OCR
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Monday 20 June 2022 – Morning

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

J250/10 Paper 10 (Higher Tier)

Time allowed: 1 hour 10 minutes

8996820112

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

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

J250010

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 **60**.
- 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

Answer **all** the questions.

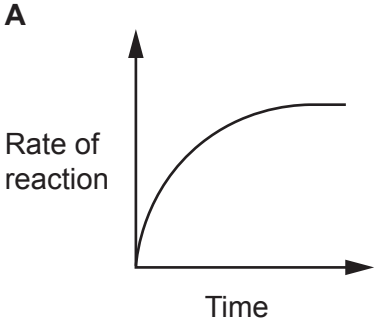
You should spend a maximum of 20 minutes on this section.

Write your answer to each question in the box provided.

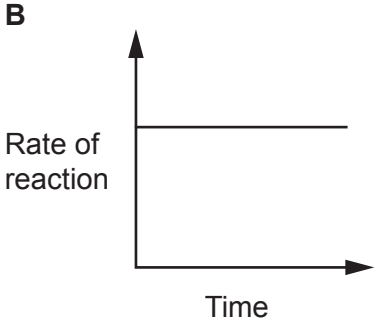
1 A student investigates the rate of reaction between magnesium and an excess of dilute sulfuric acid.

Which graph shows how the **rate of reaction** changes with time?

A



B



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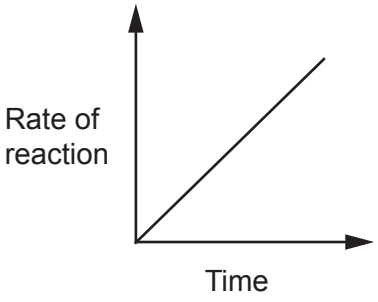

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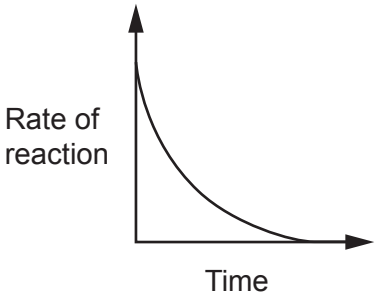


Your answer ☐ **[1]**

2 In the UK, one person produces about 9.5×10^3 kg of carbon dioxide per year.

One tree can take in 15 kg of carbon dioxide per year.

Approximately how many of these trees are needed to reduce one person's yearly carbon dioxide output to zero?

