

Modified Enlarged 24pt
OXFORD CAMBRIDGE AND RSA EXAMINATIONS

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
plus your additional time allowance**

YOU MUST HAVE:

a ruler (cm/mm)

the Data Sheet for GCSE (9–1)

Chemistry B (with this document)

the insert for Question 1 (with this document)

YOU CAN USE:

a scientific or graphical calculator

an HB pencil

Please write clearly in black ink.

Centre number

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Candidate number

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First name(s)

Last name

READ INSTRUCTIONS OVERLEAF



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 [].

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. [1]

Methane ☐

Nitrogen ☐

Oxygen ☐

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

Tick (✓) TWO boxes. [2]

Decreased algae growth in water.

☐

Flooding of low land.

☐

Increased oxygen in the atmosphere.

☐

Melting of polar ice caps.

☐

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

1 _____

2 _____

[2]

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

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

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

- (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.

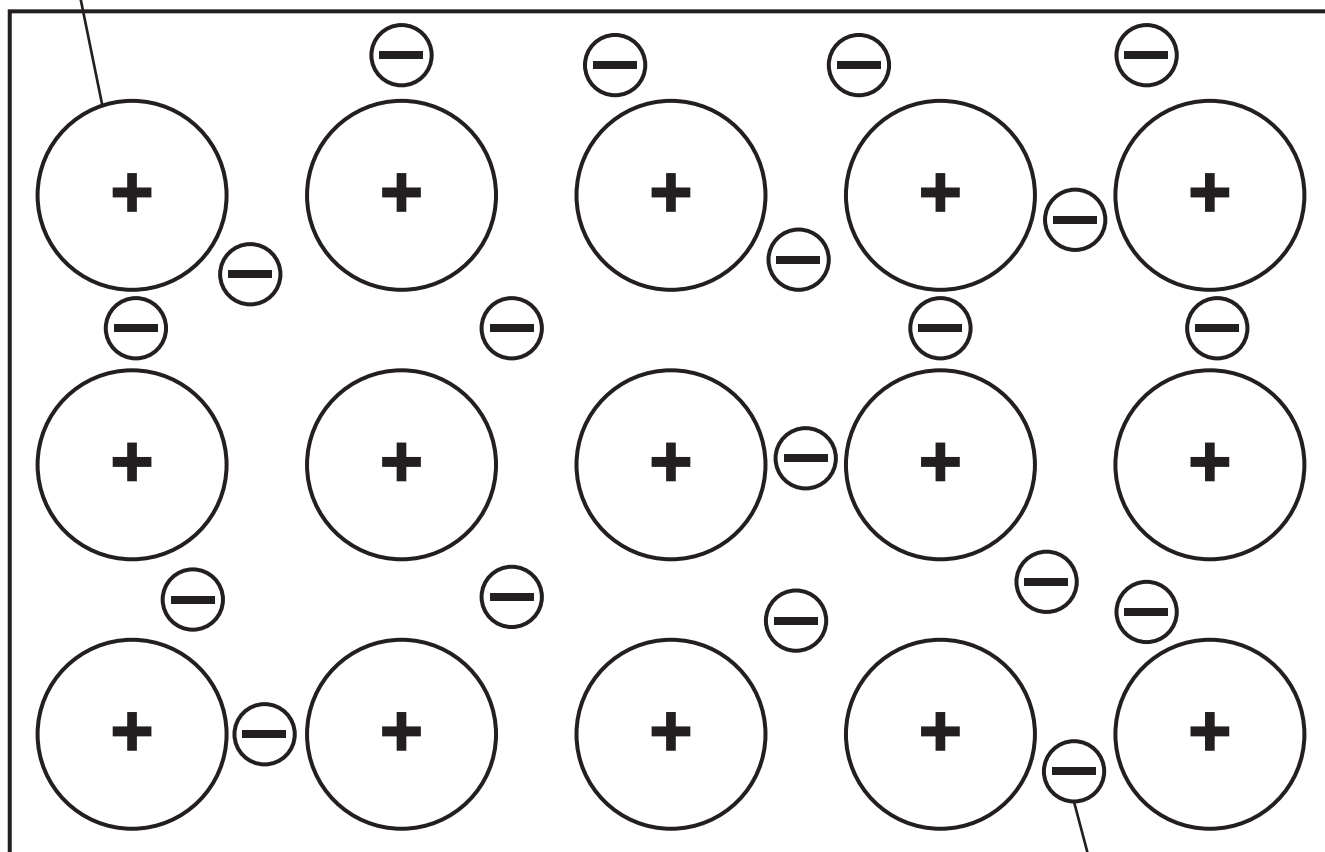
**Increase in concentration
of carbon dioxide = _____ ppm [2]**

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.

