OCR
Oxford Cambridge and RSA

Tuesday 11 June 2024 – Morning

GCSE (9–1) Chemistry A (Gateway Science)

J248/02 (Foundation Tier)

Time allowed: 1 hour 45 minutes

You must have:
- a ruler (cm/mm)
- the Data Sheet for GCSE (9–1) Chemistry A (inside this document)

You can use:
- a scientific or graphical calculator
- an HB pencil

F

* J 2 4 8 0 2 *

* 9 9 8 6 3 9 2 2 8 8 *

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined page at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **24** pages.

ADVICE
- Read each question carefully before you start your answer.

Section A

You should spend a **maximum** of **30 minutes** on this section.

Write your answer to each question in the box provided.

1 What is the test for oxygen gas?

A Burns with a lilac flame

B Burns with a squeaky pop

C Relights a glowing splint

D Turns limewater milky

Your answer ☐ **[1]**

2 A student adds sodium hydroxide solution to copper sulfate solution.

What is the colour of the precipitate made?

A Blue

B Green

C Orange-brown

D White

Your answer ☐ **[1]**

3 Which change would **decrease** the rate of a chemical reaction?

A Adding a catalyst

B Increasing the concentration of the solution

C Increasing the size of the solid pieces

D Increasing the temperature

Your answer ☐ **[1]**

4 What is the major source of oxides of nitrogen in the atmosphere?

A Combustion of impurities in coal

B High temperature reactions in car engines

C Incomplete combustion of fossil fuels

D Industrial processes such as metal extraction

Your answer ☐ **[1]**

5 How many different monomers (nucleotides) is DNA made from?

A 2

B 3

C 4

D 5

Your answer ☐ **[1]**

6 What is the functional group in an alcohol molecule?

A –C–H

B –C=C–

C –COOH

D –O–H

Your answer ☐ **[1]**

7 What is the balanced equation for the reaction of sodium with oxygen?

A $Na + O \rightarrow NaO$

B $Na + O_2 \rightarrow NaO_2$

C $4Na + O_2 \rightarrow 2Na_2O$

D $Na_2 + 2O \rightarrow 2NaO$

Your answer ☐ **[1]**

8 Which row describes the three halogens at room temperature?

	Chlorine	Bromine	Iodine
A	green gas	orange-brown gas	grey solid
B	green gas	orange-brown liquid	grey solid
C	green gas	orange-brown liquid	purple gas
D	green liquid	orange-brown liquid	grey solid

Your answer ☐ **[1]**

9 The table shows the results of the reactions between four metals and their metal oxides.

Key: ✓ = reaction ✗ = no reaction

	Metal W oxide	Metal X oxide	Metal Y oxide	Metal Z oxide
Metal W		✗	✗	✗
Metal X	✓		✓	✗
Metal Y	✓	✗		✗
Metal Z	✓	✓	✓	

What is the correct order of reactivity of the metals, from the most reactive to the least reactive?

A W, Y, X, Z

B W, Z, Y, X

C Z, X, Y, W

D Z, Y, X, W

Your answer ☐ **[1]**

10 Two chemicals react together over time to make a cloudy precipitate.

What is the best method for determining the rate of reaction?

A Measure the loss in mass using a balance.

B Use a gas syringe.

C Use a pH meter.

D Use the disappearing cross experiment.

Your answer ☐ **[1]**

11 Which polymer would be best for making a washing up bowl?

Polymer	Maximum useable temperature (°C)	Strength
A	38	high
B	85	low
C	110	high
D	160	low

Your answer ☐ **[1]**

12 4.8 dm^3 of air contains 0.12 dm^3 of water vapour.

What is the percentage of water vapour in the air?

A 0.3%

B 2.5%

C 12.0%

D 97.5%

Your answer ☐ **[1]**

13 Magnesium carbonate, $MgCO_3$, decomposes to make magnesium oxide, MgO.

Carbon dioxide is a waste product.

$MgCO_3 \rightarrow MgO + CO_2$

Relative formula mass (M_r): MgO = 40.3 CO_2 = 44.0

What is the atom economy of the reaction?

