OCR
Oxford Cambridge and RSA

Tuesday 11 June 2024 – Morning

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

J248/04 (Higher 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

H

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* 9 9 8 6 8 9 9 8 0 4 *

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 pages 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 **28** 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 Which substance is an **unsaturated** hydrocarbon?

A CH_4

B C_2H_6

C C_3H_6

D C_3H_8

Your answer ☐ **[1]**

2 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]**

3 What is a life-cycle assessment?

A Analysis of the cost of making, using, and disposing of a product.

B Analysis of the energy needed to use a product throughout its lifetime.

C Analysis of the potential environmental impact of manufacturing a product.

D Analysis of the potential environmental impact that a product may have throughout its lifetime.

Your answer ☐ **[1]**

4 Which of these is one of the four nucleotides in the polymer DNA?

A Cytosine

B Deoxyribose

C Fructose

D Phosphate

Your answer ☐ **[1]**

5 Polyesters are condensation polymers.

Which monomers are polyesters made from?

A A carboxylic acid and an ester

B An alcohol and a carboxylic acid

C An alcohol and an amine

D An amine and a carboxylic acid

Your answer ☐ **[1]**

6 Nitrogen and oxygen react together at high temperatures in car engines.

Nitrogen monoxide is made.

What is the **balanced** equation for the reaction?

A $N + O \rightarrow NO$

B $N + O_2 \rightarrow NO_2$

C $N_2 + O_2 \rightarrow 2NO$

D $2N_2 + O_2 \rightarrow 2N_2O$

Your answer ☐ **[1]**

7 What is an **advantage** of extracting metals by phytoextraction?

A It can extract metals from contaminated soils.

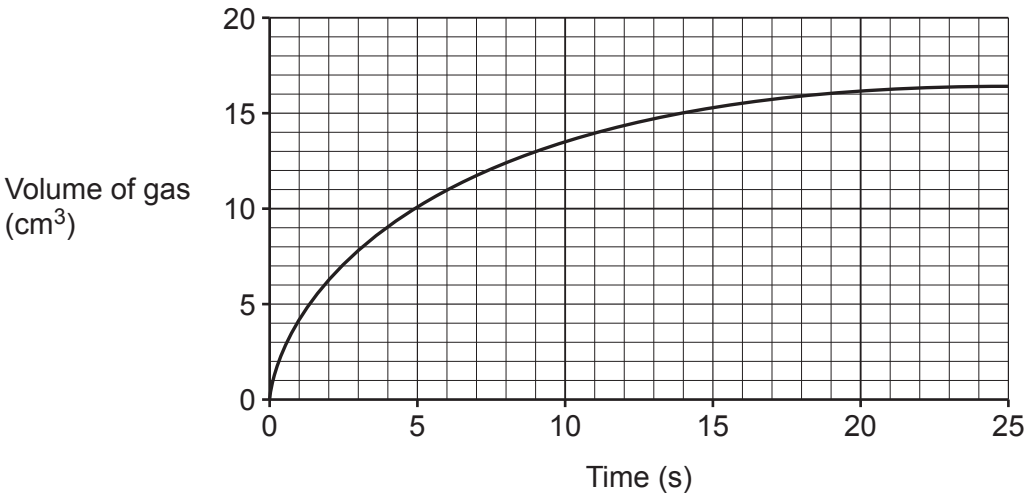
B It is dependent on weather conditions.

C It is slow.

D It produces carbon dioxide gas when the plants are burnt.

Your answer ☐ **[1]**

8 What is the average rate of this reaction, in cm^3/s, during the first 5 seconds?



A $0.5\,cm^3/s$

B $2.0\,cm^3/s$

C $5.0\,cm^3/s$

D $50.0\,cm^3/s$

Your answer ☐ **[1]**

9 How is the mass of a solute, in g, related to the concentration of the solution, in g / dm^3, and the volume of the solution, in dm^3?

