Oxford Cambridge and RSA

Monday 19 May 2025 – Morning

GCSE (9−1) Chemistry B (Twenty First Century Science)

J258/01 Breadth in Chemistry (Foundation Tier)

Time allowed: 1 hour 45 minutes

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

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

F

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 **[ ]**.
- This document has **32** pages.

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

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1 Greenhouse gases absorb energy emitted by the Earth.

(a) Carbon dioxide is a greenhouse gas.

(i) Which of these gases is another greenhouse gas?

Tick (✓) **one** box.

Methane ☐

Nitrogen ☐

Oxygen ☐

[1]

(ii) Which **two** statements describe the possible effects of increased levels of greenhouse gases?

Tick (✓) **two** boxes.

Decreased algae growth in water. ☐

Flooding of low land. ☐

Increased oxygen in the atmosphere. ☐

Melting of polar ice caps. ☐

[2]

(iii) Suggest **two** ways the amount of carbon dioxide in the environment can be reduced.

1 .....

.....

2 .....

.....

[2]

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(b) The concentration of carbon dioxide in the atmosphere has increased over time.

Fig. 1.1 shows the concentration of carbon dioxide in the atmosphere over a 50-year period.

Fig. 1.1

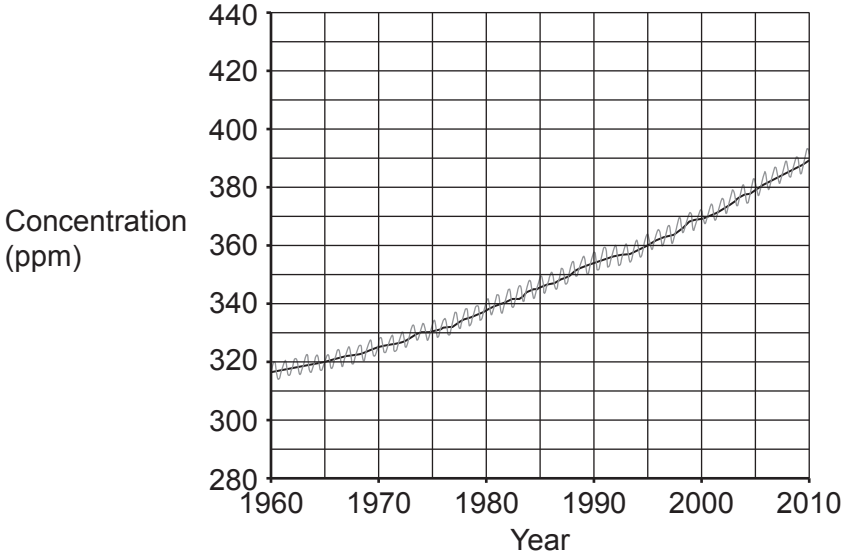
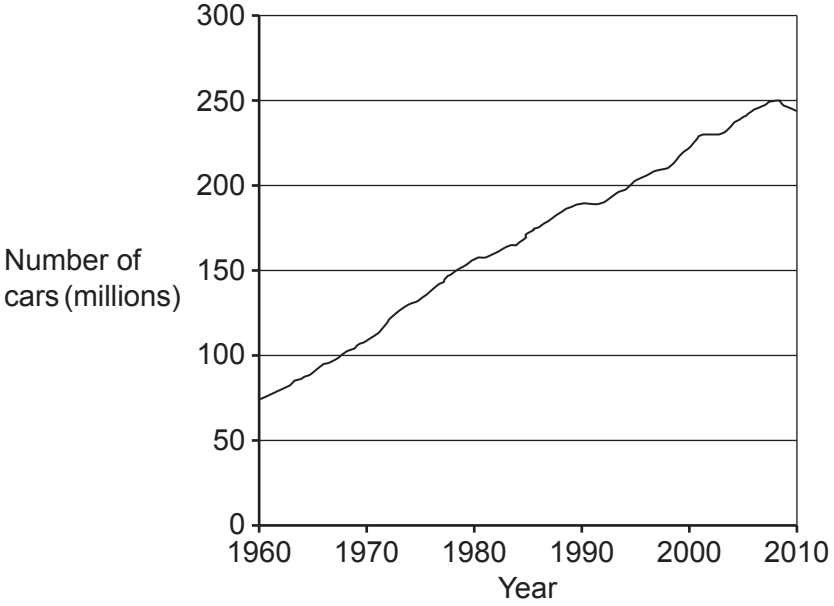


Fig. 1.2 shows the number of cars being used in the USA over the same 50-year period.