Use the equation: atom economy = $\frac{M_r \text{ of desired product}}{\text{total } M_r \text{ mass of all products}} \times 100$

A 47.8%

B 52.2%

C 91.6%

D 109.0%

Your answer ☐ **[1]**

14 Which substance is an **unsaturated** hydrocarbon?

A CH_4

B C_2H_6

C C_3H_6

D C_3H_8

Your answer ☐ **[1]**

15 What happens when liquid bromine, Br_2, boils?

A Covalent bonds break

B Electrostatic forces break

C Intermolecular forces break

D Ionic bonds break

Your answer ☐ **[1]**

Section B

16 This question is about compounds of carbon.

(a) The first member of the alkane homologous series is methane, CH_4.

State the name of the next alkane in the homologous series, C_2H_6.

..... **[1]**

(b) Complete the **balanced symbol** equation for the **complete** combustion of methane.

$$CH_4 + 2 \ldots\ldots\ldots \longrightarrow CO_2 + \ldots H_2O$$ **[2]**

(c) Carbon monoxide, CO, is made in the **incomplete** combustion of methane.

State why carbon monoxide is a problem.

..... **[1]**

(d) Methane is obtained from the fractional distillation of crude oil.

Complete the sentences to explain why crude oil is separated by fractional distillation.

Crude oil is separated by fractional distillation because the molecules have

different ....

Larger molecules have ..... intermolecular forces.

These intermolecular forces require more ..... to break.

[3]

(e) Fractional distillation produces a large amount of long chain molecules.

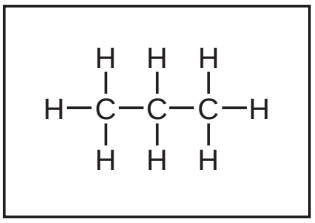
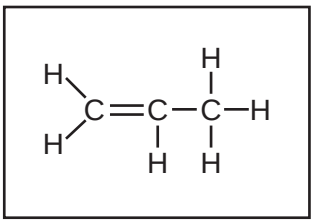
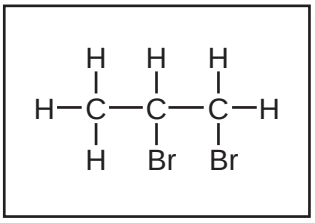
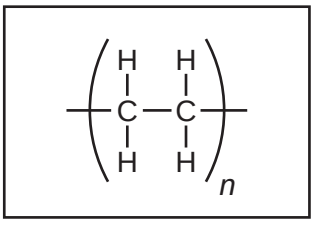
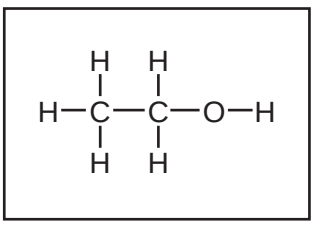
There is a high demand for short chain molecules.

Put a (ring) round the name of the process used to produce more short chain molecules.

combustion **cracking** **oxidation** **polymerisation**

[1]

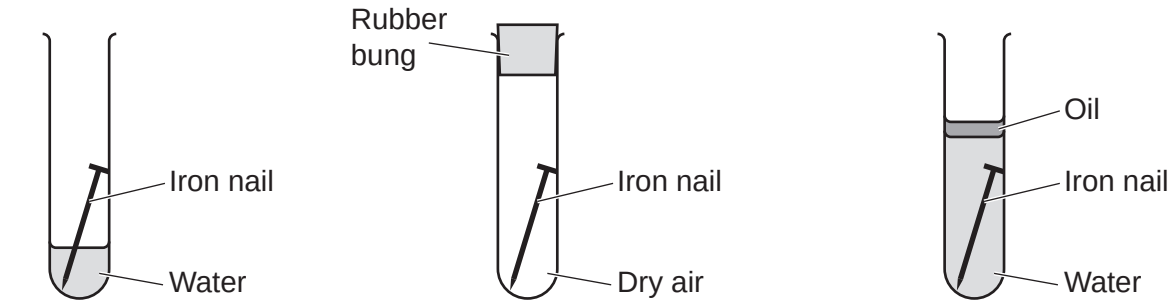
(f) Draw lines to connect each **description** with its correct **structural formula**.

Description	Structural Formula
Can be oxidised to a carboxylic acid	
Has the general formula C_nH_{2n+2}	
Decolourises bromine water	
Made in a polymerisation reaction	
	

[4]

17 A student sets up three test tubes to investigate the rusting of iron as shown in **Fig. 17.1**.

Fig. 17.1



The student measures the mass of each nail at the start and the end of the experiment.