Positive metal ion



Electron

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

Tick (✓) ONE box. [1]

Covalent

☐

Giant

☐

Simple

☐

(ii) Draw lines to connect each METAL PROPERTY with its correct EXPLANATION. [3]

**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.**

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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? **[1]**

Tick (✓) ONE box.

They form double bonds.

☐

They form negative ions.

☐

They form positive ions.

☐

They form protons.

☐

(iii) Complete the WORD equation for the reaction of potassium with dilute hydrochloric acid. [1]

potassium + hydrochloric acid →

hydrogen + _____

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	Cl₂	Gas	Yellow-green	
Bromine	Br₂		Deep-red	Red-brown
Iodine		Solid	Grey	Purple

Complete TABLE 3.1. [3]

(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

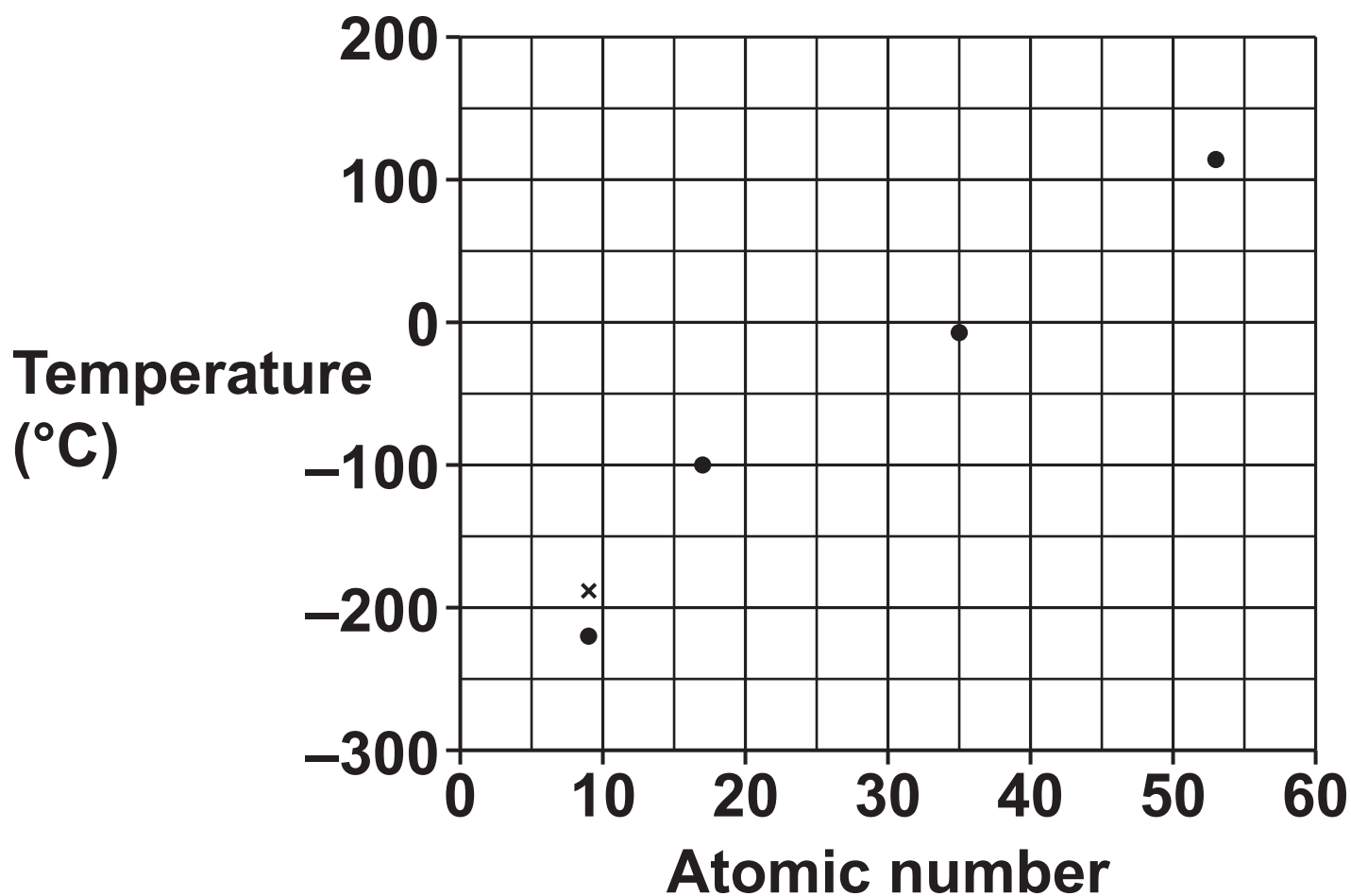
The graph opposite shows the melting point data from TABLE 3.2.

