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Monday 20 June 2022 – Morning

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

J250/04 Paper 4 (Foundation Tier)

Time allowed: 1 hour 10 minutes

8994703457

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

J250/04

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.

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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 Supplies of crude oil are running out.

Which word describes crude oil?

A Finite

B Renewable

C Reusable

D Sustainable

Your answer ☐ **[1]**

2 A student heats **four** different metals using a Bunsen burner.

The table shows their observations.

Metal	Observation when metal is heated
W	bursts into flames
X	slowly goes dull
Y	no reaction
Z	glows brightly

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

A W, X, Z, Y

B W, Z, X, Y

C Y, X, Z, W

D Z, Y, W, X

Your answer ☐ **[1]**

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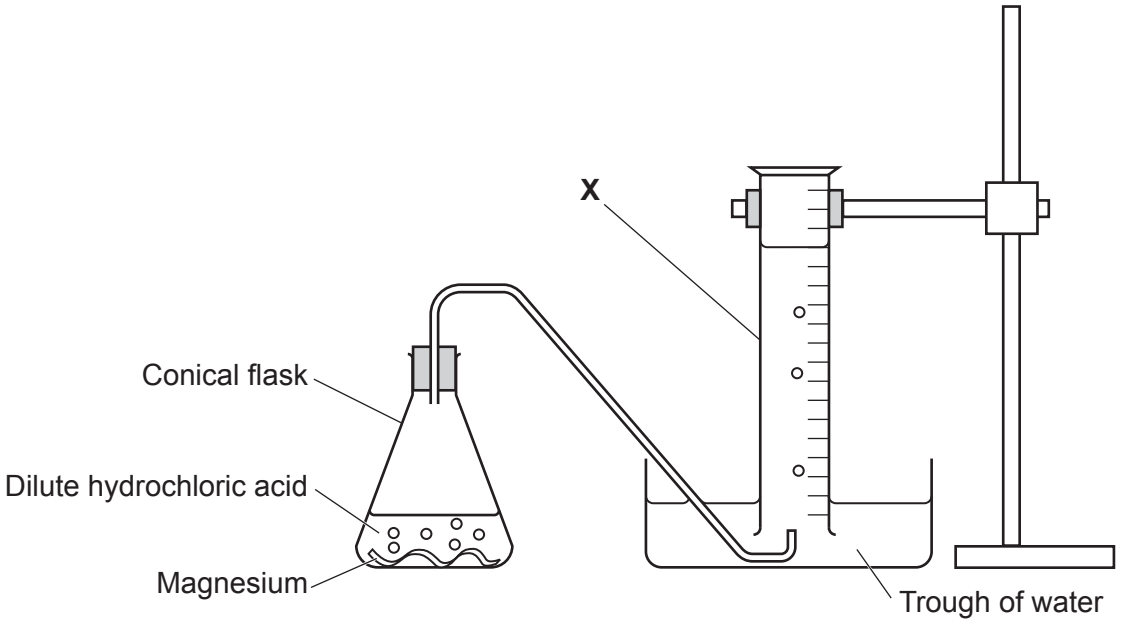
3 A teacher investigates the rate of reaction between magnesium and dilute hydrochloric acid.

The diagram shows the equipment they use.



What is the name of the piece of equipment labelled **X**?

A Burette

B Gas syringe

C Measuring cylinder

D Test tube

Your answer ☐ **[1]**

4 Nitrogen, N_2, reacts with hydrogen, H_2, to make ammonia, NH_3.

$N_2 + 3H_2 \rightleftharpoons 2NH_3$

What is the name of this type of reaction?

A Combustion

B Electrolysis

C Neutralisation

D Reversible

Your answer ☐ **[1]**

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5 Which toxic gas is produced from burning fossil fuels?

A Carbon dioxide

B Carbon monoxide

C Nitrogen

D Oxygen

Your answer ☐ **[1]**

6 Alkanes are hydrocarbons with the formula C_nH_{2n+2}.

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 A student has four different solids.

- One of the solids is a **catalyst**.
- The student tests 1 g of each solid in a chemical reaction.

The table shows the student's observations for each solid.

Solid	Observation	Mass of the solid at the end of the reaction (g)
A	disappears	0
B	fizzes and disappears	0
C	changes colour	1
D	same colour	1

Which solid is the **catalyst**?