A 15

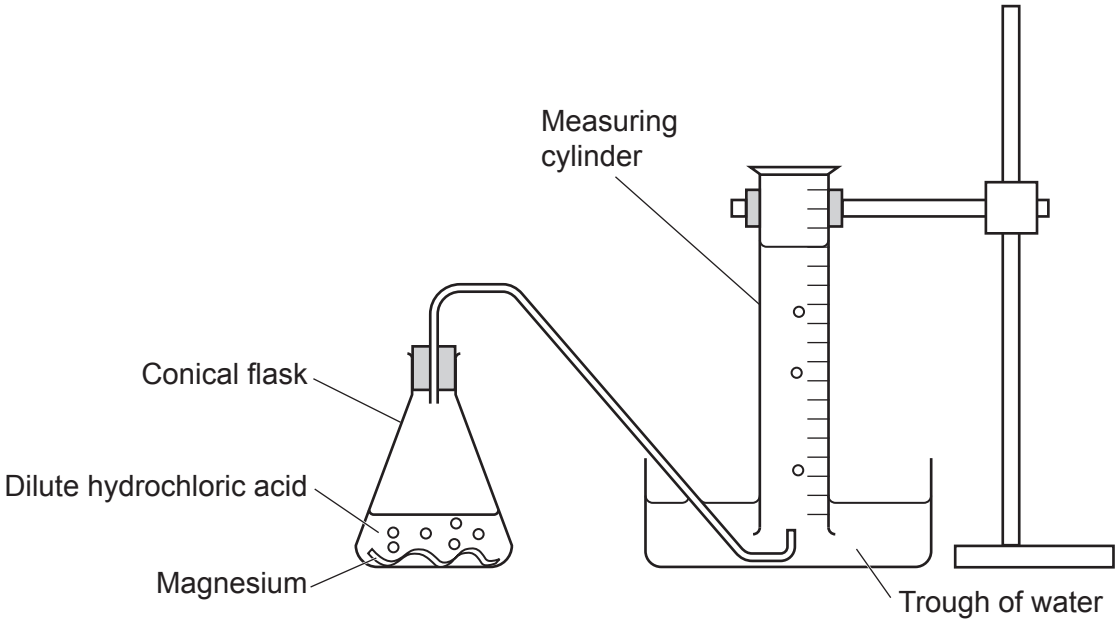
B 650

C 1600

D 140 000

Your answer ☐ **[1]**

3 A student investigates the rate of reaction between magnesium and dilute hydrochloric acid.



Which piece of equipment could the student use instead of the measuring cylinder to produce more accurate results?

A Boiling tube

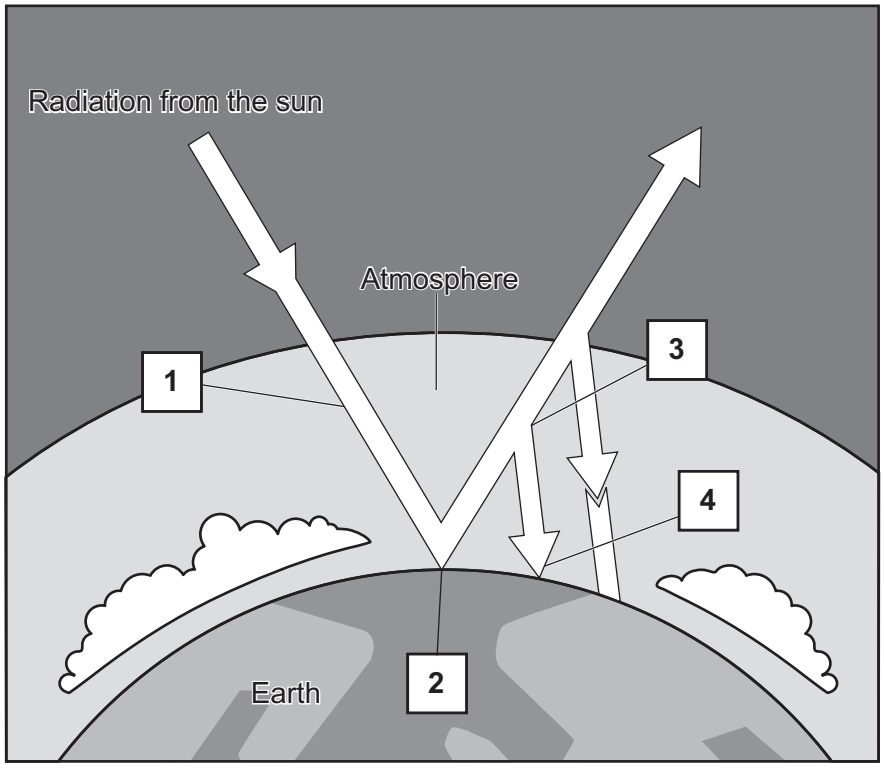
B Gas syringe

C Pipette

D Test tube

Your answer ☐ **[1]**

4 The diagram shows the four processes, **1–4**, that cause the greenhouse effect.



Which process happens at **3**?

A Greenhouse gases absorb some infrared radiation.