Only the mass of the nail in test tube 1 increases.

(a) Explain why the iron nail in test tube 1 is the only nail that rusts.

.....

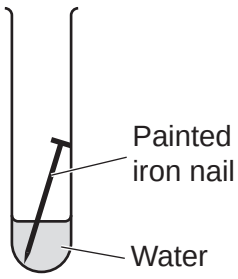
.....

.....

..... **[2]**

(b) The student sets up another test tube as shown in **Fig. 17.2**.

Fig. 17.2



The mass of this iron nail was unchanged after a week.

Explain why.

.....

.....

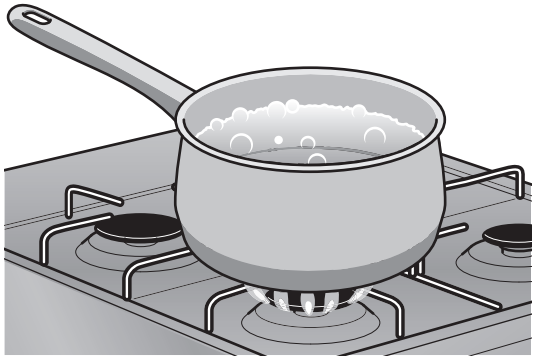
..... **[2]**

(c) **Table 17.1** shows some properties of three different materials.

Table 17.1

	Ceramic	**Metal**	**Polymer**
Melting point (°C)	2200	1083	204
Strength (MPa)	416	69	27
Relative thermal conductivity	18	388	0.21

(i) The diagram shows a pan of boiling water.



Which material would you choose to make the base of a pan?

Explain your choice using the information in **Table 17.1**.

Material .....

Explanation .....

.....

.....

[3]

(ii) Estimate how many times higher the melting point of the ceramic is compared to the polymer.

You will need to round the melting points to 1 significant figure.

Answer = ... **[1]**

(d) **Table 17.2** shows some information about recycling containers made from different materials.

Table 17.2

	Time powering a TV from the energy saved by recycling (hours)	**CO_2 saved by recycling each year (kg)**
Aluminium cans	4	294
Glass bottles	3	9
Plastic bottles	6	23

A student thinks that recycling aluminium cans is the most beneficial to the environment.

Explain why they are correct.

Use information from **Table 17.2**.

.....

.....

.....

..... **[2]**

18

(a) The sentences describe one possible theory for how the Earth's atmosphere evolved.

A The Earth cooled.

B Carbon cycle now keeps the composition of the atmosphere almost constant.

C Carbon dioxide from the air dissolved in oceans.

D Water vapour condensed to form oceans.

E Plants evolved and used photosynthesis to take in carbon dioxide and make oxygen.

F Volcanoes released water vapour and carbon dioxide.

Write the letters in the boxes to show the correct order of the sentences.

Two have been done for you.

F			**C**		

[3]

(b) Complete the table to show the gases in the Earth's atmosphere today.

Gas	Percentage in Earth's atmosphere (%)
.....	78
.....	21
Carbon dioxide / noble gases / water vapour	1

[2]

(c) Clean water is essential for life.

(i) State the name used for water that is safe to drink.

..... **[1]**

(ii) Explain why chlorine is added to water to make it safe to drink.

..... **[1]**

(iii) Describe the test for chlorine gas.

.....