Your answer ☐ **[1]**

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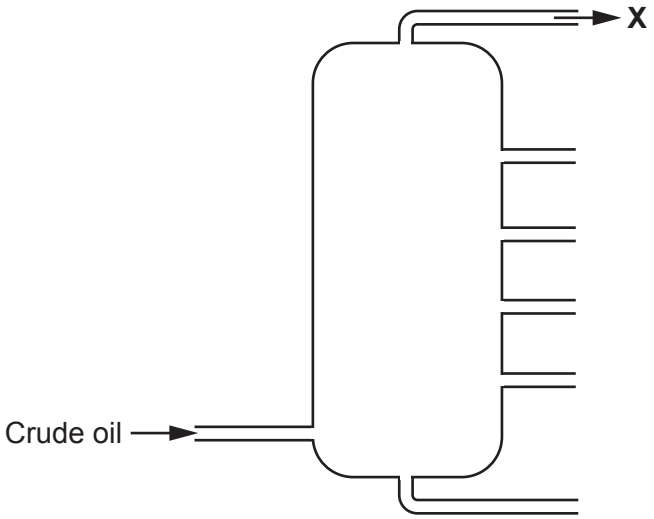
8 The diagram shows the fractional distillation of crude oil.



The table shows the boiling point ranges of four different fractions.

Fraction	Boiling point range (°C)
A	below 20
B	20–80
C	180–260
D	260–320

Which fraction is collected at **X**?

Your answer ☐ **[1]**

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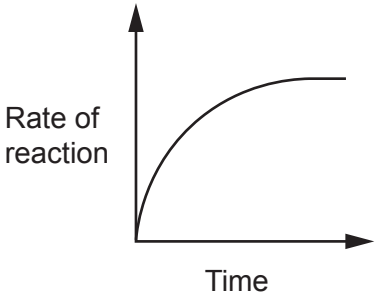
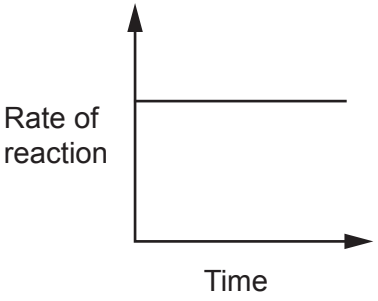
9 A student investigates the rate of reaction between magnesium and an excess of dilute sulfuric acid.

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

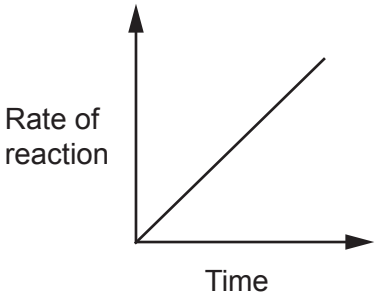
A



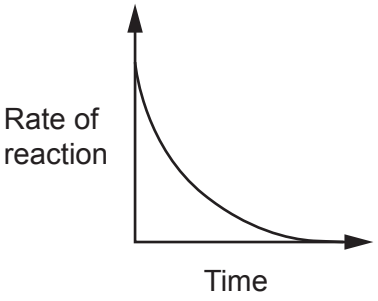
B



C



D



Your answer ☐ **[1]**

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10 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]**

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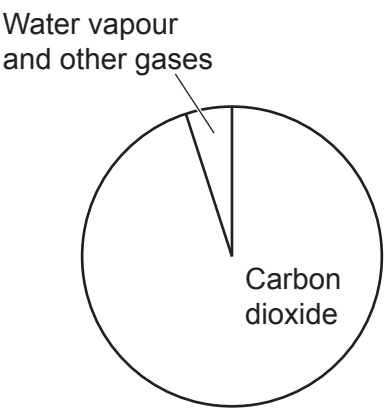
SECTION B

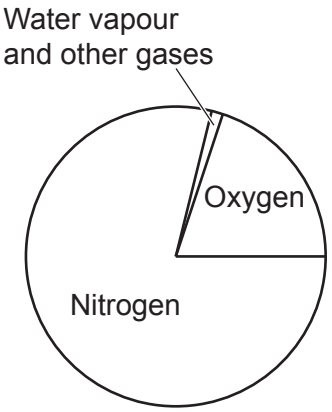
Answer **all** the questions.

11 The diagram shows how the composition of the Earth's atmosphere has changed over time.

Earth's early atmosphere



Earth's atmosphere today



(a) What produced the gases present in the Earth's **early** atmosphere?

Tick (✓) **one** box.

Earthquakes ☐

Thunderstorms ☐

Volcanoes ☐

[1]

(b) What is the percentage of oxygen in the Earth's atmosphere **today**?