(i) Plot the boiling point data from TABLE 3.2 on the graph opposite.

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

KEY

- Melting point
- × Boiling point



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

Tick (✓) ONE box. [1]

Solid ☐

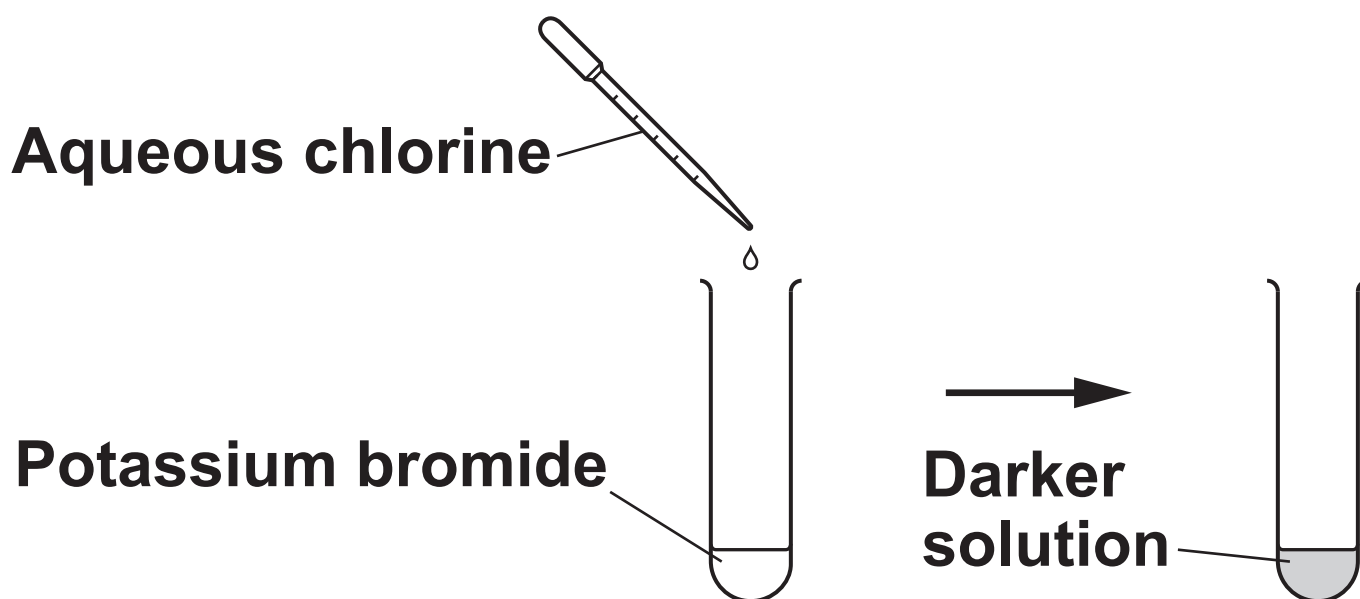
Liquid ☐

Gas ☐

(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. [1]

Bromine

☐

Chlorine

☐

Potassium

☐

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

Tick (✓) ONE box. [1]

Combustion

☐

Displacement

☐

Neutralisation

☐

Titration

☐

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. [1]

Compound ☐

Element ☐

Formulation ☐

Pure ☐

- (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.