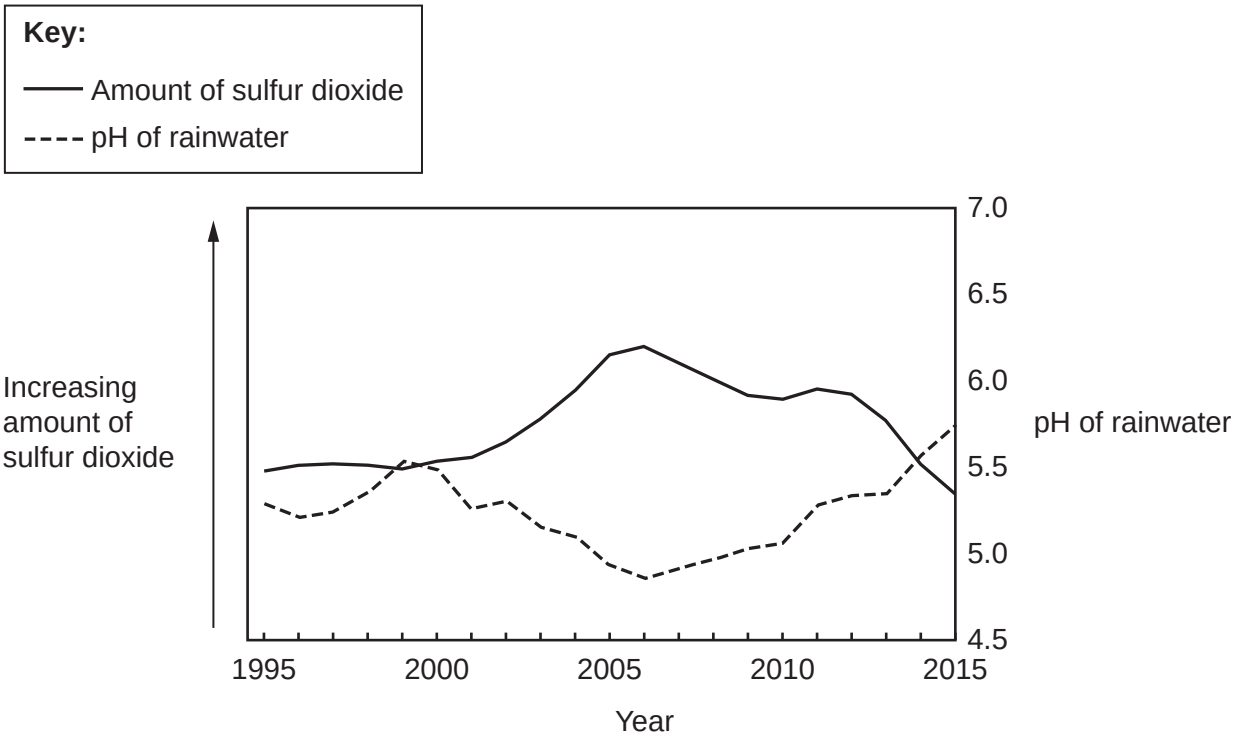
.....

..... **[2]**

(d) Sulfur dioxide is a pollutant in the atmosphere.

The graph shows how the amount of sulfur dioxide changed from 1995 to 2015.

The graph also shows how the pH of rainwater changed from 1995 to 2015.



Acid rain is an environmental problem.

(i) There is a link between the amount of sulfur dioxide in the atmosphere and the amount of acid rain.

Complete the table by correctly identifying which word finishes each sentence.

Put **one** tick (✓) in each row.

	Decreases	**Increases**	**Stays the same**
When the amount of sulfur dioxide increases the pH of rainwater...			
Rainwater is more acidic when the pH...			
When the rainwater is more acidic the amount of acid rain...			

[3]

(ii) State **one** problem caused by acid rain.

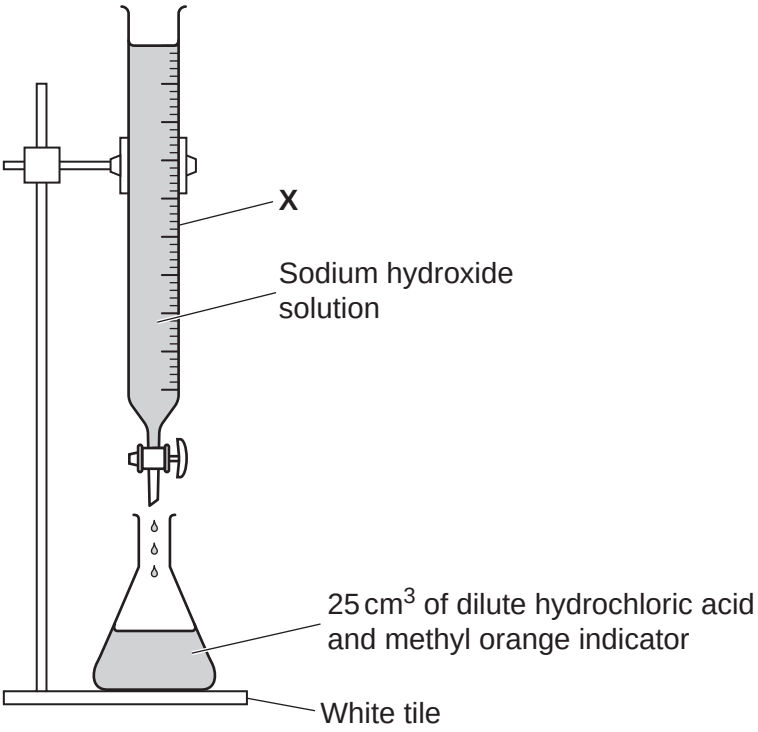
.....

