NAME: NO: CLASS:

ADMIRALTY SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2025

SUBJECT	:	Science (Chemistry)
CODE/PAPER	:	5086/3, 5088/3
LEVEL/STREAM	:	Secondary 4 Express / Secondary 5 Normal (Academic)
DATE	:	22 August 2025
TIME	:	1100h – 1215h
DURATION	:	1 hour 15 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, glue or correction fluid.
The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

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

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

A copy of the Data Sheet is printed on page 15.
A copy of the Periodic Table is printed on page 16.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	/ 55
Section B	/ 10
Total	/ 65

DO NOT TURN OVER THIS PAPER UNTIL YOU ARE TOLD TO DO SO.

This question paper consists of **16** printed pages including this cover page.

Section A
Answer all questions.

1 **(a)** Table 1.1 shows some information about the first four elements in Group 1.

Group 1 elements		
element	atomic number	melting point / °C
lithium	3	180.5
sodium	11	98.0
potassium	19	63.5
rubidium	37	39.5

Table 1.1

(i) With reference to the electronic structures of the elements, explain why lithium and sodium are in the same group.

.....

..... [2]

(ii) Explain why Group 1 metals are called alkali metals.

..... [1]

(iii) Write a balanced chemical equation for the reaction between rubidium metal and cold water.

..... [2]

(iv) Rubidium exists as two isotopes $^{85}_{37}Rb$ and $^{87}_{37}Rb$.

Explain, with reference to sub-atomic particles, why different atoms of rubidium have different masses.

.....

.....

..... [2]

(b) The melting point of a metal is dependent on the strength of forces of attraction between metal ions and the valence electrons. Using your knowledge of electronic structures, describe and explain the trend in the melting points of Group 1 metals down the group.

.....

.....

.....

..... [3]

2 Carbon dioxide is a greenhouse gas that impacts global warming.

(a) Explain how photosynthesis and respiration help to regulate the amount of carbon dioxide in the atmosphere.

.....

..... [2]

(b) **(i)** Since 1st July 2017, the National Environmental Agency (NEA), made it mandatory to supply cleaner petrol with sulfur content lower than 0.001% to motor vehicles.

Explain how sulfur dioxide is formed in power plants.

..... [1]

(ii) Suggest a reason why NEA is working towards lowering sulfur dioxide emissions.

.....

.....

..... [2]

(c) Shell refineries implemented the Shell Claus Off-gas Treating (SCOT) process to minimise the SO_2 emissions from its refineries. The process operates within the temperature range of 200°C to 315°C.

The chemical reactions in the SCOT process are:

$$SO_2 + 3H_2 \rightarrow H_2S + 2H_2O$$

$$2H_2S + O_2 \rightarrow 2S + 2H_2O$$

(i) Draw a 'dot and cross' diagram to show the bonding in hydrogen sulfide, H_2S. Show only the valence electrons.

[2]

(ii) With reference to its structure and bonding, predict if H_2S can conduct electricity.

.....

.....

..... [2]

3 When liquid hydrogen peroxide (H_2O_2) is mixed with liquid hydrazine (N_2H_4), a fast exothermic reaction takes place, which can propel a rocket. Nitrogen gas and steam are produced in this reaction.

$$2H_2O_2 + N_2H_4 \rightarrow N_2 + 4H_2O$$

(a) Explain what is meant by an *exothermic* reaction.

.....

..... [1]

(b) If the rocket is loaded with 680 kg of hydrogen peroxide, calculate the volume of gaseous products formed.

volume = ... dm^3 [3]

(c) Using your knowledge on kinetic particle theory, suggest why this reaction is suitable for use to propel the rocket engines.

.....

.....

..... [1]

4 Small pieces of different metals were added to solutions of metal ions in water. The results are summarized in Table 4.1.

Solution	Metal added			
	Copper	Iron	Nickel	Zinc
Copper(II) chloride		✓	✓	✓
Iron(II) chloride	x		x	✓
Nickel(II) chloride	x	✓		✓
Zinc chloride	x	x	x	

✓ = reaction observed
x = no reaction observed

Table 4.1

(a) Arrange the metals in order of increasing reactivity.

..... [1]

(b) State two observations when zinc was added to copper(II) chloride solution.

.....

..... [2]

(c) **(i)** The displacement of nickel by excess iron powder is represented by the chemical equation shown below.

$$Fe\,(s) + NiCl_2\,(aq) \rightarrow FeCl_2\,(aq) + Ni(s)$$

Suggest one method to increase the rate of displacement of nickel from the reaction.