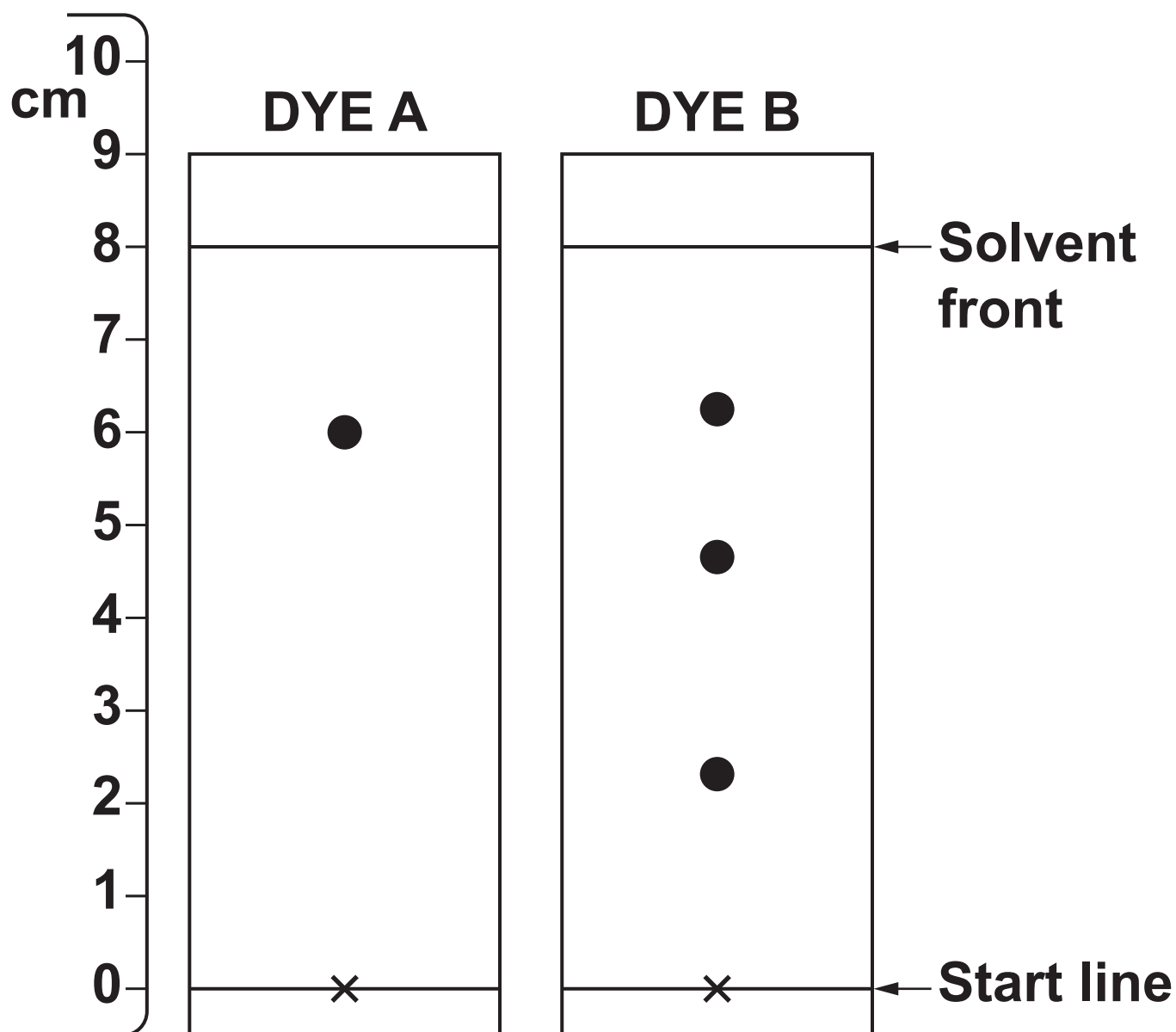
State ONE safety precaution that must be taken when using cement.

_____ [1]

(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:

$$R_f = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$$

$$R_f = \underline{\hspace{10em}} \quad [2]$$

(iii) Paper chromatography uses two phases.

The MOBILE phase is the solvent.

What is the name of the OTHER phase?

Tick (✓) ONE box. [1]

Separation

☐

Solute

☐

Stationary

☐

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5 Some substances have a covalent structure.

(a) Which TWO statements about covalent bonds are TRUE?

Tick (✓) TWO boxes. [2]

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.

☐

(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.