..... **[1]**

19 A student investigates the neutralisation reaction between sodium hydroxide solution and dilute hydrochloric acid.

They do a titration experiment.

The diagram shows the apparatus they use.



(a) What is the name of the piece of equipment labelled **X**?

..... **[1]**

(b) The student places the conical flask on a white tile.

Explain why.

.....

..... **[1]**

(c) The student adds the alkali to the acid drop by drop near the endpoint of the titration.

Explain why.

.....

..... **[1]**

(d) The neutralisation reaction between sodium hydroxide solution, NaOH, and dilute hydrochloric acid, HC*l*, makes a salt and water.

Write the **balanced symbol** equation for the reaction.

..... **[2]**

(e) In another neutralisation reaction dilute sulfuric acid, H_2SO_4, reacts with potassium hydroxide solution, KOH.

$H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O$

Calculate the mass of potassium sulfate, K_2SO_4, that could be made from 6.54 g of dilute sulfuric acid, H_2SO_4.

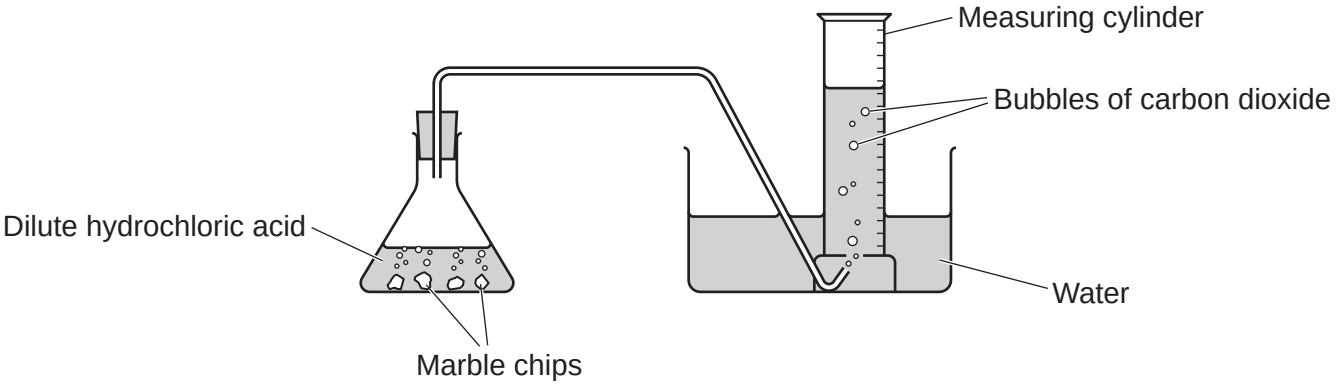
Give your answer to **3** significant figures.

Relative atomic mass (A_r): H = 1.0 K = 39.1 O = 16.0 S = 32.1

Mass of potassium sulfate = ... g **[4]**

20 A student investigates the reaction between marble chips and dilute hydrochloric acid.

The diagram shows their experiment.



The student measures the volume of carbon dioxide gas collected in the measuring cylinder every 30 seconds.

(a) Which other piece of equipment could the student use to measure the volume of carbon dioxide gas collected?

Tick (✓) **one** box.