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

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(c) The amounts of carbon dioxide and water vapour in the Earth's early atmosphere decreased over time.

Draw lines to connect each **gas** with the correct description of **how it decreased over time**.

Gas	How it decreased over time
	Condensed to form the oceans
Carbon dioxide	Reacted with bacteria
Water vapour	Reacted with metals in rocks
	Absorbed by plants during photosynthesis

[2]

(d) The Earth's atmosphere today contains gases from Group 0 in the Periodic Table.

(i) The table shows the amounts of the gases from Group 0 in the Earth's atmosphere today.

Gas	Amount of gas (%)
Helium	0.000524
Neon	0.00182
Argon	0.934
Krypton	.....

The **total** amount of the gases from Group 0 is 0.938%.

Complete the table by calculating the **exact** amount of krypton in the Earth's atmosphere today.

Write your answer in the box in the table. **[2]**

(ii) What is a property of the Group 0 gases?

Tick (✓) **one** box.

They are coloured. ☐

They are unreactive. ☐

They exist as molecules. ☐

[1]

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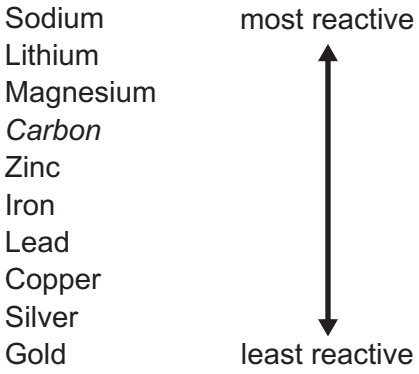
12 The reactivity series lists metals in order from the most reactive to the least reactive.

Fig. 12.1 shows part of the reactivity series, including the non-metal carbon.

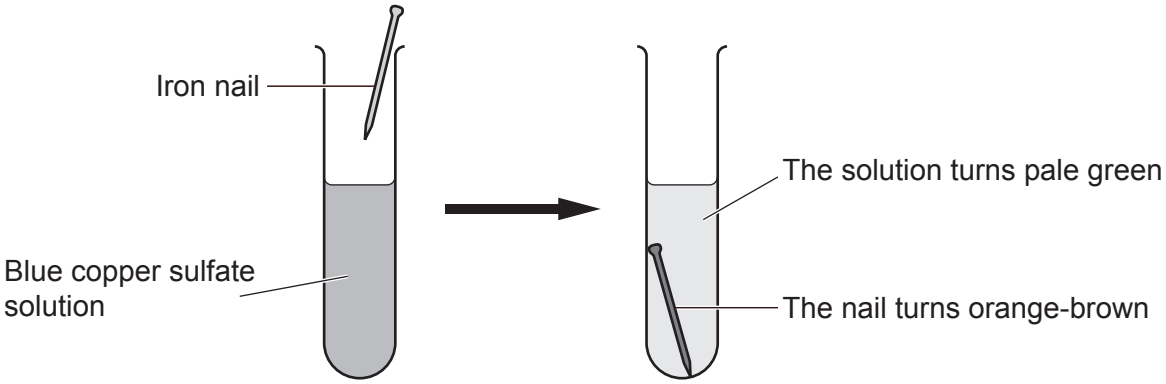
Fig. 12.1



(a) A student places an iron nail in a solution of copper sulfate.
A displacement reaction takes place.

Fig. 12.2 shows their experiment.

Fig. 12.2



(i) The student writes the word equation for the reaction.

iron + copper sulfate → ..... + ...

Complete the word equation for the reaction. **[1]**

(ii) Why does this reaction happen?

Use the reactivity series in **Fig. 12.1**.

.....

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

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Use the reactivity series in **Fig. 12.1** to answer parts **(b)**, **(c)** and **(d)**.

(b) Another student repeats the experiment but places a **different** metal in the solution of copper sulfate.

There is **no** chemical reaction.

Suggest a metal that this student used.

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

(c) **(i)** Name **one** metal that can be extracted by heating its oxide with **carbon**.

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

(ii) Name **one** metal that can be extracted from its oxide by electrolysis but **not** by heating its oxide with carbon.

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

(d) Complete the sentence below to explain the difference in the reactivity of sodium and lithium.

Use **one** of the words.

electrons	**neutrons**	**protons**

Sodium atoms lose ..... more easily than lithium atoms. **[1]**

(e) **(i)** State the trend in reactivity of the Group 1 metals.