A mass = concentration × volume

B $\text{mass} = \frac{\text{concentration} \times \text{volume}}{1000}$

C $\text{mass} = \frac{\text{concentration}}{\text{volume}}$

D $\text{mass} = \frac{\text{volume}}{\text{concentration}}$

Your answer ☐ **[1]**

10 Which equation shows the reaction at the **anode** in a hydrogen/oxygen fuel cell?

A $H_2(g) \rightarrow 2H^+(aq) + 2e^-$

B $4H^+(aq) + O_2(g) + 4e^- \rightarrow 2H_2O(g)$

C $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$

D $O_2(g) + 4e^- \rightarrow 2O^{2-}(g)$

Your answer ☐ **[1]**

11 The polymer nylon can be made from hexanedioyl dichloride, $ClOC(CH_2)_4COCl$, and hexane-1,6-diamine, $NH_2(CH_2)_6NH_2$.

Which small molecule is made as well as nylon?

A HCl

B H_2

C H_2O

D NH_3

Your answer ☐ **[1]**

12 The reaction between hydrogen, H_2, and iodine, I_2, is reversible.

$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

The reaction is exothermic.

What will increase the yield of hydrogen iodide, HI?

A Adding a catalyst

B Adding less hydrogen

C Decreasing the temperature

D Increasing the pressure

Your answer ☐ **[1]**

13 Which statement about activation energy is correct?

A Activation energy is increased by the addition of a catalyst.

B Activation energy is lowered when the temperature is increased.

C Activation energy is the minimum amount of energy for a reaction to occur.

D The greater the activation energy, the greater the rate of reaction.

Your answer ☐ **[1]**

14 What is the volume of 0.6 moles of nitrogen gas, N_2, at room temperature and pressure?

A 14.4 dm^3

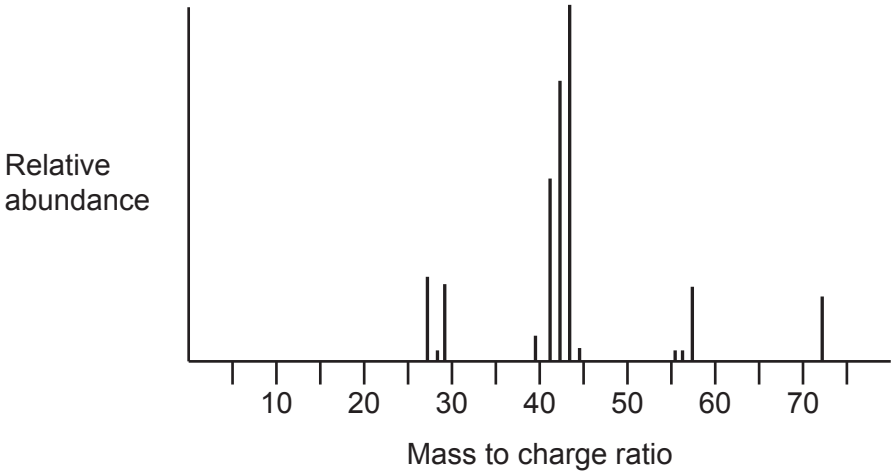
B 16.8 dm^3

C 40.0 dm^3

D 46.7 dm^3

Your answer ☐ **[1]**

15 Which carbon compound produces this mass spectrum?



Relative atomic mass (A_r): C = 12.0 H = 1.0

A C_2H_4

B C_3H_8

C C_4H_8

D C_5H_{12}

Your answer ☐ **[1]**

Section B

16

(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.