Balance ☐

Beaker ☐

Gas syringe ☐

Pipette ☐

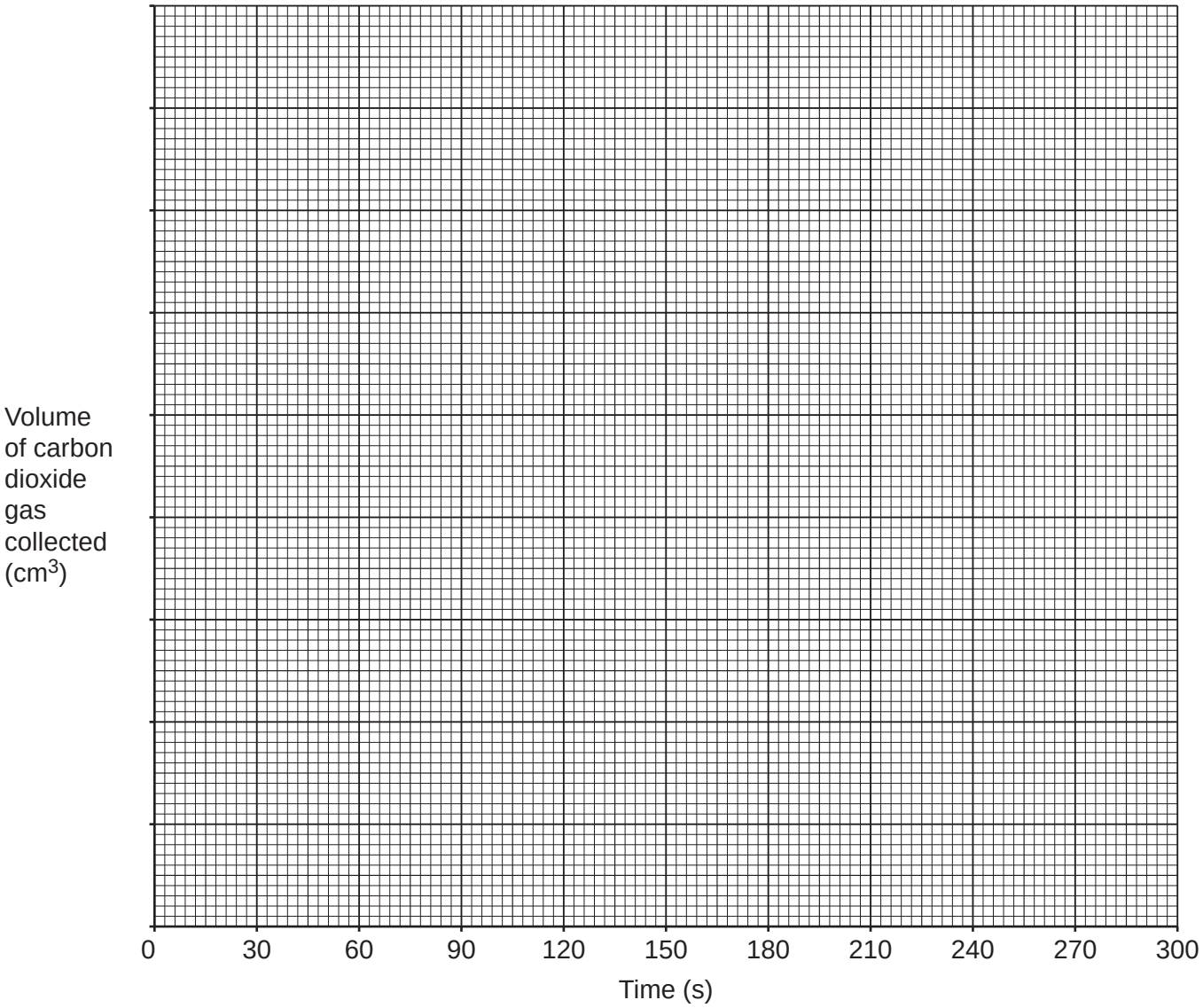
[1]

(b) The table shows the student's results.

Time (s)	**Volume of carbon dioxide gas collected (cm^3)**
0	0
30	30
60	46
90	56
120	65
150	72
180	76
210	79
240	80
270	80

(i) Plot the results from the table on the graph. **[3]**

(ii) Draw a curve of best fit. **[1]**



(iii) State the time when the reaction stops.

Time = ... s **[1]**

(iv) The student observes that there are still some marble chips in the conical flask when the reaction stops.

Explain why the reaction stops.

.....

..... **[1]**

(c)* Another student reacts dilute hydrochloric acid with magnesium.

The student does two experiments.