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

(ii) Name a Group 1 metal which is more reactive than sodium.

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

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13 Drinking water that comes from lakes and reservoirs must be made safe to drink.

(a) Which name is given to water that has been made safe to drink?

Tick (✓) **one** box.

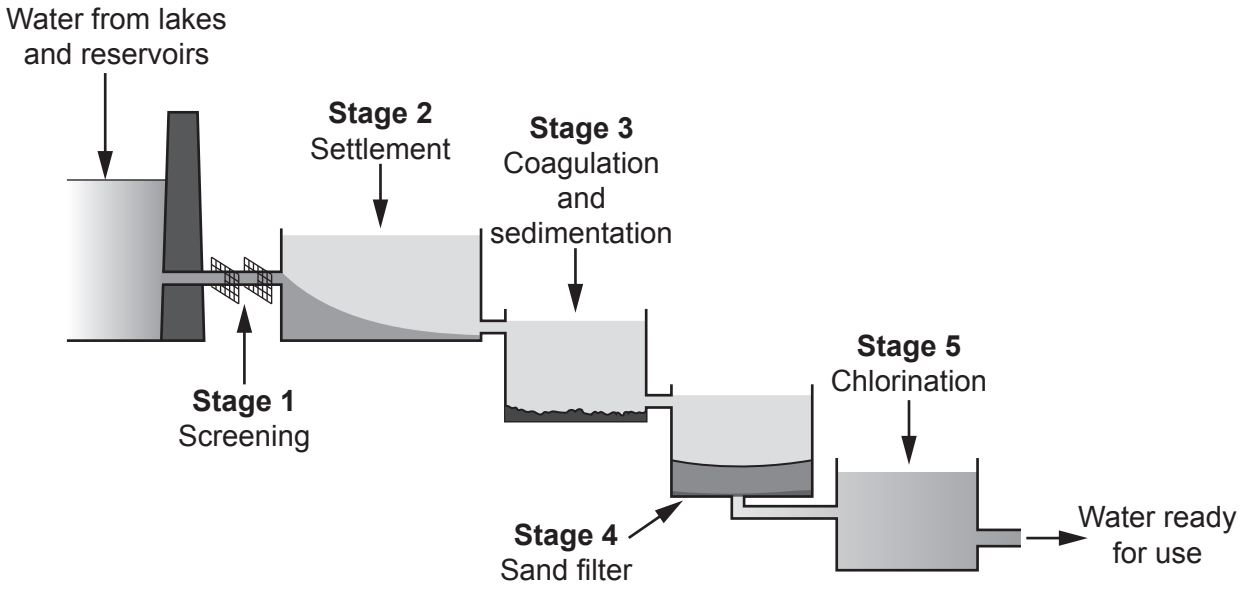
Filtered ☐

Ground ☐

Potable ☐

[1]

(b) The diagram shows the stages in the treatment of water from lakes and reservoirs.



In **Stage 1** large objects such as leaves and twigs are removed.

What happens at **Stages 2**, **3** and **4**?

Tick (✓) **one** box in each row.

	Stage 2 Settlement	**Stage 3** Coagulation and sedimentation	**Stage 4** Sand filter
Any remaining mud or grit is removed.			
Sand and soil sink to the bottom of the tank.			
Small particles of dirt clump together to form sludge.			

[2]

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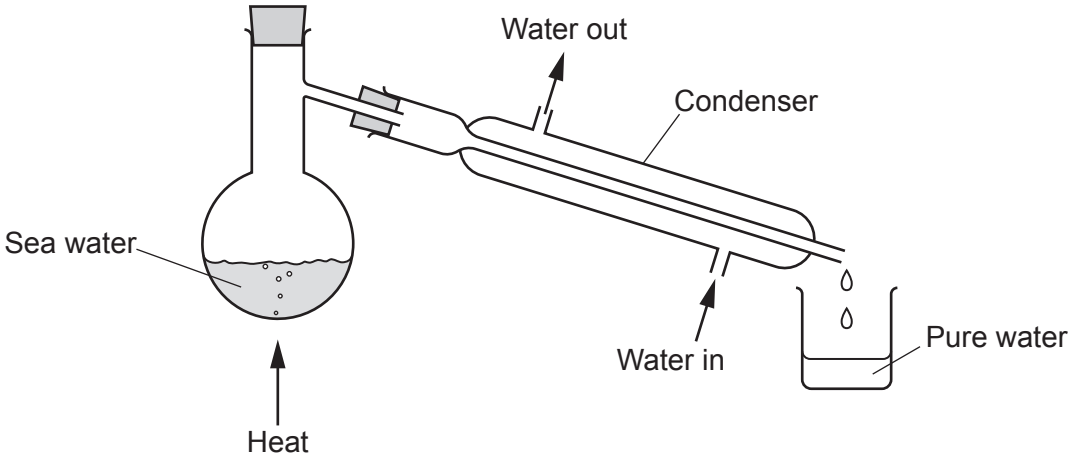
(c) Water can also be purified by simple distillation.