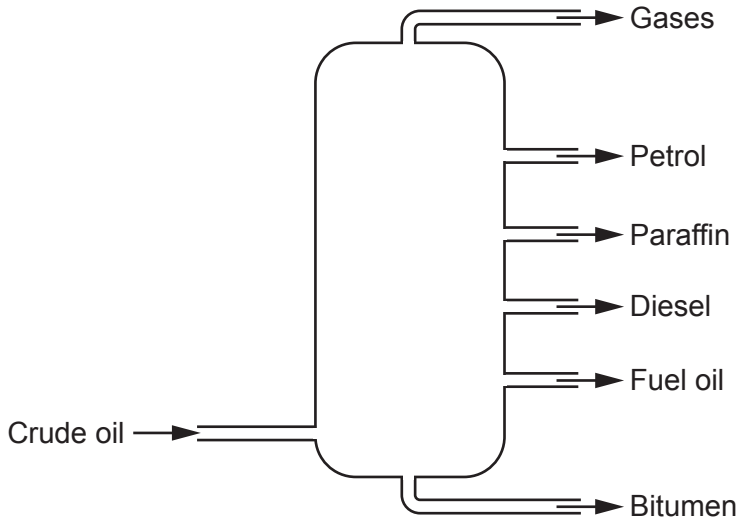
B Infrared radiation is emitted by the Earth's surface.

C Infrared radiation warms the Earth's surface.

D Radiation of all wavelengths passes through the atmosphere.

Your answer ☐ **[1]**

5 The diagram shows how crude oil is separated into its fractions in a fractionating column.



What is the physical state of the crude oil as it enters the fractionating column?

A Aqueous

B Gas

C Liquid

D Solid

Your answer ☐ **[1]**

6 Which compound is an alkane?

A C_6H_8

B C_7H_{12}

C C_8H_{16}

D C_9H_{20}

Your answer ☐ **[1]**

7 Sulfur dioxide, SO_2, reacts with oxygen, O_2, to make sulfur trioxide, SO_3, to form a dynamic equilibrium.

$2SO_2 + O_2 \rightleftharpoons 2SO_3$

Which statement describes the reaction at equilibrium?

A Rate of forward reaction < rate of backward reaction

B Rate of forward reaction > rate of backward reaction

C Rate of forward reaction = rate of backward reaction

D Rate of forward reaction ~ rate of backward reaction

Your answer ☐ **[1]**

8 The equation shows the extraction of iron, Fe, from an oxide of iron, **X**, using carbon, C.

$2\mathbf{X} + 3C \rightarrow 4Fe + 3CO_2$

What is the formula of **X**?

A FeO

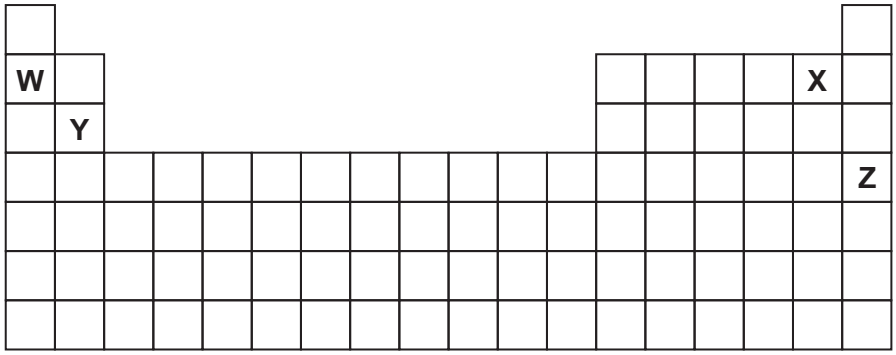
B Fe_2O

C Fe_2O_3

D Fe_4O_6

Your answer ☐ **[1]**

9 Look at the diagram of the Periodic Table.



Which elements react with dilute hydrochloric acid to form **positive** ions?