Fig. 1.2



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(i) Explain how the graphs shown in **Fig. 1.1** and **Fig. 1.2** show that there is a correlation between the number of cars being used and the concentration of carbon dioxide in the atmosphere.

.....

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

(ii) Calculate the increase in concentration of carbon dioxide in the atmosphere between 1960 and 2010.

Use **Fig. 1.1**.

Increase in concentration of carbon dioxide = ... ppm **[2]**

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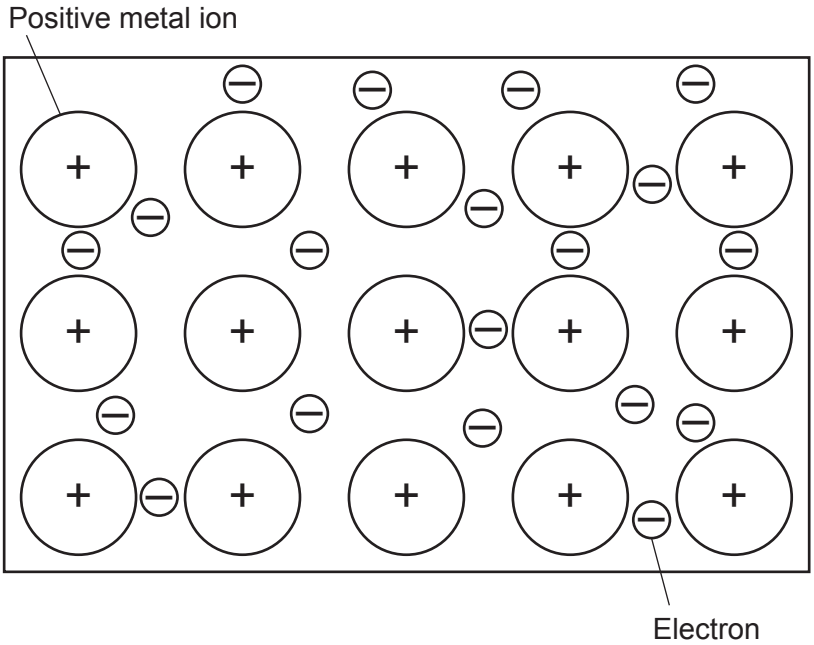
2 A student investigates the reactivity of metals.

(a) The diagram shows a model of a metallic structure.

The positive metal ions are shown as spheres, packed closely together in a regular pattern.



(i) What type of structure do metal atoms form?

Tick (✓) **one** box.

Covalent ☐

Giant ☐

Simple ☐

[1]

(ii) Draw lines to connect each **metal property** with its correct **explanation**.

Metal Property	**Explanation**
Conducts electricity	Electrons are free to move.
High melting point	Layers of ions are in fixed positions.
Malleable	Layers of ions can slide over each other.
	Strong electrostatic attraction.

[3]

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(b) Metals are placed in order of reactivity by observing their reactions.

A student adds three metals to water and dilute hydrochloric acid and observes the reactions.

The table shows their results.

Metal	**Reaction with water**	**Reaction with dilute hydrochloric acid**
Potassium	Reacts violently	Reacts violently
Zinc	No reaction	Slow reaction
Silver	No reaction	No reaction

(i) Which of the metals in the table is the **least** reactive?

Explain your answer.

Least reactive metal .....

Explanation .....

.....

.....

[2]

(ii) What happens to metal atoms when they lose electrons?

Tick (✓) **one** box.

They form double bonds. ☐

They form negative ions. ☐

They form positive ions. ☐

They form protons. ☐

[1]

(iii) Complete the **word** equation for the reaction of potassium with dilute hydrochloric acid.

potassium + hydrochloric acid → hydrogen + ...

[1]

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3 The properties of elements in the same group of the Periodic Table show trends.