The diagram shows the equipment used by a student to distil sea water.



Give **two** reasons why this equipment is **not** suitable to produce water on a large scale.

1 .....

.....

2 .....

.....

[2]

(d) On average **one person** in the UK uses 149 litres of water every day.

Only 3% of this water is used for drinking.

Calculate the amount of drinking water a family of **four** uses every day.

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

Amount of drinking water = ... litres **[3]**

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

Fig. 14.1 shows an experiment where paraffin is turned into decane and gas **X**.

Fig. 14.1

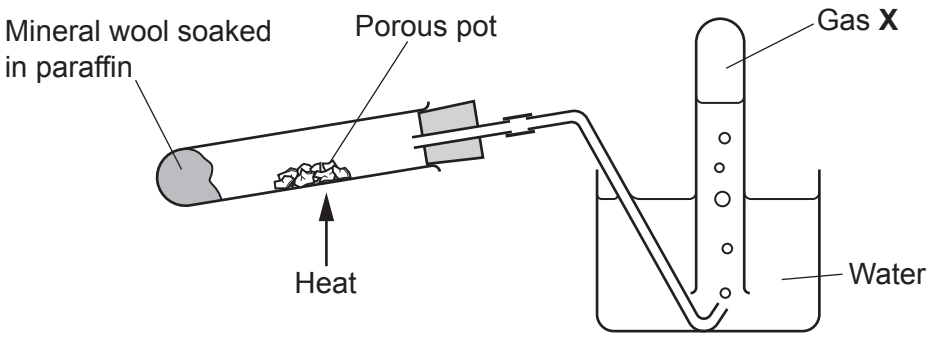
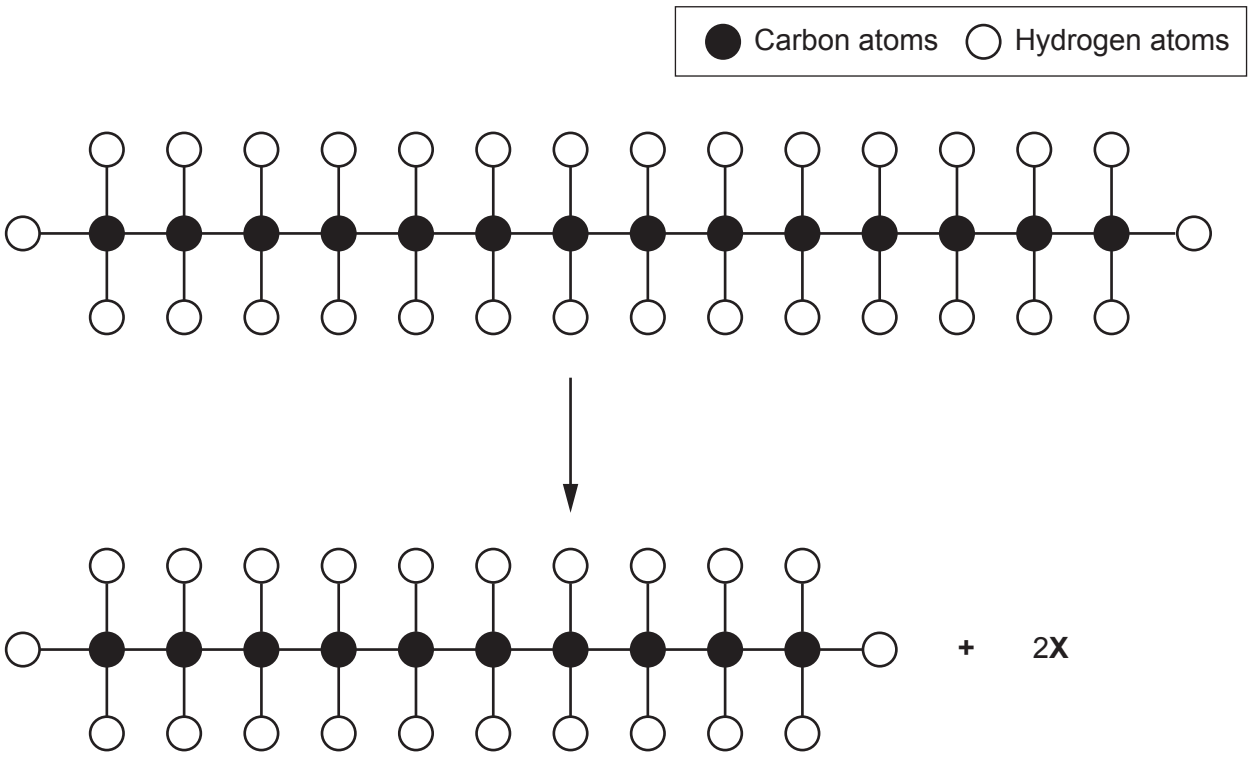


