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OCR
Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE CHEMISTRY B

J258

For first teaching in 2016

J258/02 Summer 2024 series

Version 1

ocr.org.uk/science

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Paper 2 series overview

This paper was intended to assess the depth of chemical knowledge shown by the candidates. Most candidates were able to attempt many of the question.. To do well, candidates needed to make use of the information they had been given but also to bring their own knowledge of chemistry into play. The extended prose required in some questions (Question 6 (a) and Question 8) is a challenge for candidates. However, these questions often provide a structure which the best candidates use to good effect. Some candidates showed familiarity with laboratory practice (Question 11 (a) (i)) and experimental design but there is much scope for improvement here. Questions 10 and 11 overlap with the Higher Paper so provided some of the most demanding challenges.

To achieve a good grade, candidates needed to take careful note of the questions as there is often key information in the stem. Some candidates also lost marks by misreading the question or answering a question of their own devising. Candidates seemed able to access the whole paper and many of the questions were attempted throughout.

There was little or no indication of time pressure or other constraints for most candidates.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• understood atomic structure and properties of sub-atomic particles (Question 1) • used the question stem to structure a complete answer (Questions 6 (a) and 8) • could substitute data in an equation, rearrange and then evaluate it (Question 10 (b)) • plotted and interpreted graphical data successfully (Questions 4 and 9) • integrated their knowledge with the information in the question (Question 4 (c)).	• did not give the required number of responses (Questions 3 (b), 4 (b), 4 (c) (ii) and 9 (c)) • did not demonstrate familiarity with laboratory apparatus (Question 11 (a) (i)) • were not confident in handling very large numbers (Questions 4 and 10) • could not draw structural formulae with the correct numbers of bonds to each atom (Question 7).

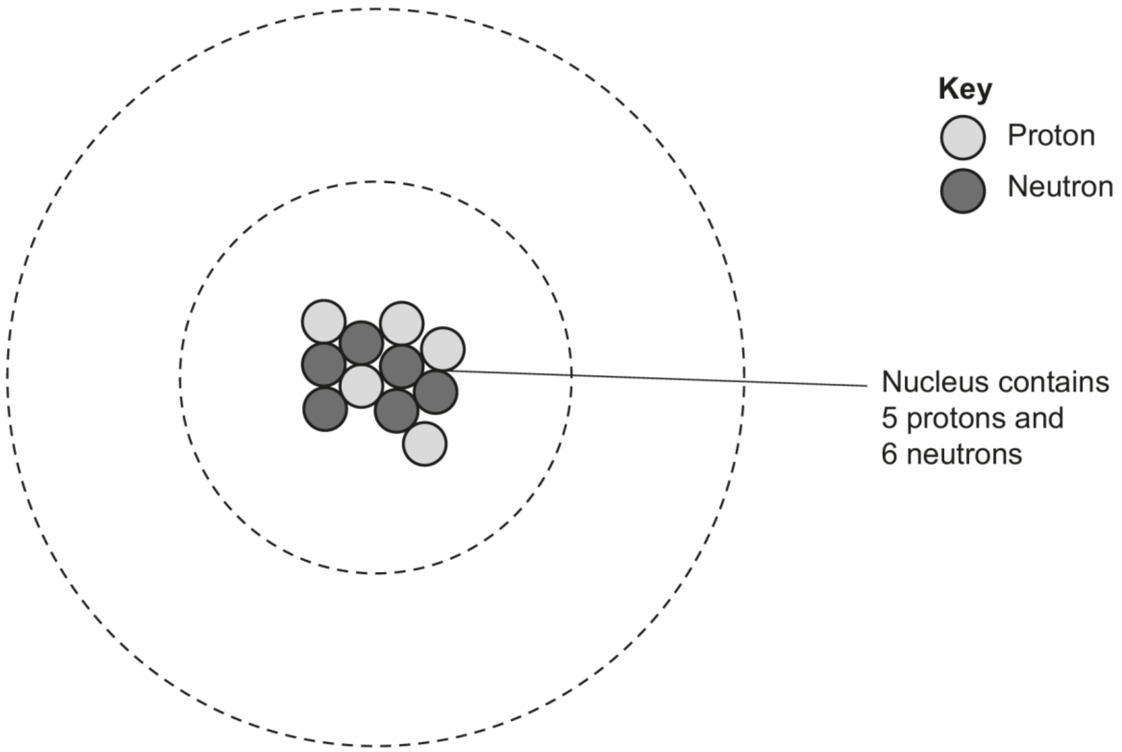
Question 1 (a)

1 A student makes a model of an atom.

(a) The student uses small, coloured beads to represent the protons and neutrons in the nucleus of the model. This is shown in the diagram below.