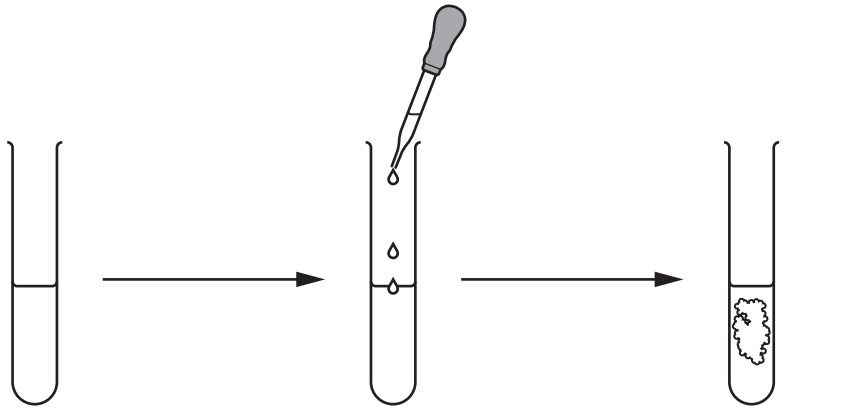
Write the **balanced symbol** equation for this reaction.

..... **[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.



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

Explain why.

.....

.....

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

17 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.

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

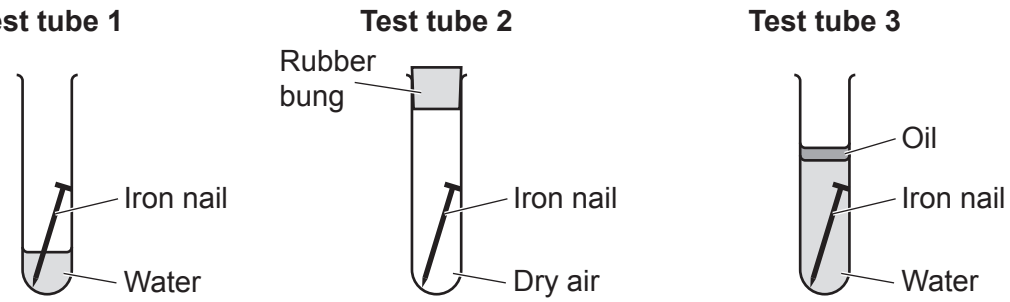
(d) State why the reaction in the Haber process has an atom economy of 100%.

Use the balanced symbol equation.

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

18 A student sets up three test tubes to investigate the rusting of iron as shown in **Fig. 18.1**.

Fig. 18.1



- The student measures the mass of each nail at the start of the experiment.
- They measure the mass of each nail again after a week.

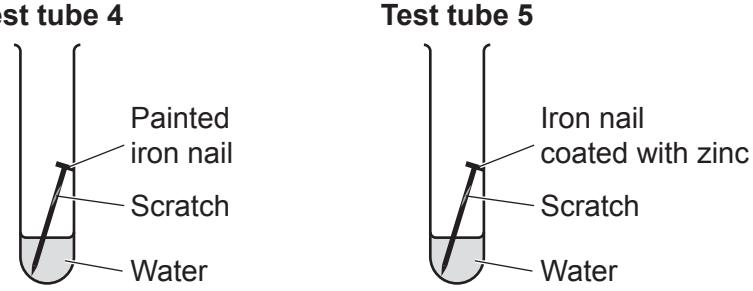
(a) The table shows the results.

Test tube	Mass of nail at start (g)	Mass of nail after a week (g)
1	4.42	.....
2	4.46	.....
3	4.51	4.51

Complete the table to estimate the mass of the nails in test tubes 1 and 2 after a week. **[2]**

(b) The student sets up another two test tubes as shown in **Fig. 18.2**.

Fig. 18.2



The iron nail in test tube 4 rusted. The iron nail in test tube 5 did **not** rust.

Explain why.

Test tube 4 .....

.....

Test tube 5 .....

.....

.....

[3]

(c) Copper is extracted by heating copper oxide with carbon.

$2CuO + C \rightarrow 2Cu + CO_2$

(i) Explain why this is an example of a **redox** reaction.

.....

.....

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

(ii) Calculate the mass of copper that can be made from 15 tonnes of copper oxide.