(a) **Table 3.1** shows information about some Group 7 elements.

Table 3.1

Element	**Formula**	**State at room temperature and pressure**	**Colour at room temperature and pressure**	**Colour in the gas state**
Chlorine	Cl_2	Gas	Yellow-green	.....
Bromine	Br_2	.....	Deep-red	Red-brown
Iodine	.....	Solid	Grey	Purple

Complete **Table 3.1**. **[3]**

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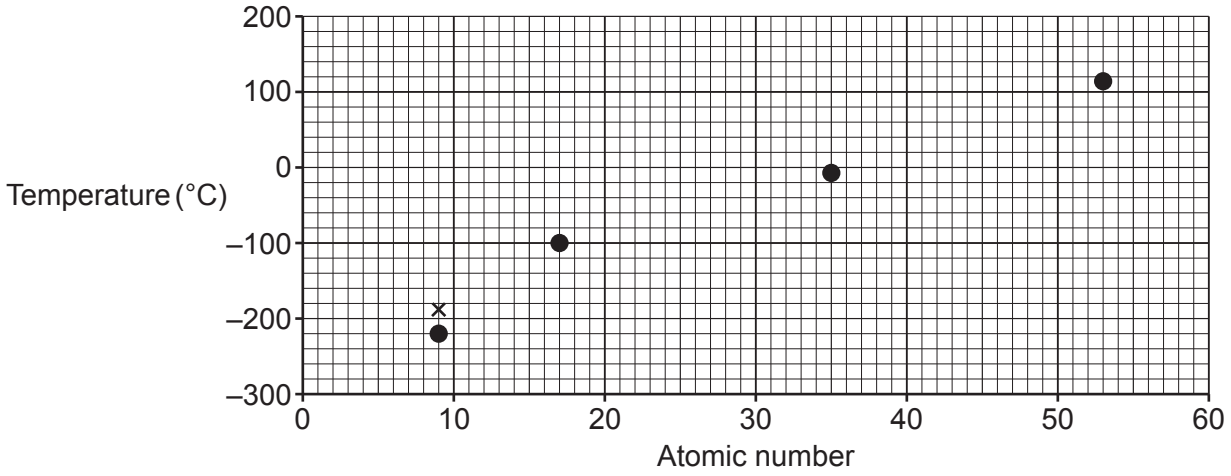
(b) **Table 3.2** shows the atomic number, melting point and boiling point of some Group 7 elements.

Table 3.2

Name	Atomic number	Melting point (°C)	Boiling point (°C)
Fluorine	9	–220	–188
Chlorine	17	–102	**–35**
Bromine	35	–7	**59**
Iodine	53	114	**184**

The graph shows the melting point data from **Table 3.2**.

Key
● Melting point
× Boiling point



(i) Plot the boiling point data from **Table 3.2** on the graph.

The boiling point of fluorine has been done for you. **[2]**

(ii) Find whether iodine is a solid, liquid or gas at 100 °C.

Tick (✓) **one** box.

Solid ☐

Liquid ☐

Gas ☐

[1]

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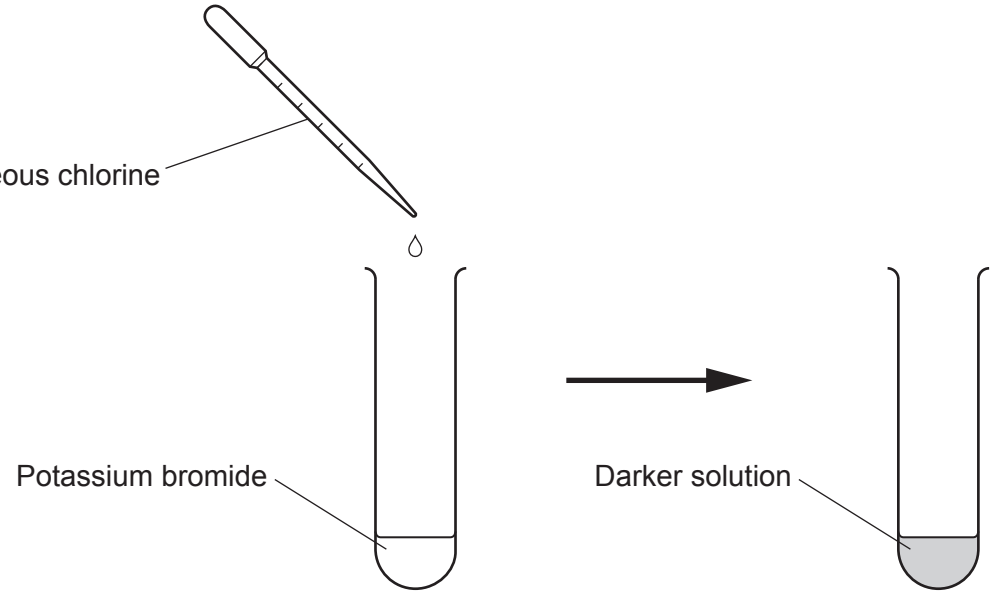
(c) A student investigates the reactivity of chlorine and bromine.