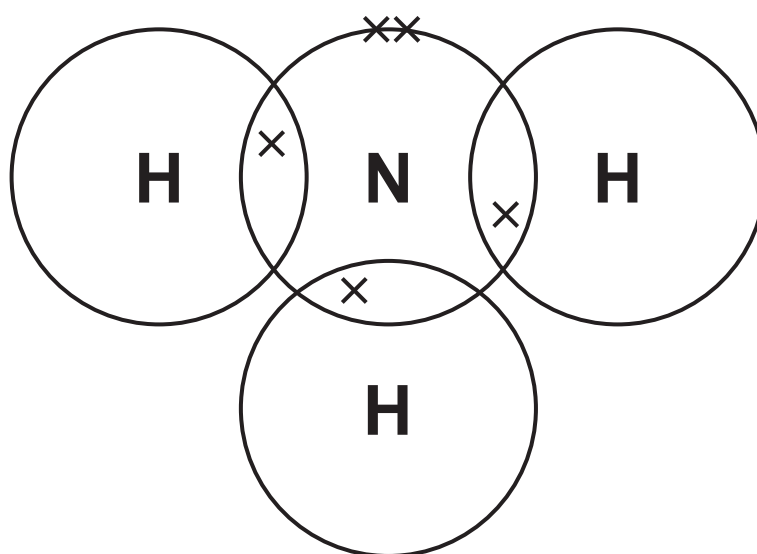
**To boil ammonia, energy is transferred
to it.**

**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]



(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. [3]

	TRUE	FALSE
Diamond contains delocalised electrons.		
Diamond has a 2D arrangement of atoms.		
Diamond has a giant structure.		
Diamond is an allotrope of carbon.		

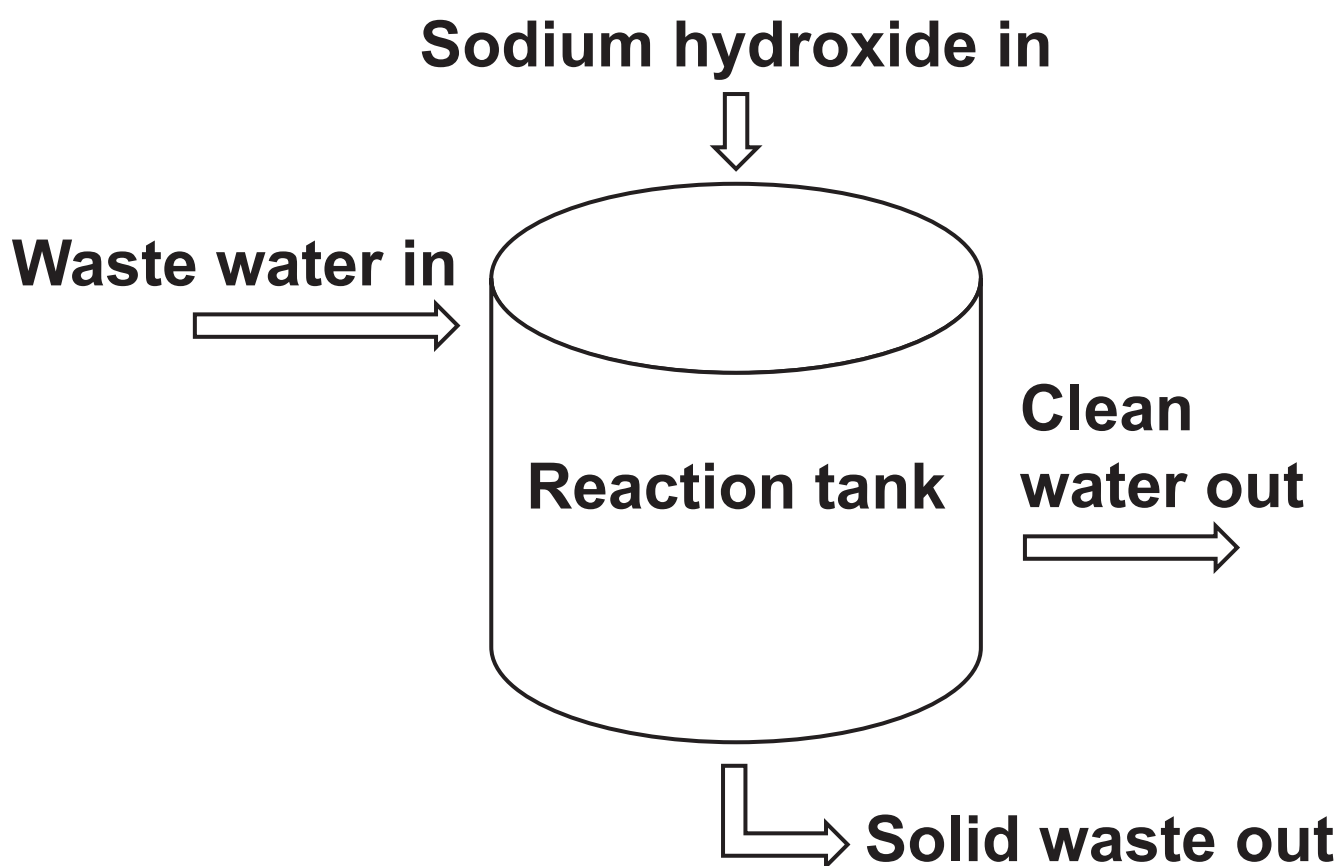
- 6 Waste water is treated to remove impurities before it is released into rivers.**

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.