$2CuO + C \rightarrow 2Cu + CO_2$

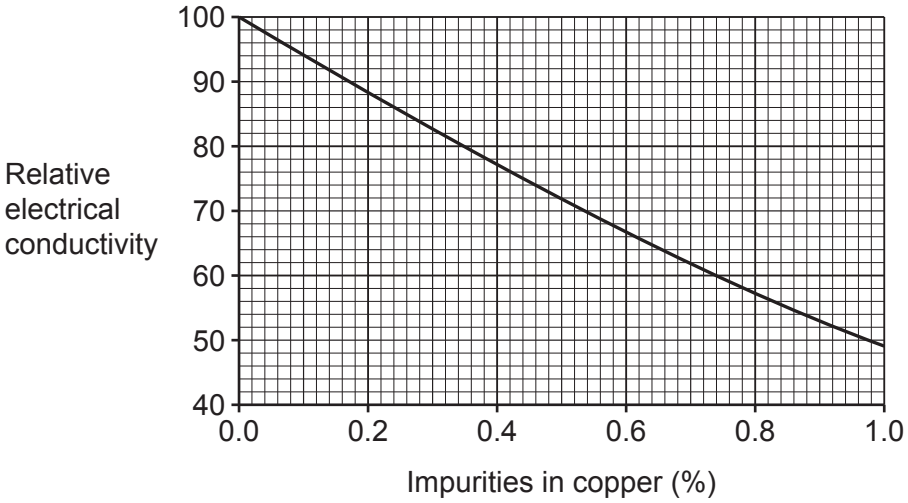
Give your answer to **2** significant figures.

Relative atomic mass (A_r): Cu = 63.5
Relative molecular mass (M_r): CuO = 79.5

Mass of copper = ... tonnes **[3]**

(iii) Copper is used in electrical wires.

The graph shows how impurities in copper affect the relative electrical conductivity of copper.



Copper extracted from copper oxide is about 99% pure.

Explain why copper extracted from copper oxide is purified to almost 100% pure using electrolysis.

Use data from the graph in your answer.

.....

.....

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

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19 The first member of the alkane homologous series is methane, CH_4.

(a) State the formula of the alkane with 10 carbon atoms.

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

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

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

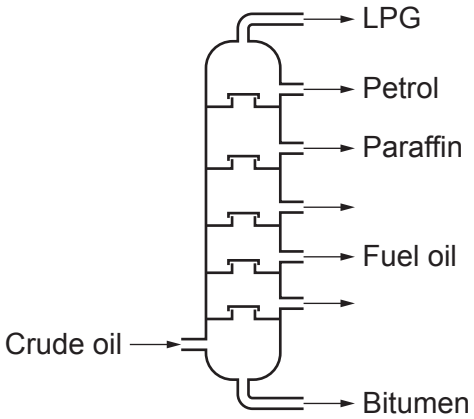
(c) Methane can also undergo **incomplete** combustion.

Carbon monoxide and water are made in incomplete combustion.

State **one** other possible product of the incomplete combustion of methane.

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

(d) Alkanes are obtained from the fractional distillation of crude oil.



The LPG fraction contains propane and butane.

Explain why the LPG fraction leaves at the **top** of the fractionating column.
Use ideas about intermolecular forces.