They add aqueous chlorine to aqueous potassium bromide.

A colour change is seen.



(i) Which of these is a **product** of the reaction?

Tick (✓) **one** box.

Bromine ☐

Chlorine ☐

Potassium ☐

[1]

(ii) What is the name for this type of reaction?

Tick (✓) **one** box.

Combustion ☐

Displacement ☐

Neutralisation ☐

Titration ☐

[1]

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4 Many useful products contain mixtures.

(a) Cement is a product used in the construction industry.

It contains substances mixed together in definite proportions.

(i) What is the name of this type of mixture?

Tick (✓) **one** box.

Compound ☐

Element ☐

Formulation ☐

Pure ☐

[1]

(ii) The table shows the percentage of each substance used in one type of cement.

Substance	**Percentage (%)**
Calcium oxide	91.5
Magnesium oxide	3.5
Water	

Calculate the percentage of water in this cement.

Percentage of water = ... % **[1]**

(iii) Cement can be harmful to skin and eyes.

State **one** safety precaution that must be taken when using cement.

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

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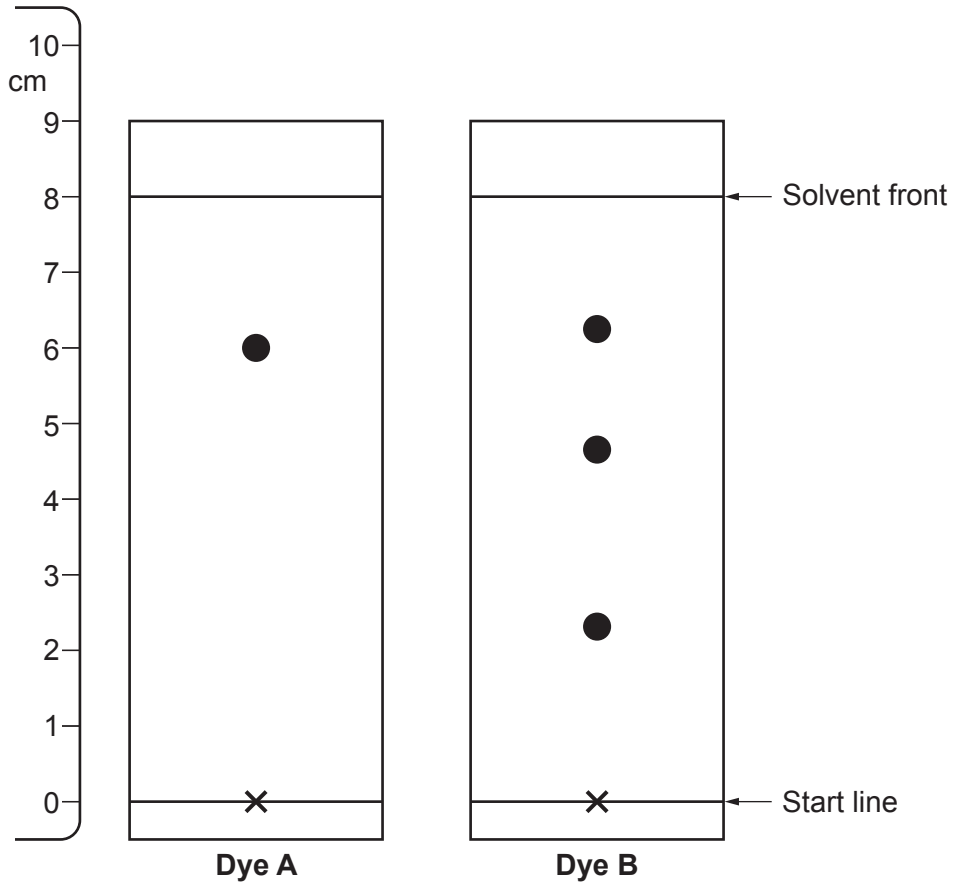
(b) A scientist uses paper chromatography to separate the colours in two dyes.