A **W** and **X**

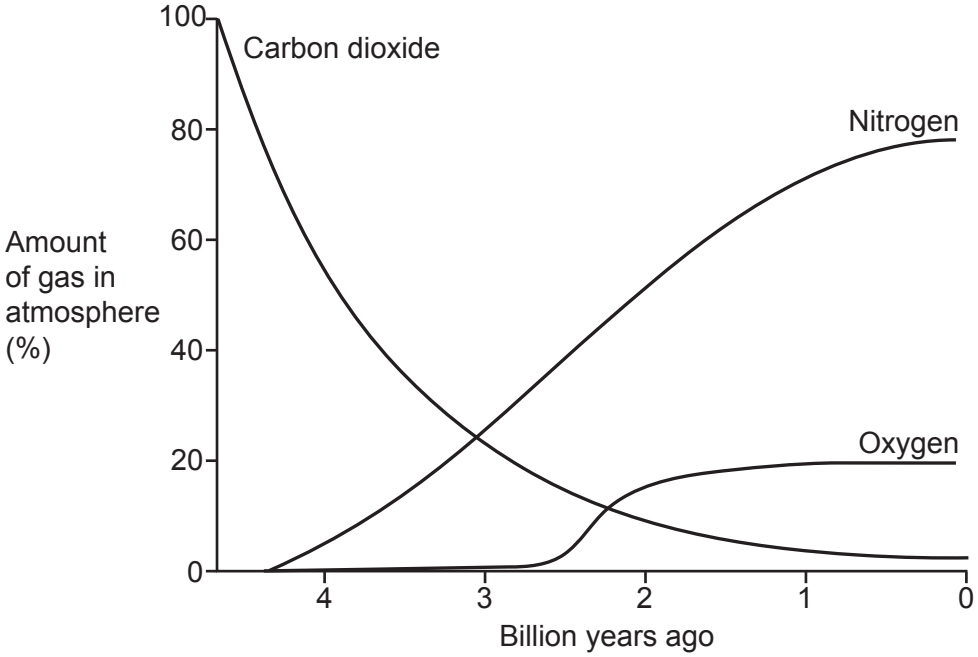
B **W** and **Y**

C **X** and **Y**

D **X** and **Z**

Your answer ☐ **[1]**

10 The graph shows how the amounts of carbon dioxide, nitrogen and oxygen in the Earth's early atmosphere may have changed over time.



How many years ago does the graph suggest that photosynthesis started to happen?

A 1.2–1.6 billion years ago

B 2.2–2.6 billion years ago

C 3.2–3.6 billion years ago

D 4.0–4.4 billion years ago

Your answer ☐ **[1]**

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SECTION B

Answer **all** the questions.

11 This question is about the Group 7 elements.

Table 11.1 shows some information about the Group 7 elements.

Table 11.1

Element	Molecular formula	Appearance at room temperature	Size of molecule (pm)	Boiling point (°C)
Fluorine	F_2	pale-yellow gas	128	–188
Chlorine	Cl_2	green gas	204	–34
Bromine	Br_2	orange-brown liquid	240	
Iodine	I_2	grey-black solid	278	184
Astatine	At_2	.....	300	350

(a) Complete the table by predicting the appearance of astatine at room temperature.

Write your answer in the box in **Table 11.1**. **[1]**

(b) The sizes of the molecules are measured in picometres (pm).

1 picometre = $\frac{1}{1\,000\,000\,000\,000}$ metre

What is the size of a fluorine molecule in metres (m)?

Tick (✓) **one** box.

1.28×10^{-12} m ☐

1.28×10^{-10} m ☐

1.28×10^{10} m ☐

1.28×10^{12} m ☐

[1]

(c) Which element has a molecule that is **closest** to twice the size of a molecule of fluorine?