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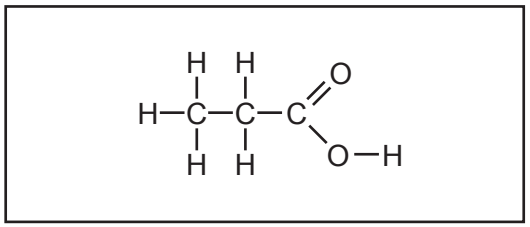
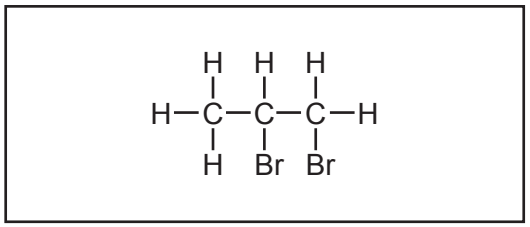
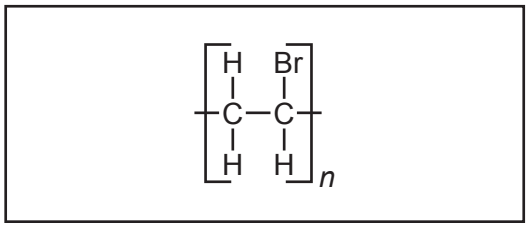
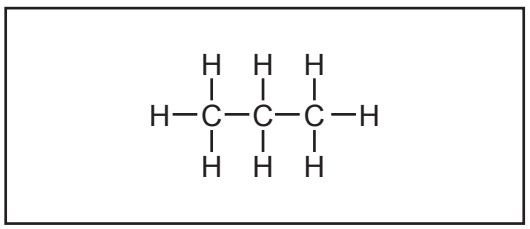
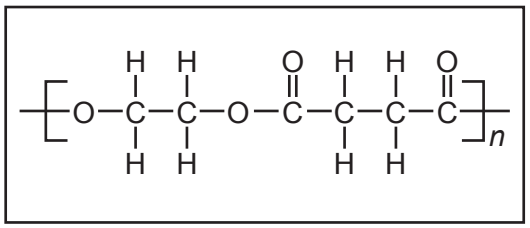
..... **[4]**

(e) Which industry is crude oil a feedstock for?

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

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

Description	Structural Formula
Made by an addition reaction between an alkene and hydrogen, H_2	
Made when propanol is oxidised	
Made when propene reacts with bromine water	
Made in a condensation polymerisation reaction	 

[4]

20 The Earth's early atmosphere is thought to have been mainly carbon dioxide, with smaller amounts of water vapour.

(a) Describe how the amounts of these gases changed over time to develop an oxygen-rich atmosphere.

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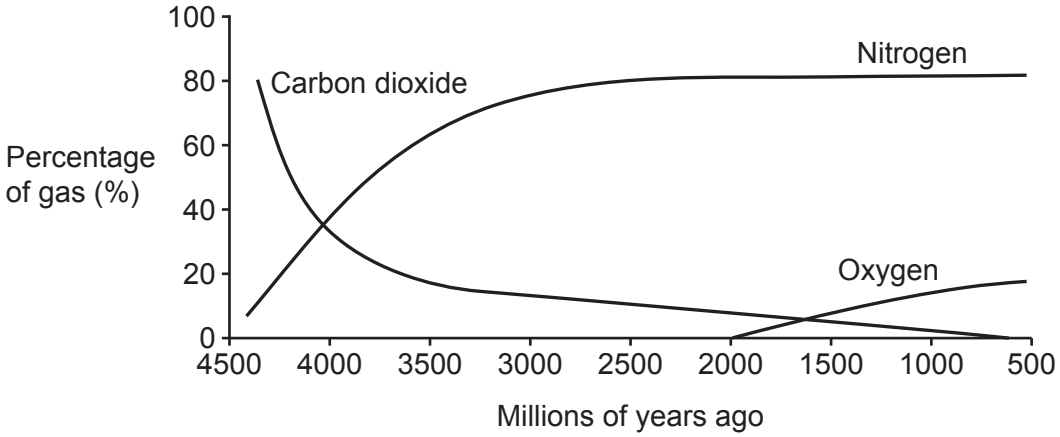
..... **[3]**

(b) The graph shows how the percentages of different gases in the atmosphere have changed over time.



(i) Describe the relationship between the percentage of carbon dioxide and the percentage of nitrogen in the atmosphere.

.....