Fig. 4.1 shows the results.

Fig. 4.1



(i) The scientist thinks that dye B is a mixture.

Explain how the results show that dye B is a mixture.

.....

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

(ii) Calculate the R_f value for the colour used in dye A.

Use the formula: $R_f = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$

R_f = ... **[2]**

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(iii) Paper chromatography uses two phases.

The **mobile** phase is the solvent.

What is the name of the **other** phase?

Tick (✓) **one** box.

Separation ☐

Solute ☐

Stationary ☐

[1]

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5 Some substances have a covalent structure.

(a) Which **two** statements about covalent bonds are **true**?

Tick (✓) **two** boxes.

A covalent bond always forms between electrons in the shell closest to the nucleus. ☐

A covalent bond forms between two non-metals. ☐

A covalent bond forms from a shared pair of electrons. ☐

A covalent bond is very weak. ☐

[2]

(b) Ammonia has a simple covalent structure.

(i) Ammonia has a low boiling point.

Complete the sentences to explain the low boiling point of ammonia.

Use words from the list.

atoms	**bonds**	**ions**	**molecules**

Ammonia molecules have covalent bonds joining the ..... within the molecule.

To boil ammonia, energy is transferred to it.

A small amount of energy is needed because of the weak forces of attraction between

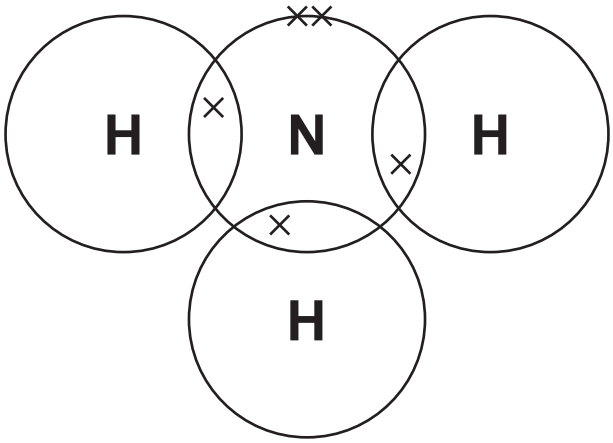
the ..... .

[2]

(ii) **Complete** the dot and cross diagram for ammonia.

Hydrogen has 1 electron.

The electrons for nitrogen have been done for you.



[2]

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(c) Diamond is a covalent structure.

Diamond is a naturally occurring material containing only carbon.

(i) State the number of covalent bonds that carbon forms.

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

(ii) Diamond is a pure substance.

Explain what is meant by a pure substance.

.....

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

(iii) State **one** property of diamond.

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

(iv) Which statements about the nature and arrangement of bonds in diamond are **true** and which are **false**?

Tick (✓) **one** box in each row.

	True	**False**
Diamond contains delocalised electrons.		
Diamond has a 2D arrangement of atoms.		
Diamond has a giant structure.		
Diamond is an allotrope of carbon.		