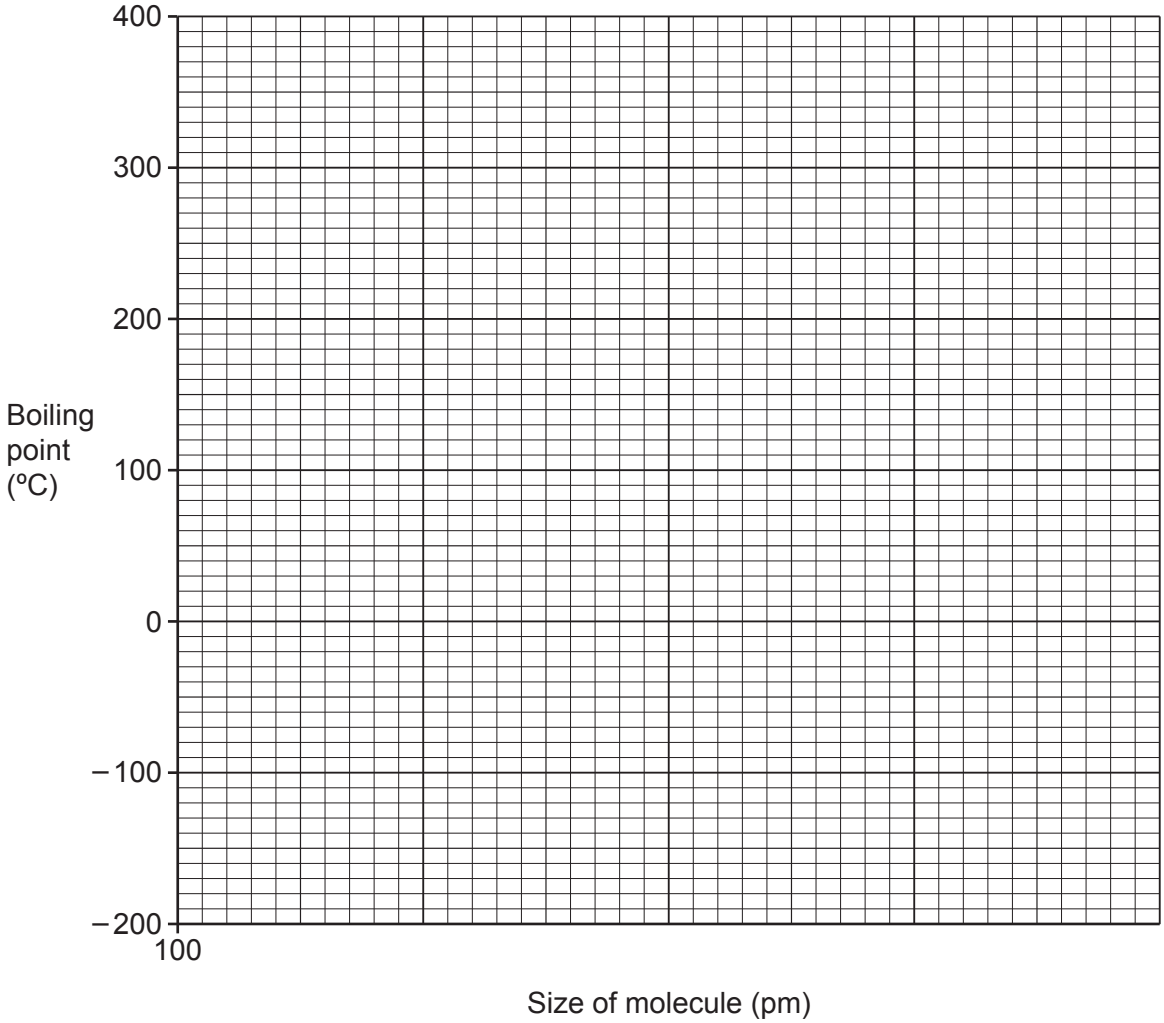
Tick (✓) **one** box.

Chlorine ☐ Bromine ☐ Iodine ☐ Astatine ☐

[1]

(d) (i) Use **Table 11.1** to complete the x axis and plot a **line graph** of the boiling points of fluorine, chlorine, iodine and astatine against the size of their molecules.

Draw a line of best fit.



[4]

(ii) Use your graph to predict the boiling point of bromine.

Boiling point of bromine = ... °C **[1]**

Table 11.1 is repeated below.

Table 11.1

Element	Molecular formula	Appearance at room temperature	Size of molecule (pm)	Boiling point (°C)
Fluorine	F_2	pale-yellow gas	128	–188
Chlorine	Cl_2	green gas	204	–34
Bromine	Br_2	orange-brown liquid	240	
Iodine	I_2	grey-black solid	278	184
Astatine	At_2		300	350

(e) A student thinks that fluorine molecules have the **weakest** intermolecular forces.

Give **two** reasons why they are correct.

Use data from **Table 11.1**.

1 .....

.....

2 .....

.....

[2]

(f) Describe **one** similarity and **one** difference in the arrangement of electrons in **atoms** of fluorine and chlorine.

Similarity .....

.....

Difference .....

.....