Fig. 14.2 shows the reaction of paraffin, $C_{14}H_{30}$, to make decane, $C_{10}H_{22}$, and gas **X**.

Fig. 14.2



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(a) Complete the sentences below to describe the experiment.

Put a ring around the correct choice to complete each sentence.

The experiment is called **cracking** / **displacement** / **distillation**.

It is an example of **combustion** / **reduction** / **thermal decomposition**.

[2]

(b) The porous pot in **Fig. 14.1** acts as a **catalyst** in the reaction.

(i) What effect does the porous pot have on the **rate of the reaction**?

Put a ring around the correct answer.

decreases it **increases it** **no effect**

[1]

(ii) What effect does the porous pot have on the **activation energy** of the reaction?

Put a ring around the correct answer.

decreases it **increases it** **no effect**

[1]

(c) Use **Fig. 14.2** to answer these questions.

(i) Write the formula of gas **X**.

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

(ii) Describe what happens to a molecule of paraffin as it turns into a molecule of decane.

.....

.....

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

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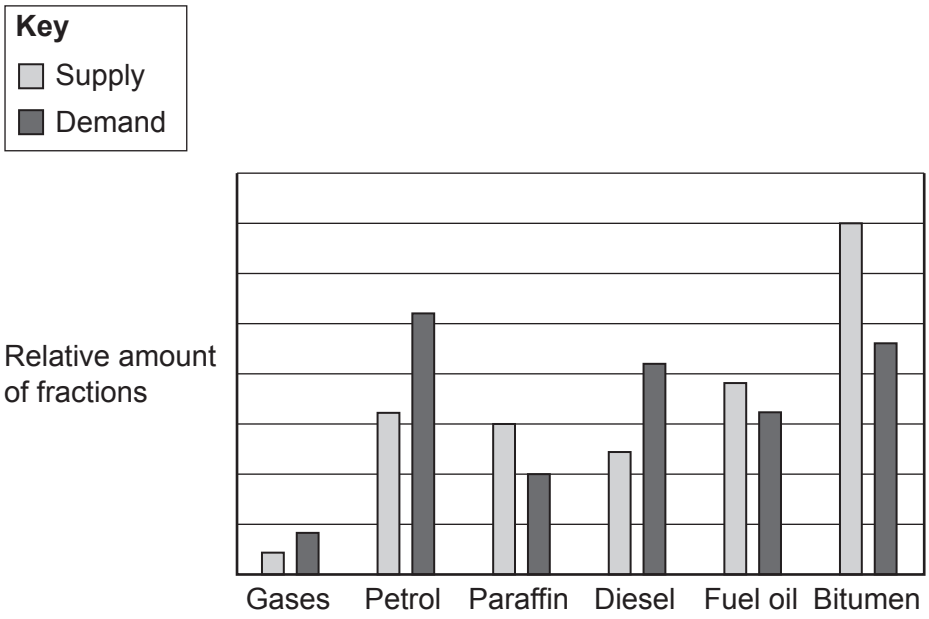
(d) **Fig. 14.3** shows the supply and demand of different fractions of crude oil.

Fig. 14.3



Give **two** reasons why the oil industry turns paraffin into different hydrocarbons.

Use data from **Fig. 14.3**.

1 .....

.....

2 .....

.....

[2]

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15* Carrier bags can be made from either **recycled paper** or **biodegradable plastic** (which will decay and break down when in the ground).

Figs 15.1 to **15.4** show information about the production of carrier bags from recycled paper and from biodegradable plastic.