[3]

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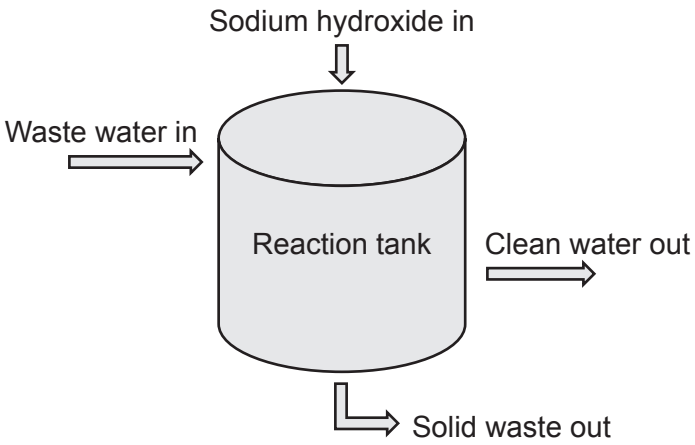
6 Waste water is treated to remove impurities before it is released into rivers.

Waste water from a factory contains aqueous copper chloride as an impurity.

The copper chloride is removed in a reaction with aqueous sodium hydroxide.

Fig. 6.1 shows the reaction tank where copper chloride is removed.

Fig. 6.1



(a) The word equation for the reaction is:

copper chloride + sodium hydroxide → copper hydroxide + sodium chloride

(i) Complete the **balanced symbol** equation for the reaction.

$$CuCl_2(aq) + ...NaOH(aq) \rightarrow Cu(OH)_2(s) + 2.....(aq)$$

[2]

(ii) The copper hydroxide produced in the reaction is **insoluble** in water.

Name the process used to remove the copper hydroxide from the water.

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

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(iii) Scientists use analysis to calculate the mass of copper chloride in the waste water.

What is the name for this type of analysis?

Tick (✓) **one** box.

Experimental ☐

Instrumental ☐

Qualitative ☐

Quantitative ☐

[1]

(b) A scientist wants to identify the metal ions contained in four different samples of waste water.

The scientist uses dilute sodium hydroxide to test each of the four samples.

The table shows their results.

Sample	Observation
A	light blue precipitate
B	green precipitate
C	white precipitate
D	white precipitate

(i) Complete the method for the tests.

1. Place four test tubes in a test tube holder.
2. .....

.....

3. .....

.....

4. Record results.

[2]

(ii) Which water sample, **A**, **B**, **C** or **D** contains copper ions?

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

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7 Crude oil is a mixture of hydrocarbons.

(a) Crude oil is separated into fractions by fractional distillation.

(i) Modern life is dependent on crude oil.

Which statements about crude oil are **true** and which are **false**?

Tick (✓) **one** box in each row.

	True	False
Crude oil contains substances that combust.		
Crude oil is a feedstock for the petrochemical industry.		
Crude oil is a renewable resource.		
Crude oil is a source of coal.		

[3]

(ii) Complete the sentences to describe fractional distillation.

Use words from the list.

different	**equal**	**gases**
solids	**strongest**	**weakest**

In fractional distillation, the hydrocarbons are separated because their boiling points are

..... .

The smallest hydrocarbon molecules have the ..... intermolecular forces so

leave the column as ..... .

[3]

(iii) Name the process in which long chain hydrocarbon molecules are broken down into smaller, more useful hydrocarbon molecules.

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

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(b) Crude oil contains hydrocarbons from the alkane homologous series.

Table 7.1 shows information about the first five alkanes in the series.

Table 7.1

Alkane	**Molecular formula**	**Boiling point (°C)**
Methane	CH_4	–162
Ethane	C_2H_6	–89
Propane	C_3H_8	–42
Butane	C_4H_{10}	–1
Pentane	C_5H_{12}	

(i) Find the empirical formula of butane.

Empirical formula = ... **[1]**

(ii) Predict the boiling point of pentane.

Explain your answer using information from **Table 7.1**.

Boiling Point ..... °C

Explanation .....

.....

.....
[2]

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8 PET is the plastic most commonly used to make plastic bottles.

About 13 billion of these bottles are produced in the UK each year.

(a) Life cycle assessments are used to consider the overall impact of plastic bottles.

Complete the sentences to describe the basic principles of a life cycle assessment.

Use words from the list.

disposal	**environment**	**information**
use	**water**	

A life cycle assessment involves collecting data from each stage in the life cycle of a product.

Manufacturers can assess the use of raw materials, energy and ..... from manufacture to ..... of the product.

A life cycle assessment considers the impact on the ..... of each of the stages. **[3]**

(b) Explain the difference between the terms **reuse** and **recycle**.