[2]

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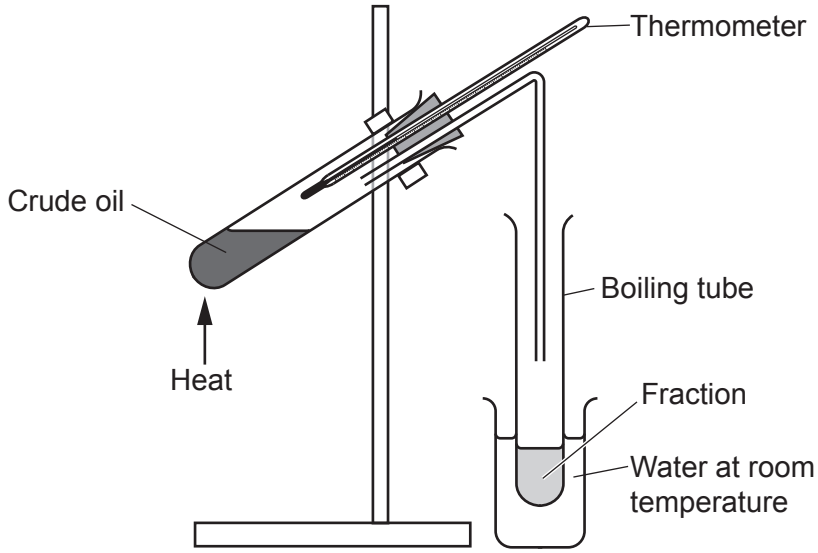
12 The processing of crude oil by the petrochemical industry can be shown by different experiments.

The diagram shows how crude oil can be separated into its fractions.



The crude oil is heated. Different fractions are collected at different temperatures.

(a) What is the name of this separation technique?

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

(b) Explain how a fraction is separated and collected in the experiment.

.....

.....

.....

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

(c) A fraction with a boiling point of about 10 °C is **not** collected in the experiment.

How could the experiment be improved so this fraction is collected?

.....

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

(d) The table shows the temperatures at which four different fractions are collected.

Fraction	Temperature fraction collected (°C)
A	below 100
B	100–150
C	150–200
D	200–250

Which statements about the fractions are **true**, and which are **false**?

Tick (✓) **one** box in each row.

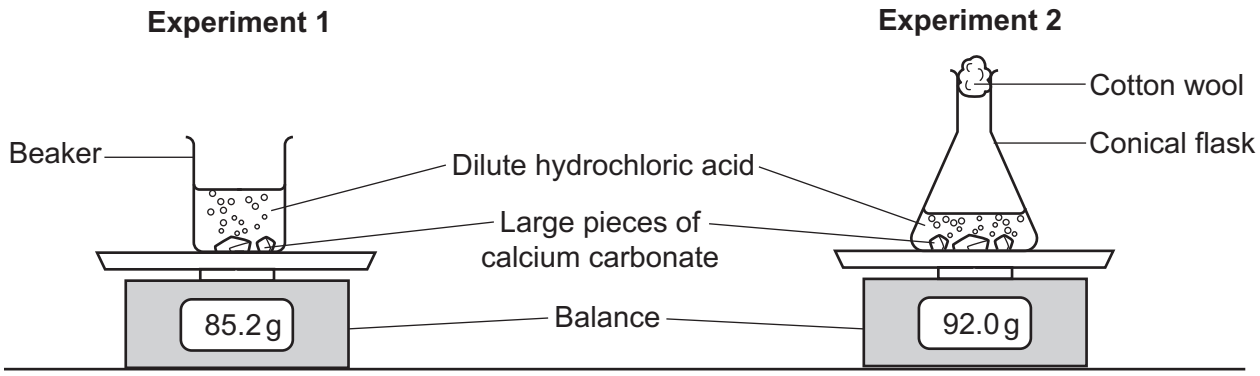
	True	False
The fractions consist mostly of compounds which are hydrocarbons.		
Fraction **C** is collected before Fraction **D**.		
The molecules in Fraction **A** are larger than the molecules in Fraction **B**.		