Fig. 15.1

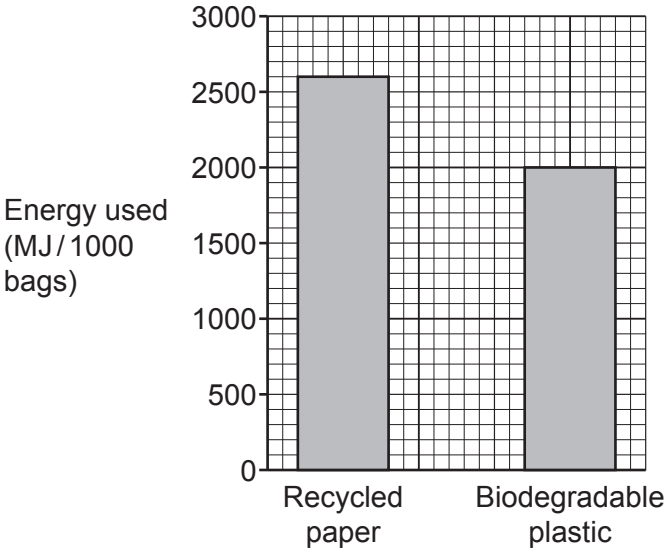


Fig. 15.2

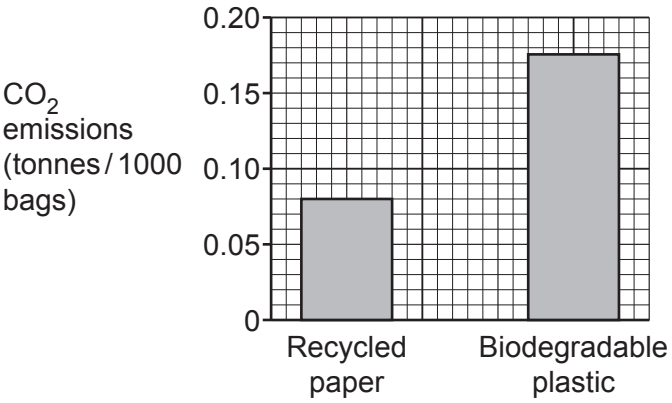


Fig. 15.3

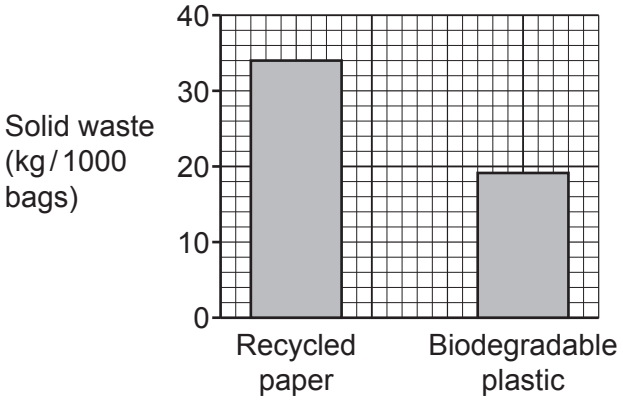
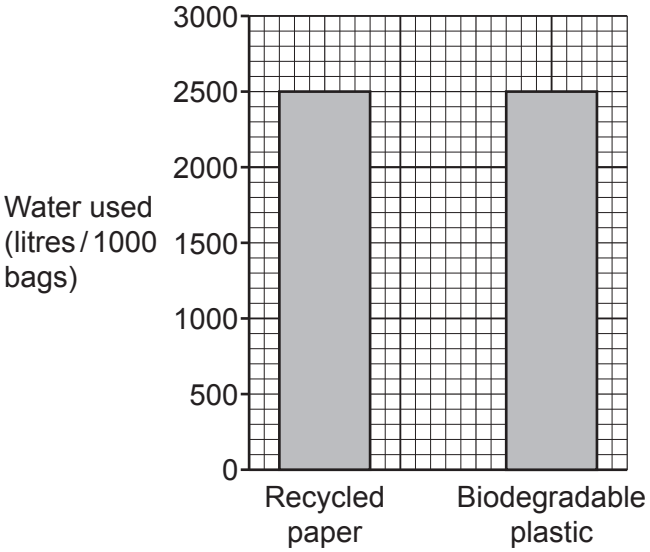


Fig. 15.4



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Suggest whether the carrier bags should be made from recycled paper or biodegradable plastic.

Explain your choice using the information from **Figs 15.1** to **15.4** and your own scientific knowledge.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

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

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16 This question is about the Group 7 elements.