.....

.....

.....

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

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(c) Disposal of the products is an important step to consider when conducting a life cycle assessment of PET bottles.

The table shows some information about the incineration, landfill and recycling of PET bottles.

	Incineration	**Landfill**	**Recycling**
Cost (per tonne of bottles disposed)	£250	£25	£300
Greenhouse gas released	Carbon dioxide	Carbon dioxide	None
Energy generated	Electricity	None	None
Raw material recovered (%)	0	0	80

(i) State **one** advantage and **one** disadvantage of the disposal of PET bottles by incineration.

Use the table to help you answer.

Advantage .....

.....

Disadvantage .....

.....

[2]

(ii) Explain how the data in the table supports this statement:

'Recycling of PET bottles has a less negative impact on the environment than incineration and landfill of them.'

.....

.....

.....

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

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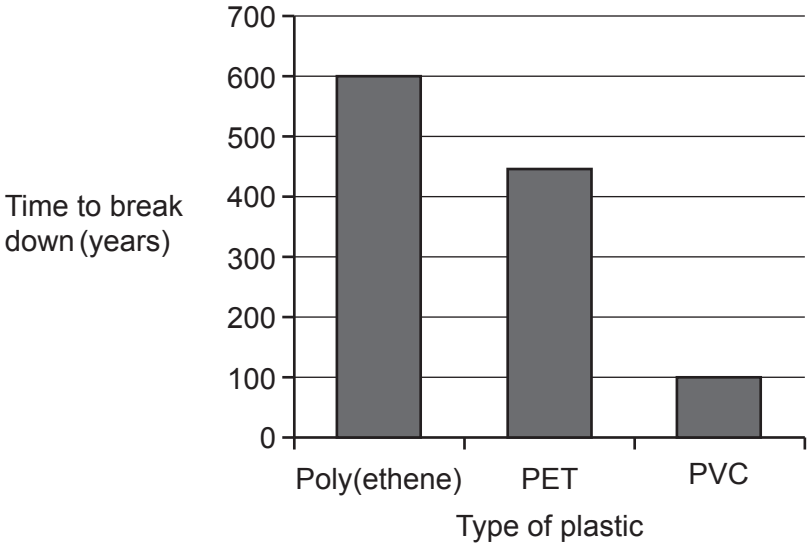
(d) PET and other plastics take a very long time to break down in the environment.

The graph shows the time taken for three types of plastics to break down in the environment.



Calculate the mean of the times taken for the three plastics to break down in the environment.

Use information from the graph.

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

Mean = ... years **[3]**

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9 A student investigates rate of reaction.

(a) The student does three experiments adding limestone to dilute hydrochloric acid.

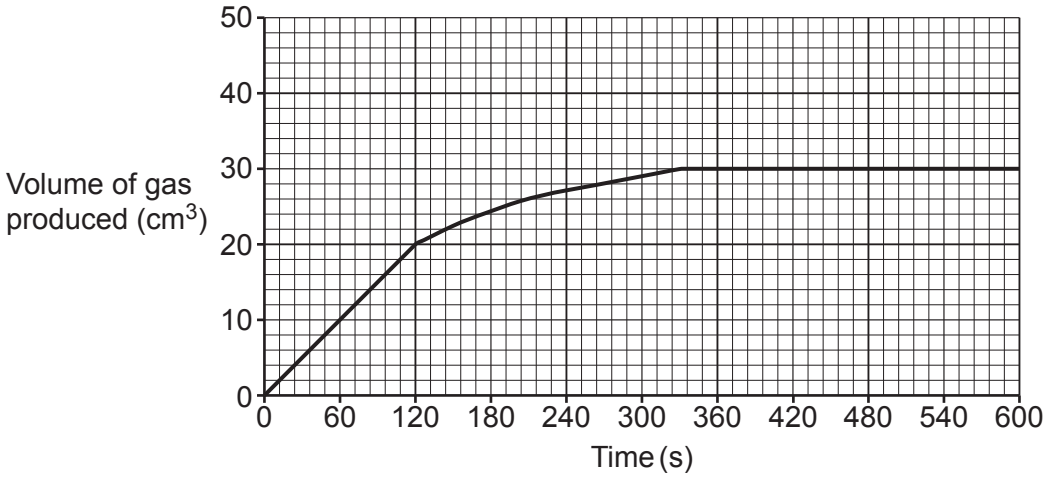
In all three experiments, the student keeps these the same:
- the mass of limestone
- the volume of acid
- the concentration of acid.