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

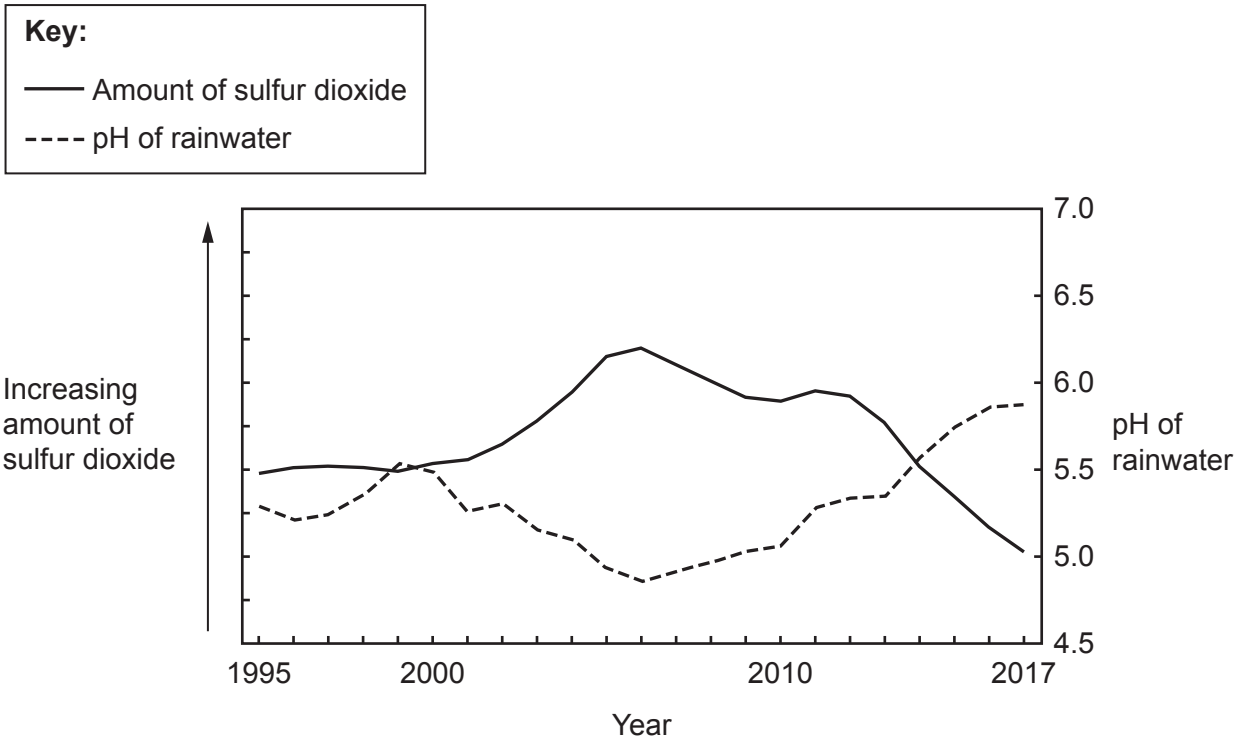
(ii) Estimate when the percentage of carbon dioxide and the percentage of oxygen were equal.

Answer = ... millions of years ago **[1]**

(c) Sulfur dioxide can be a pollutant in the atmosphere.

This graph shows

- how the amount of sulfur dioxide changed from 1995 to 2017
- how the pH of rainwater changed from 1995 to 2017.



(i) Describe the link between the amount of sulfur dioxide in the atmosphere and the concentration of the hydrogen ion, H^+, in the rainwater between the years 2000 and 2005.

Use the graph.

.....

.....

.....

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

(ii) Since 2014 the amount of acid rain in the atmosphere has decreased.

Suggest why.