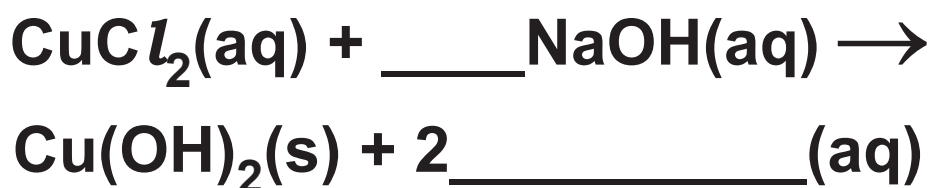
FIG. 6.1



(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. [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]

(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. [1]

Experimental

☐

Instrumental

☐

Qualitative

☐

Quantitative

☐

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(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]**

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. [3]

	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.		

(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]

(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 ₂ H ₆	–89
Propane	C ₃ H ₈	–42
Butane	C ₄ H ₁₀	–1
Pentane	C ₅ H 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]

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]

(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]

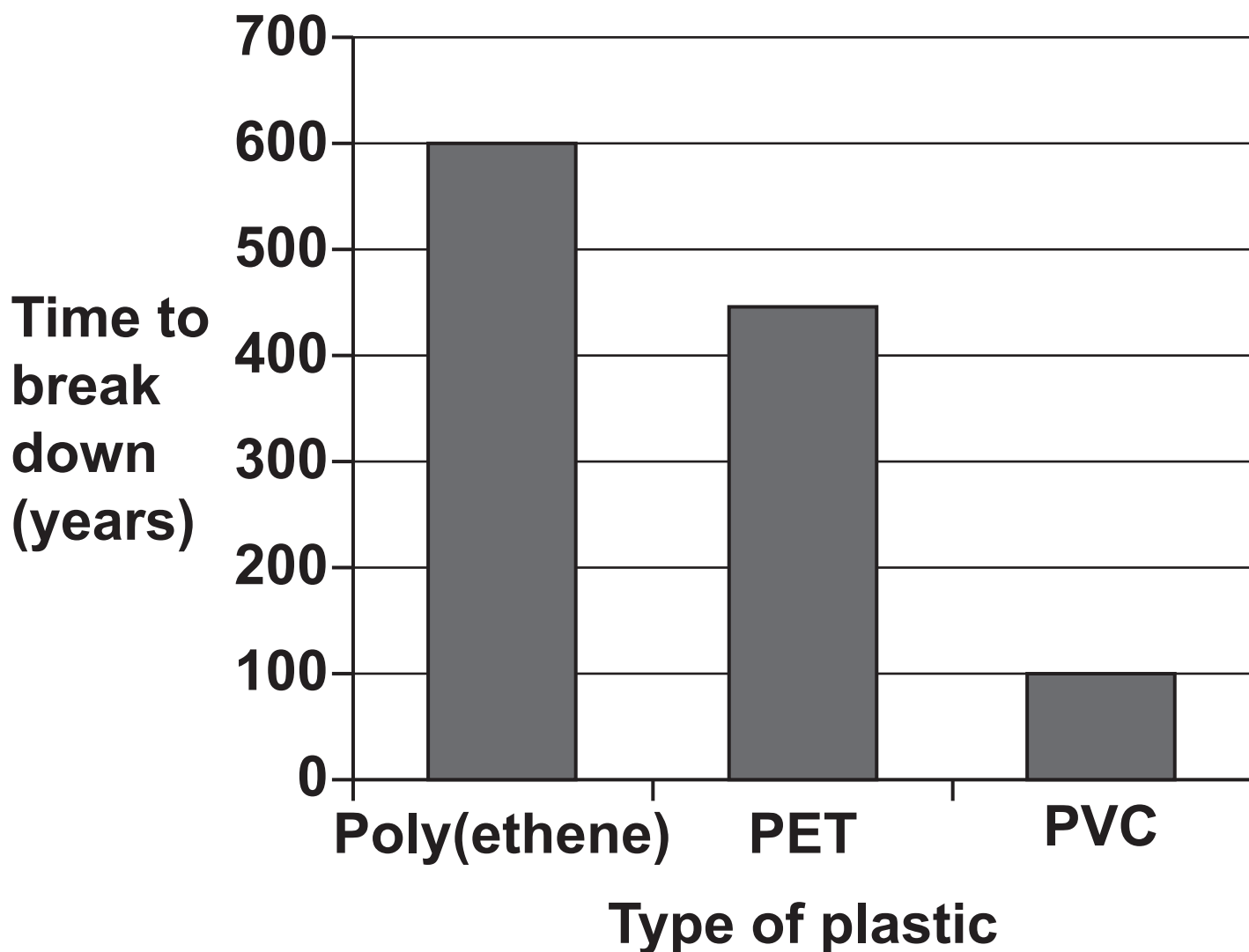
- (ii) Explain how the data in the table supports this statement:**