In experiment 1 the student adds **one** large piece of limestone to the acid at 20 °C.

The student measures the volume of gas produced every 30 seconds.

Fig. 9.1 shows the results of experiment 1.

Fig. 9.1



Calculate the rate of reaction during the first 120 seconds.

Use **Fig. 9.1**.

Give your answer to **2** decimal places.

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

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(b) **Table 9.1** shows the conditions used for all three experiments.

Table 9.1

	Type of limestone	Temperature (°C)
Experiment 1	Large piece	20
Experiment 2	Large piece	40
Experiment 3	Powder	40

(i) Draw a line on **Fig. 9.1** to show the expected results for experiment 2.

Use the information in **Table 9.1** to help you. **[2]**

(ii) Experiment 3 is the **fastest**.

Explain why.

Use the information in **Table 9.1**.

Include ideas about collisions in your answer.

.....

.....

.....

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

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(c) A scientist investigates the effect of four metals, **A**, **B**, **C** and **D**, on the rate of reaction to make ethane.

The scientist uses 5.0 g of each metal.

Table 9.2 shows their results.

Table 9.2

Metal	Mass of metal at end of reaction (g)	Time taken to make 10 g of ethane (s)
A	2.5	25
B	0.0	30
C	5.0	40
D	5.0	25

(i) Which metal **A**, **B**, **C** or **D** is the best metal to use as a catalyst in this reaction?

Explain your reasoning.

Use the information in **Table 9.2**.

Metal .....

Explanation .....

.....

.....

[2]

(ii) Which statements about catalysts are **true** and which are **false**?

Tick (✓) **one** box in each row.

	True	False
A catalyst changes the overall energy change for a reaction.		
A catalyst lowers the activation energy of a reaction.		
A catalyst provides an alternative route for a reaction.		

[2]

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10 Atoms contain protons, neutrons and electrons.

(a) The table shows the relative masses and relative charges of protons, neutrons and electrons.

Complete the table by filling in the blanks.

Particle	**Relative mass**	**Relative charge**
.....	1	.....
.....	.....	0
Electron	0.0005	–1

[2]

(b) **Fig. 10.1** shows information about fluorine.

Fig. 10.1

9
F
Fluorine
19.00

Find the number of protons, neutrons and electrons in an atom of fluorine.

Protons = ...

Neutrons = ...

Electrons = ...

[3]

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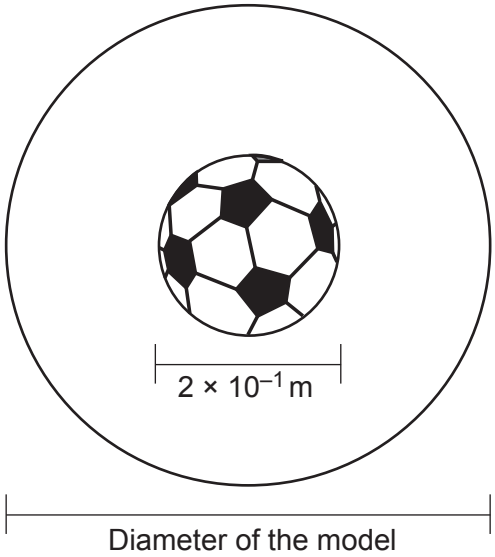
(c) The size and scale of atoms can be compared to objects in the physical world.

A student builds a model of a hydrogen atom using a football to represent the nucleus.

Fig. 10.2 shows their model.

Fig. 10.2



The diameter of the football is 2×10^{-1} m.

The diameter of a hydrogen atom is 5×10^{4} times bigger than its nucleus.

Calculate the diameter of the model of the hydrogen atom.

Give your answer in **standard form** in **metres**.

Diameter = ... m **[2]**

END OF QUESTION PAPER

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