[2]

13 A student investigates the rate of reaction between large pieces of calcium carbonate and dilute hydrochloric acid.

Fig. 13.1 shows two different experiments the student could use.
In both experiments the mass decreases as the reaction progresses.

Fig. 13.1



(a) The equation shows the reaction between calcium carbonate and hydrochloric acid.

$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$

Use this equation to explain why the mass **decreases** as the reaction progresses.

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

(b) The student decides to use **Experiment 2** because they think it will produce more accurate results than **Experiment 1**.

Explain why the student is correct.

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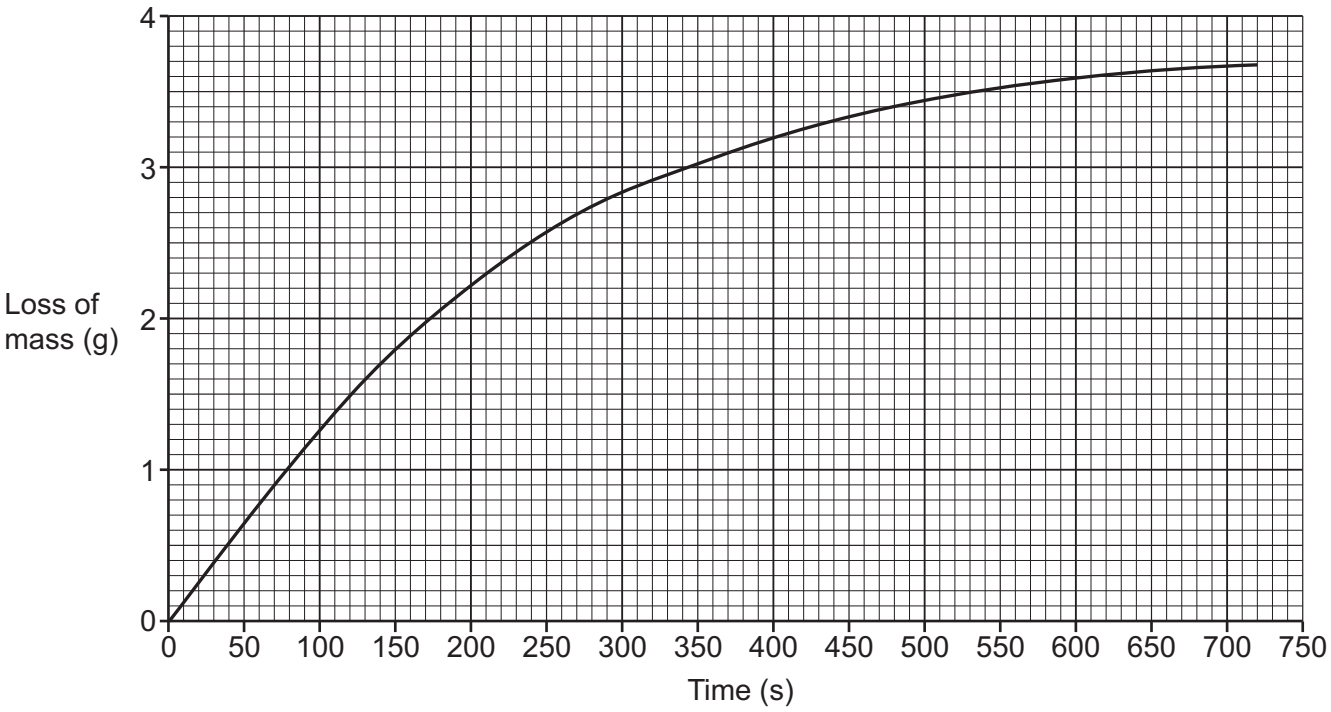
..... **[2]**

(c) **Fig. 13.2** shows the graph of the student's results.

Fig. 13.2



The rate of reaction can be found by using a tangent.

Draw a tangent at 300 seconds on the graph in **Fig. 13.2**.

Use the tangent to calculate the rate of reaction at 300 seconds.

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

Rate of reaction at 300 seconds = ... g/s **[4]**

(d) The student repeats **Experiment 2** with **smaller** pieces of calcium carbonate to see how this changes the rate of the reaction.