In each experiment they use the **same**
- concentration of dilute hydrochloric acid
- mass of magnesium.

The table shows their results.

	Experiment 1	**Experiment 2**
Magnesium	large pieces	small pieces
Temperature of dilute hydrochloric acid (°C)	20	42
Reaction time (s)	225	25

Describe and explain the difference in the rate of reaction between the two experiments.
Use the student's results and the reacting particle model.

State how the student's experiment could be improved.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[6]**

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21

(a) The table shows some properties of four Group 1 elements.

Element	Density (g/cm^3)	Melting Point (°C)	Boiling Point (°C)
Lithium	0.53	180	1342
Sodium	0.97	98	883
Potassium	0.86	63	759
Rubidium	1.53	39	688

(i) State **one** trend in the properties of the Group 1 elements shown in the table.

.....

..... **[1]**

(ii) Caesium is below rubidium in Group 1.

Predict the melting point of caesium using the information in the table.

Melting point of caesium = ... °C **[1]**

(b) The Group 1 elements all react with Group 7 elements to form ionic compounds.

(i) Explain why the Group 1 elements all react in the same way.

.....

..... **[1]**

(ii) The Group 1 elements become **more** reactive down the group.

Explain why.

.....

.....

.....

.....

..... **[3]**

(iii) Sodium reacts with bromine, Br_2, to make sodium bromide, NaBr.

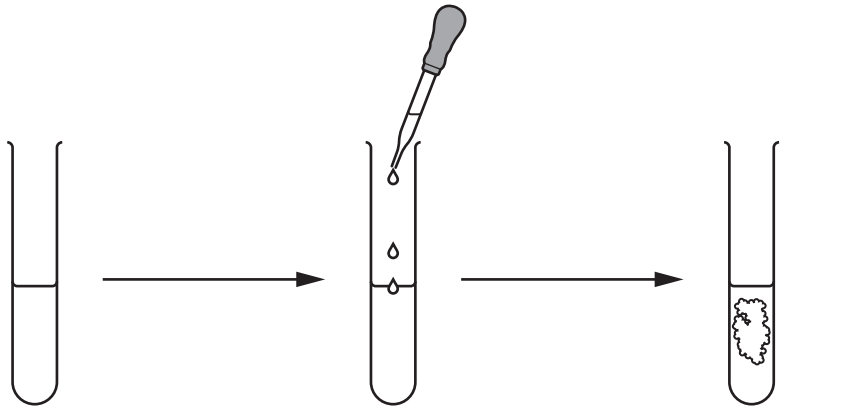
Write the **balanced symbol** equation for this reaction.

..... **[2]**

(c) Group 7 ions can be identified using silver nitrate solution.

A student tests a compound for chloride ions.

The diagram shows the student's experiment.



Solution of compound dissolved in dilute hydrochloric acid

Add silver nitrate solution

White precipitate formed

The student's experiment does **not** work to identify chloride ions.

Explain why.

.....

.....

..... **[2]**

22 Ammonia is made in the Haber process. This is the balanced symbol equation for this process.

$N_2 + 3H_2 \rightleftharpoons 2NH_3$

(a) The reversible reaction is carried out in a closed system.

(i) State how you can tell that this reaction is **reversible**.

..... **[1]**

(ii) What is a **closed system**?

.....

..... **[1]**

(iii) If **dynamic equilibrium** is reached, which of these statements are correct?

Tick (✓) **two** boxes.

Only ammonia, NH_3, is being made. ☐

The amounts of reactants and products are constant. ☐

The forward and backward reactions are happening at the same rate. ☐

The forward reaction is faster than the backward reaction. ☐

The reaction has finished. ☐

[2]

(b) The reaction in the Haber process can be reversed by altering the reaction conditions.

The reaction can be reversed by altering the pressure.

Suggest **one other** change that could be made to the reaction conditions.

..... **[1]**

(c) A factory predicts they will make 800 tonnes of ammonia.

They actually make 620 tonnes of ammonia.

Calculate the percentage yield of ammonia.

Percentage yield of ammonia = ... % **[2]**

(d) State why the reaction in the Haber process has an atom economy of 100%.

Use the balanced symbol equation.

..... **[1]**

END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use this lined page. You must write the question numbers clearly in the margin.