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

[2]

(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 opposite shows the results of experiment 1.

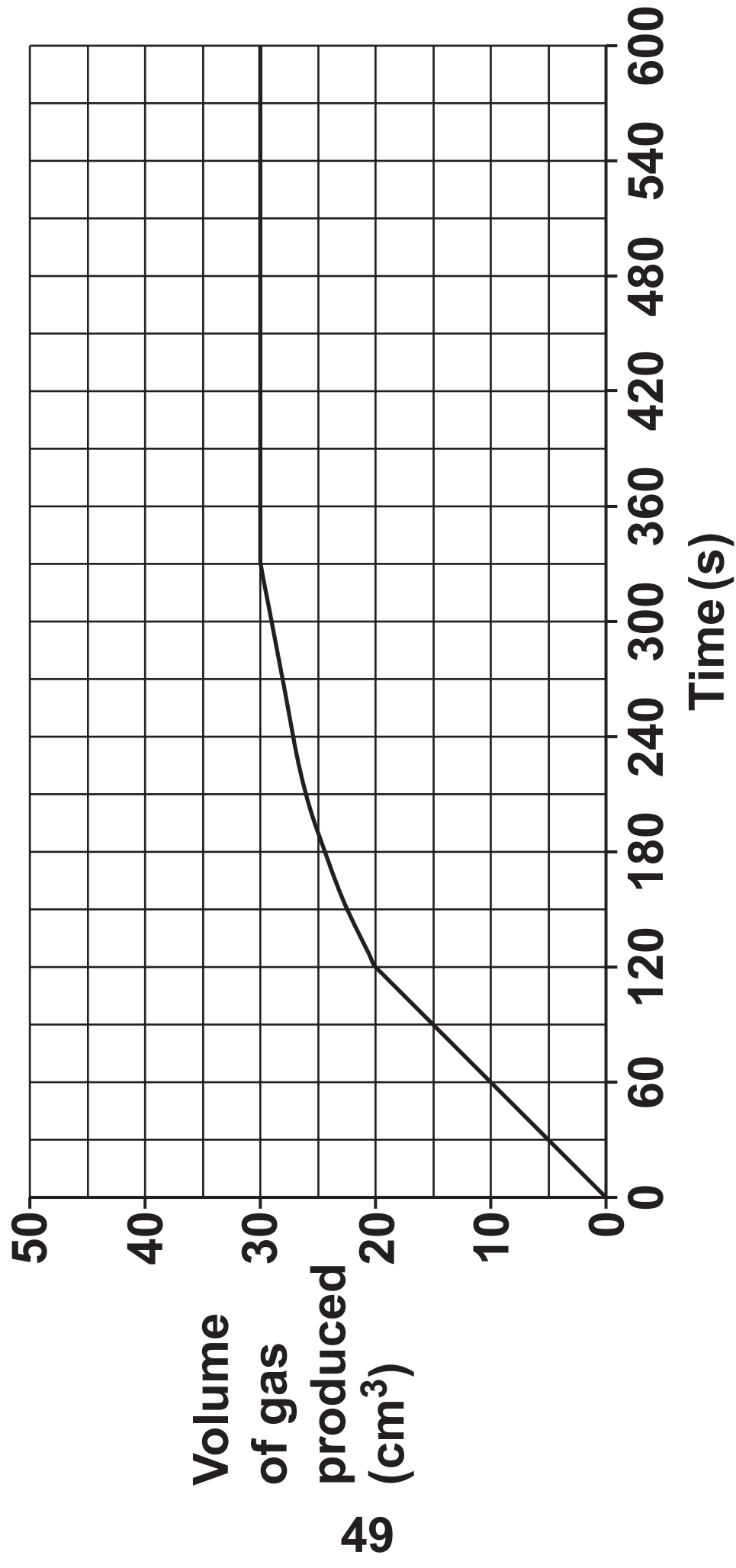
Calculate the rate of reaction during the first 120 seconds.