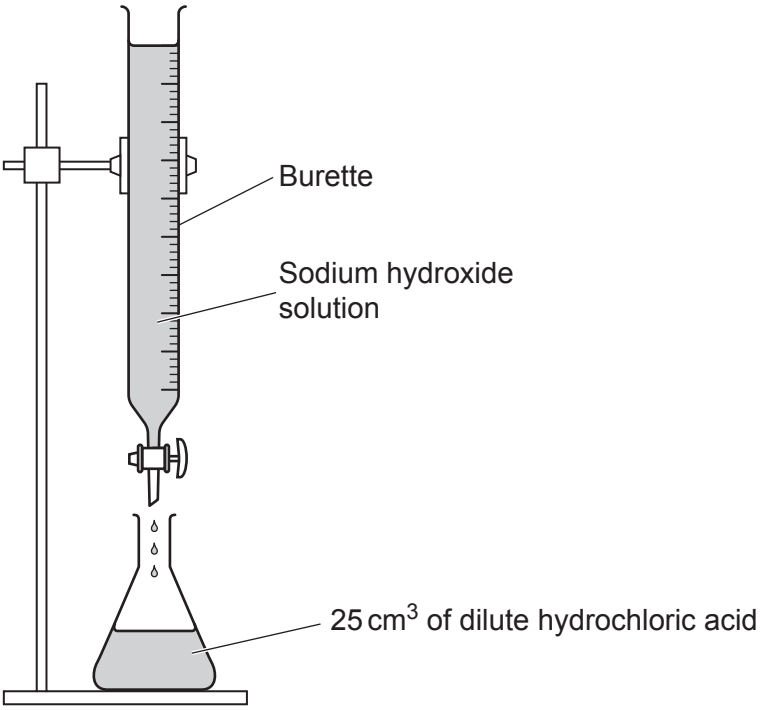
.....

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

21 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) Describe how the student uses the apparatus to do the titration.

Include the name of a suitable indicator and state the colour change that would be seen.

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..... **[5]**

(b) The student repeats the titration four times.

They work out the average volume of sodium hydroxide from their concordant results.

(i) What is meant by **concordant** results?

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

(ii) In the titration the student:

- uses 25 cm^3 of 0.12 mol/dm^3 dilute hydrochloric acid in the conical flask
- adds 0.4 mol/dm^3 sodium hydroxide solution from the burette.

The equation for the reaction is shown.

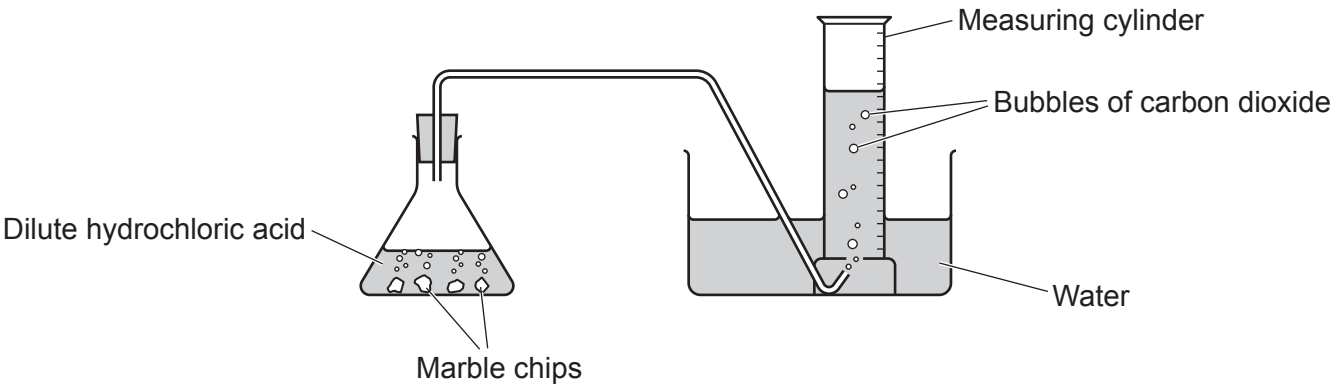
$HCl + NaOH \rightarrow NaCl + H_2O$

Calculate the average volume of sodium hydroxide used **in cm^3**.

Average volume of sodium hydroxide = ... cm^3 **[4]**

22 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)

(i) Suggest another piece of equipment that could be used to measure the volume of carbon dioxide gas.

