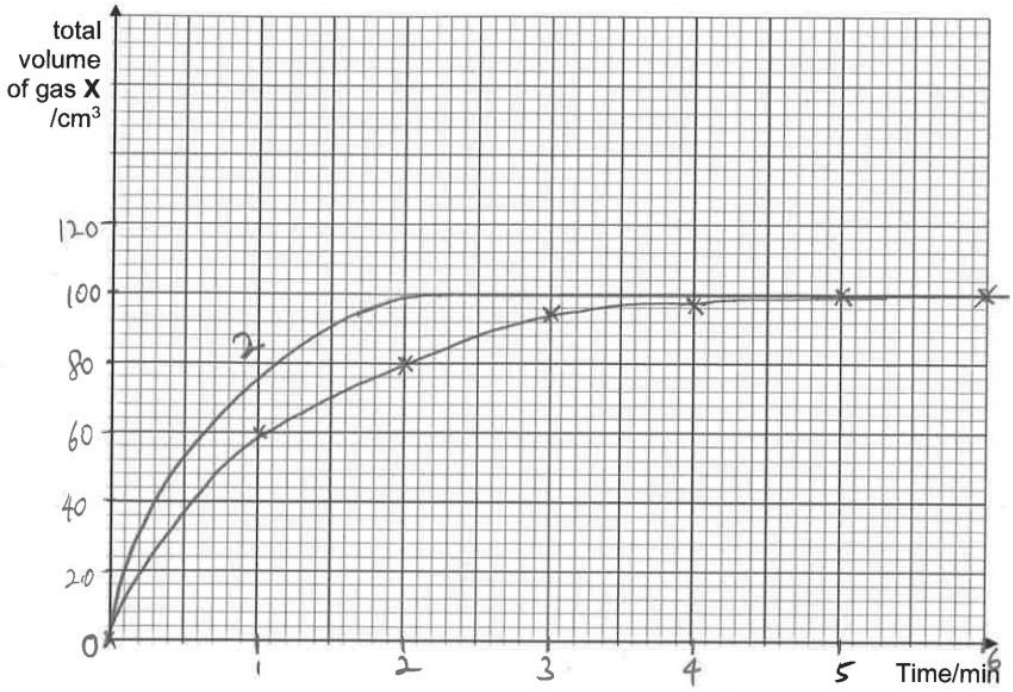
7	(a)	(i)	 1m for cation and 1m for anion. [if only valence electrons shown, 1 mark]	[2]
		(ii)	**One** oxygen **atom gains 2 electrons** from **two** sodium **atoms** [0.5] in order to achieve a **fully-filled valence** shell/ stable electronic configuration of noble gas.[0.5] **Two** sodium **atom each lose 1 electron** to **one** oxygen **atom** in order to achieve a **fully-filled valence** shell/ stable electronic configuration of noble gas.[0.5]	[1]
	(b)	(i)	 [1 mark for correct number of bonding electrons ; 1 mark for correct number of non-bonding electrons]	[2]
		(ii)	NF_3 has a **<u>low boiling point</u>** as it has **<u>a simple molecular structure</u>** [1]. **<u>Small amount of energy</u>** <u>is needed to overcome the</u> **<u>weak intermolecular forces</u>** <u>between molecules [1]</u> during boiling, hence it is a gas at room temperature.	[2]
		(iii)	Increased levels of greenhouse gases trap heat, leading to global warming and climate change causing: • Decrease in crop yield due to droughts • Melting of ice caps leading to flooding which destroys habitats • Increase in heat-related illnesses due to higher temperatures	[1]

			• Death and destruction of property due to increase in frequency and intensity of typhoons / tornadoes [Accept any answers – 1 mark]	

8	(a)		$C_6H_{12} + 9O_2 \rightarrow 6CO_2 + 6H_2O$ [0.5] for correct formula [0.5] for correct balancing	[1]
	(b)	(i)	Substitution	[1]
		(ii)	$C_6H_{11}Cl$	[1]
	(c)	(i)		[1]
		(ii)	$C_6H_{12}Br_2$	[1]

9	(a)	(i)	$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$	[1]
		(ii)	The enzyme in yeast will be killed (denatured) by heat and fermentation will stop.	[1]
		(iii)	fractional distillation	[1]
		(iv)		[1]
	(b)	(i)	burette	[1]
		(ii)	measuring cylinder	[1]
		(iii)	gas syringe	[1]
	(c)		The alcohols can be represented by the **same general formula**, $C_nH_{2n+1}OH$. / **Successive** alcohols will differ by a CH_2 unit. / **Physical** properties of alcohols show a **gradual** change as the molecular mass increases [Exhibit similar chemical reaction – Rejected]	[2]

10	(a)	Mg $H_2SO_4 \rightarrow MgSO_4 + H_2$	[1]
	(b)	Place a lighted splint near the mouth of test tube. [1] Hydrogen gas extinguishes with a 'pop' sound. [1]	[2]

	(c)	(i) (iv)	 [1] for all points plotted correctly; [1] smooth curve drawn For **(c)(iv),** [1] steeper gradient; same height	[2] [1]
		(ii)	The **limiting reactant** has been completely/fully reacted.	[1]
		(iii)	Time taken for zinc is longer as zinc is less reactive than magnesium so slower rate of reaction.	[1]
		(v)	In experiment 2, the reacting particles gain more **kinetic energy**. They move faster and **collide more**. [0.5] There is a **higher proportion** of reacting particles having **sufficient (minimum) energy** to overcome activation energy barrier. [0.5] The **frequency** of effective collisions between reacting particles increases[0.5], thus **speed** of reaction increases. [0.5]	[2]

11	(a)	(i)	potassium : **Electrolysis** of molten ore iron: **Reduction** using **carbon/ carbon monoxide**	[1] [1]
		(ii)	silver/gold/platinum	[1]
	(b)	(i)	The rate of uptake of potassium ions increases as the soil pH increase from 2 to 7 and remains constant after pH 7.	[1]
		(ii)	Excess calcium hydroxide increases the pH of the soil above 7 [1] but the rate of update of potassium ions does not increase after pH 7.[1]	[2]
	(c)	Add the **same mass** of ore A and B in the **same volume and concentration** of nitric acid, separately in each conical flask. [1] Measure the **volume** of carbon dioxide gas collected [1] until the volume of gas collected **remains constant**. [1] The metal ore that produces a greater volume of carbon dioxide gas contains more copper(II) carbonate. [1]		[4]