Use FIG. 9.1.

Give your answer to 2 decimal places.

Rate of reaction = _____ cm³/s [3]

FIG. 9.1



(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]

- (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. [2]

	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.		

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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. [2]

Particle	Relative mass	Relative charge
	1	
		0
Electron	0.0005	-1

(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 = _____

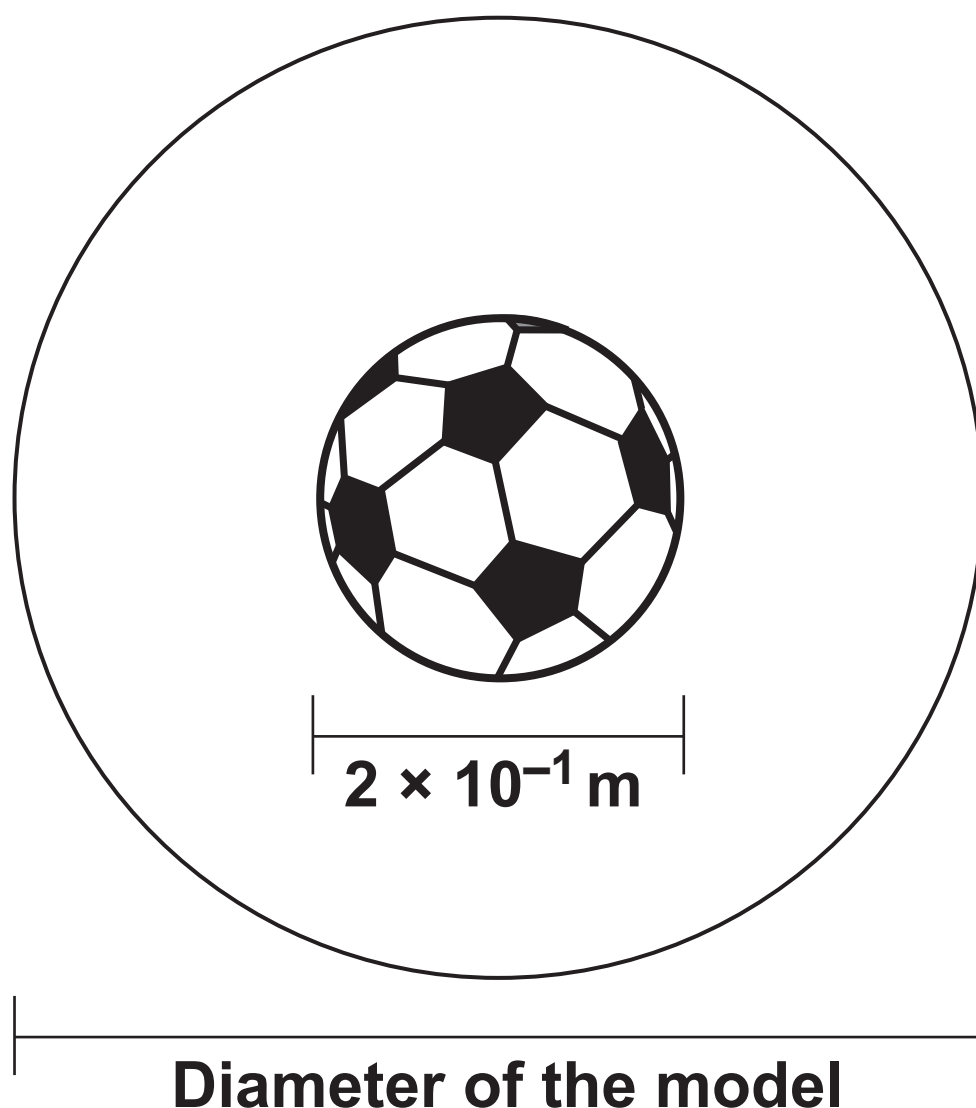
[3]

- (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

EXTRA ANSWER SPACE

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

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