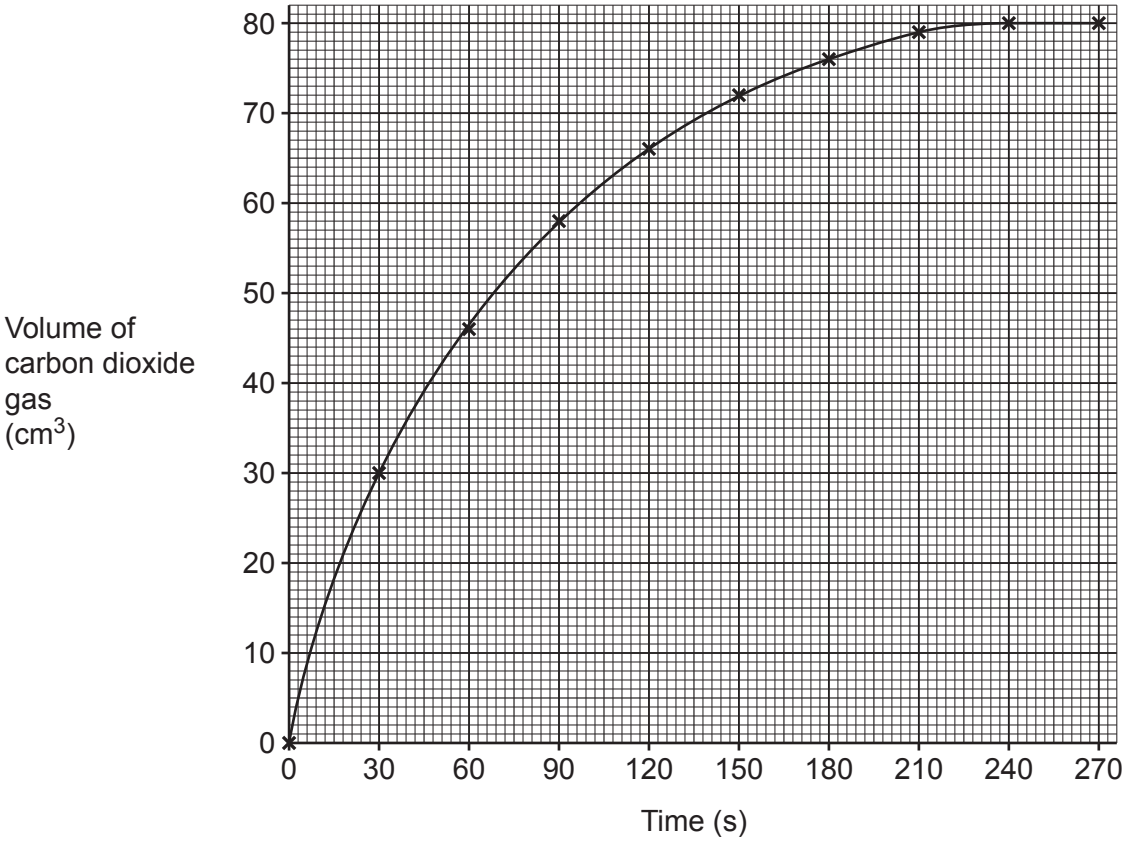
..... **[1]**

(ii) Explain how the student could tell that the dilute hydrochloric acid is the limiting reactant in this reaction.

.....

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

(b) The student plots their results on a graph.



Use the graph and a tangent line to calculate the rate of the reaction at 60 seconds.

Rate of reaction at 60 seconds = ... cm^3/s **[3]**

(c) The rate of the reaction can be changed by adding a catalyst.

(i) What happens to the final volume of carbon dioxide when a catalyst is added?

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

(ii) How does the mass of the catalyst change during the experiment?

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

(d)* 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
Rate of reaction (/s)	0.0044	0.04

Evaluate the student's results, explaining the difference in the rate of reaction.

Use the reacting particle model.

State how the student's experiment could be improved.

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

END OF QUESTION PAPER

EXTRA ANSWER SPACE

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