(i) Describe **two** variables the student must keep the same in this experiment.

1 .....

.....

2 .....

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

(ii) Describe and explain the effect of using **smaller** pieces of calcium carbonate on the rate of the reaction.

.....

.....

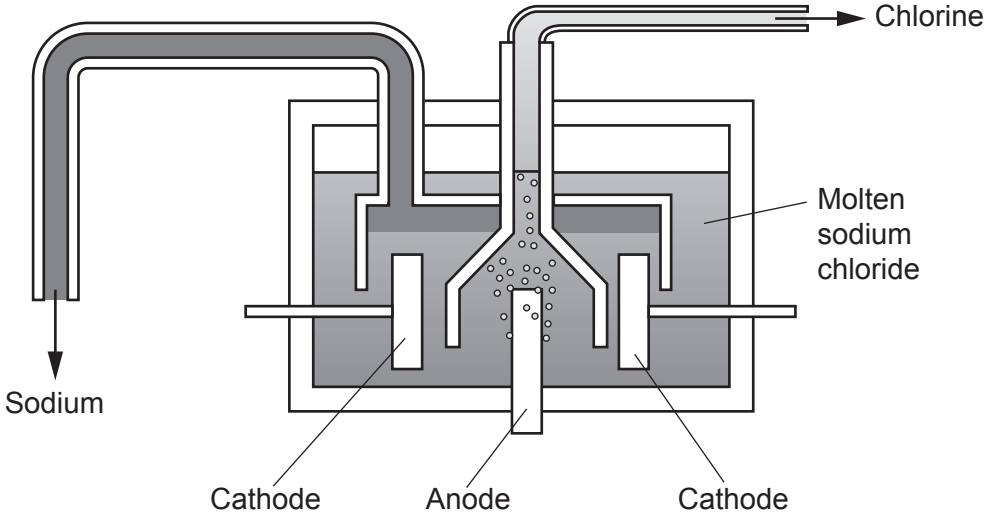
.....

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

14* Sodium is extracted from molten sodium chloride, NaC*l*, by electrolysis. Sodium produced by this process is expensive.

Sodium chloride is an ionic compound. It has a melting point of 801 °C.

The diagram shows the industrial electrolysis of molten sodium chloride.



Describe how the electrolysis of molten sodium chloride produces sodium and evaluate the process to explain why the sodium produced is expensive.

Use a balanced symbol equation and half-equations in your answer.

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

15 For many years it was thought that the Group 0 elements were completely unreactive.

However, more recently, scientists have been able to react some of the Group 0 elements with fluorine.

The table shows information about some of the compounds Group 0 elements make with fluorine.

Group 0 element	Year compound first made	Formula of compound
Helium	no compounds yet made	
Neon	no compounds yet made	
Argon	2003	ArF_2
Krypton	1963	KrF_2
Xenon	1962	XeF_2

(a) Give a reason why the Group 0 elements are usually described as unreactive.

.....

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

(b) Give a reason why scientists have used **fluorine** to make compounds of the Group 0 elements.

.....

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

(c) Xenon difluoride, XeF_2, is a solid at room temperature. It melts at 129 °C and boils at 155 °C. It does **not** conduct electricity in any state.

(i) Suggest the structure of xenon difluoride, XeF_2.

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

(ii) Give **two** reasons for your answer in **(c)(i)**.

1 .....

.....

2 .....

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

(d) Describe how the trend in reactivity of the Group 0 elements is linked to the size of the atoms.

.....

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

16 Ethanol, C_2H_5OH, can be made by reacting ethene, C_2H_4, with steam, H_2O.

$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$

The forward reaction is exothermic.

(a) State Le Chatelier's principle.

.....

.....

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

(b) (i) As the temperature of the reaction is **increased** does the amount of ethanol decrease, increase or stay the same?

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

(ii) Explain your answer to **(b)(i)**.

.....

.....

.....

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

(c) (i) As the pressure of the reaction is **increased** does the amount of ethanol decrease, increase or stay the same?

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

(ii) Explain your answer to **(c)(i)**.

.....

.....

.....

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

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).