Table 16.1 shows some information about the Group 7 elements.

Table 16.1

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 16.1**. **[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]

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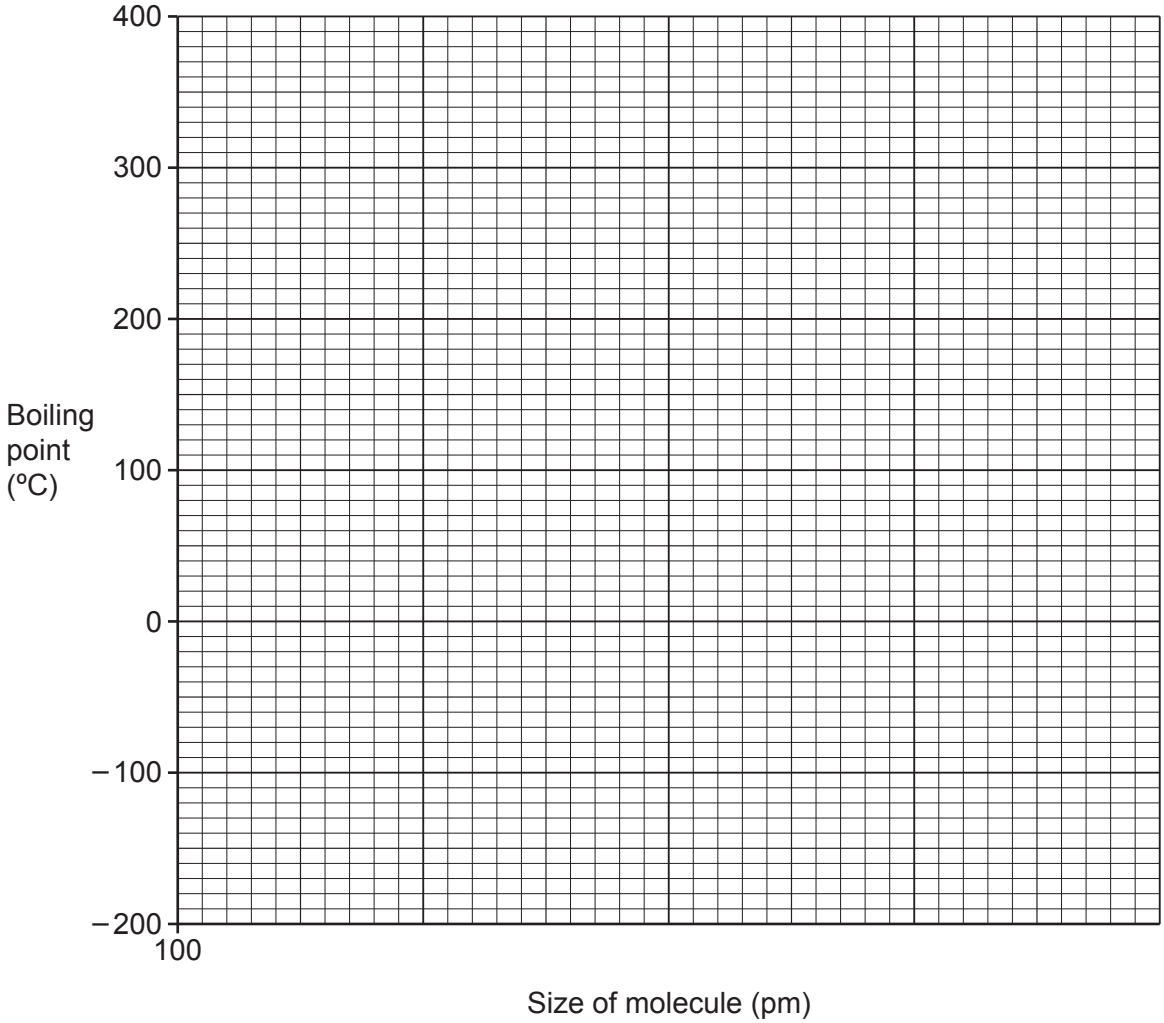
(d) (i) Use **Table 16.1** to complete the x axis and plot a **line graph** of the boiling points of fluorine, chlorine, iodine and astatine against the size of their molecules.

Draw a line of best fit.



[4]

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

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

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Table 16.1 is repeated below.

Table 16.1

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 16.1**.

1 .....

.....

2 .....

.....

[2]

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

Similarity .....

.....

Difference .....

.....

[2]

END OF QUESTION PAPER

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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).

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