..... [1]

(ii) Calculate the mass of nickel formed when 150 cm^3 of 1.5 mol/dm^3 aqueous nickel(II) chloride reacted with excess iron powder.

Mass = ... g [2]

5 (a) Ethanol, C_2H_5OH, is used in Brazil as a liquid fuel instead of petrol. Ethanol is manufactured by fermentation of cane sugar. Cane sugar is raw sugar which is extracted from sugarcane.

Describe how factories obtain pure ethanol from the fermentation process of cane sugar. Support your answer with relevant equations and the conditions required.

.....

.....

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.....

.....

..... [4]

(b) Fig 5.1 shows two types of alcohol.

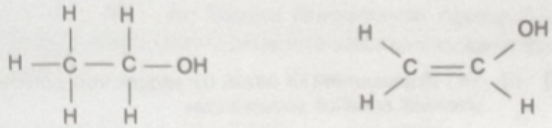

Fig. 5.1

Describe a test to distinguish between the two alcohols shown in Fig 5.1.

.....

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.....

.....

..... [3]

6 Fig 6.1 shows some properties and reactions involving substances **A** to **F**.

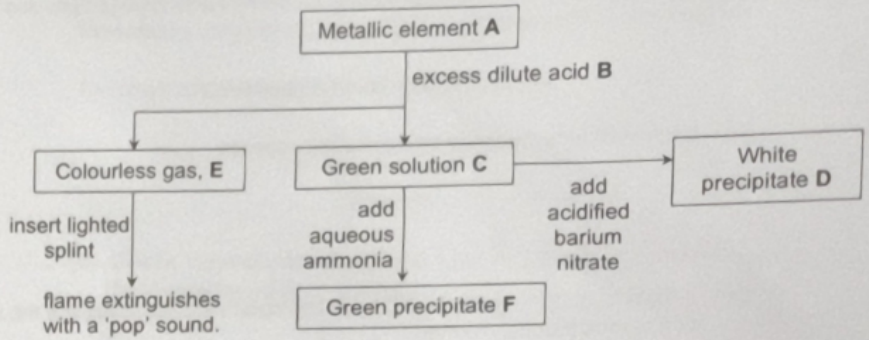


Fig. 6.1

(a) Identify substances **A**, **B**, **C**, **D**, **E** and **F**.

A: .....

B: .....

C: .....

D: .....

E: .....

F: ..... [6]

(b) Write a balanced chemical equation for any one of the reactions shown in Fig. 6.1.

..... [2]

7 A student investigated the reaction between excess powdered potassium carbonate and 150 cm^3 of 1.5 mol/dm^3 dilute hydrochloric acid at 30°C.

$$K_2CO_3 + 2HCl \rightarrow 2KCl + CO_2 + H_2O$$

Fig 7.1 shows the apparatus the student used.

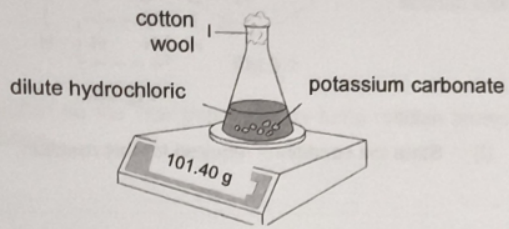


Fig 7.1

The mass of the flask and its contents were measured regularly every minute and the readings were recorded in Table 7.2.

time/min	balance reading/g
0	101.40
1	101.38
2	101.35
3	101.32
4	101.28
5	101.24
6	101.21
7	101.19
8	101.18
9	101.17
10	101.17

Table 7.2

(a) Describe and explain the changes in the electronic balance reading during the experiment.

.....

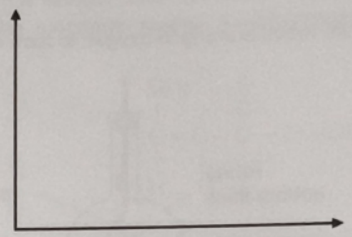
.....

.....

.....

..... [3]

(b) Sketch the graph that you would obtain from the data collected. Label both axes.



[2]

(c) In another experiment, excess lumps of potassium carbonate were reacted with 150 cm^3 of 1.5 mol/dm^3 of dilute hydrochloric acid.

On the same axes in **(b)**, sketch the graph you would expect to obtain. [1]
Label your graph as '**Graph II**'.

(d) Explain, in terms of collision theory, how the rate of reaction will differ if the temperature is increased to 60°C.

.....

.....

.....

..... [2]

(e) The experimental setup is to be reassembled to measure the rate that products are formed.

Draw a labelled diagram of the apparatus required to measure the volume of gas produced in the reaction.

[2]

Section B

Answer any one question from this section.

8 Fig 8.1 shows sodium metal burning in oxygen to form a white solid, sodium oxide.

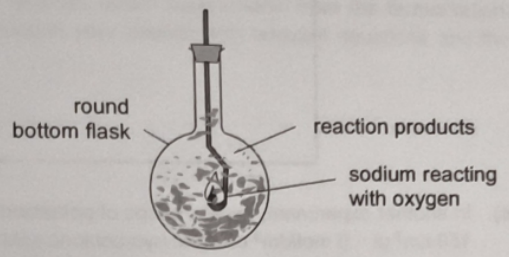


Fig 8.1

(a) **(i)** Write a balanced chemical equation for the reaction.

..... [2]

(ii) Explain, in terms of oxidation states, why the reaction in **(a)(i)** is a redox reaction.

.....

.....

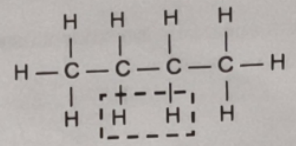
.....

..... [3]

(iii) Draw a 'dot and cross' diagram to show the arrangement of all the outershell electrons in sodium oxide.

[2]

(b) Alkene **X** has the molecular formula C_4H_8. This alkene reacts with hydrogen to form compound **Y** with the structural formula shown in Fig 8.2 below.
The hydrogen atoms within the dotted box were newly introduced.



Compound **Y**

Fig 8.2

(i) State the conditions required for this reaction.

..... [1]

(ii) State one use of this reaction in industrial applications.

..... [1]

(iii) Draw the structural formula of alkene **X**, C_4H_8.

[1]

9 (a) Fig 9.1 shows a jet of chlorine gas aimed at a filter paper soaked in a solution of sodium bromide.

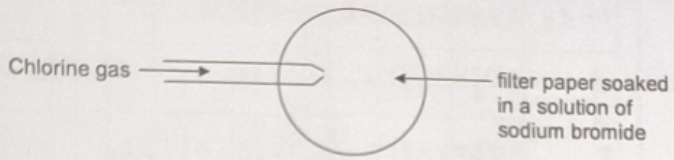


Fig 9.1

(i) The solution on the filter paper quickly turns reddish brown. Explain this observation.

.....

.....

..... [2]

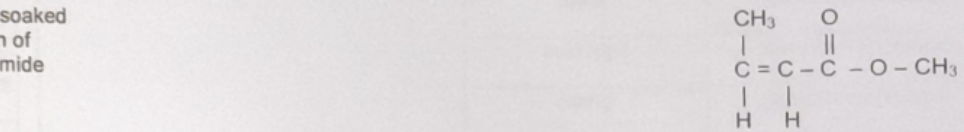
(ii) Construct the ionic equation for the reaction of chlorine gas with aqueous bromide ions.

..... [2]

(iii) The experiment was repeated with a few drops of aqueous bromine in sodium chloride solution. Predict the observation.

..... [1]

(b) Acrylic is a synthetic polymer. It is often used as an alternative to glass as it is lighter, does not shatter and transmits more light. It can be made by polymerizing the monomer methyl 2-methylpropenoate, $C_5O_2H_8$, as shown below.



methyl 2-methylpropenoate

(i) Monomer methyl 2-methylpropenoate, $C_5O_2H_8$, has a melting point of -45°C and a boiling point of 101°C. With reference to its structure and bonding, explain why this is so.

.....

.....

..... [2]

(ii) A student commented that the monomer methyl 2-methylpropenoate is a '*saturated hydrocarbon*'.

Do you agree with the statement? Explain your answer.

.....

.....

..... [2]

(iii) Draw the structural formula of the polymer formed, showing two repeating units.

[1]

END OF PAPER

DATA SHEET

Colours of Some Common Metal Hydroxides

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

The Periodic Table of Elements

Key: proton (atomic) number / atomic symbol / name / relative atomic mass

Group

1	2	3	4	5	6	7	8	9	10	11	12	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											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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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}