Complete the diagram to show the correct arrangement of electrons in the atom.

Use **X** to represent each electron.



[2]

Most candidates were able to show electrons in orbitals, but not all were aware that there would only be five electrons overall.

Question 1 (b)

(b) Complete the sentences.

Use words from the list.

ions	**negative**	**neutral**	**neutrons**	**positive**	**protons**

Atoms contain a nucleus with a .... charge.

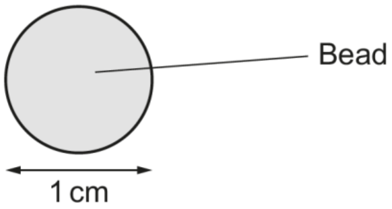
The atomic number gives the number of .... in an atom.

[2]

There were many good answers here.

Question 1 (c)

(c) The bead the student uses to represent a proton has a diameter of 1 cm.



The student finds out that an atom is 1×10^5 times larger than a proton.

If they make their model to scale, what is the diameter of the model atom?

Put a (ring) around the correct option.

100 cm **1000 cm** **10 000 cm** **100 000 cm**

[1]

This was generally well understood.

Question 1 (d) (i)

(d) The student makes models of some other atoms.

The particles in each atom are shown in the table.

Atom	Number of protons	Number of neutrons	Electron arrangement
A	3	4	2.1
B	8	8	2.6
C	12	12	2.8.2

(i) Which atom, **A**, **B** or **C**, has the **highest** mass number?

Explain your answer.

Atom ....

Explanation ....

....
[2]

Most candidates identified atom C as having the highest mass number, but some associated this with the number of electrons.

Question 1 (d) (ii)

(ii) The student uses the table to decide **A** is a metal atom.

The student is correct.

How does the student know?

Tick (✓) **one** box.

Atom **A** has one electron in the outer shell. ☐

Atom **A** has two electrons in the first shell. ☐

Atom **A** has two shells of electrons. ☐

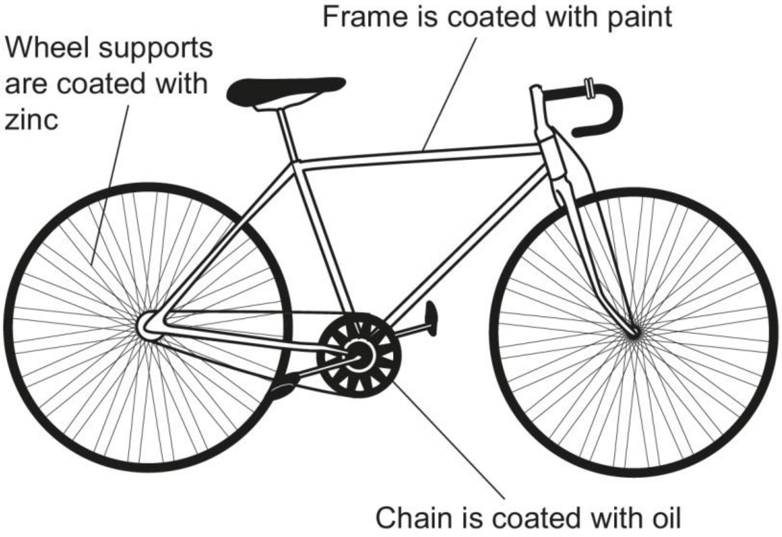
[1]

Most candidates recognised that metallic character is related to the outer shell of electrons.

Question 2 (a)

2 The parts used to make a bike contain mainly iron.

The diagram shows the methods to prevent corrosion that are used on some parts of a bike.



(a) Some methods to prevent corrosion work by forming a protective barrier. Some work by sacrificial protection.

Draw lines to connect each **coating** with **how the coating prevents corrosion** on the bike.

Coating	**How the coating prevents corrosion**
Oil	Forms a protective barrier.
Paint	
Zinc	Works by sacrificial protection.

[2]

Although any of the three coatings may form part of a protective barrier, the unique purpose of zinc is sacrificial protection.

Question 2 (b)

(b) Iron to make bikes is extracted from iron oxide.

During the extraction, iron oxide reacts with carbon monoxide to make iron.

When iron corrodes it reacts with oxygen to form iron oxide.

The equations show what happens in these two reactions.

Extraction: $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

Corrosion: $4Fe + 3O_2 \rightarrow 2Fe_2O_3$

Explain the difference between oxidation and reduction.

Use examples from the equations in your answer.

....

....

....

....

....

.... **[3]**

Carefully prepared candidates often quoted OILRIG (Oxidation is Loss, Reduction is Gain) without always associating this with electrons rather than oxygen itself.
Very few candidates were able to access the final mark, showing how both oxidation and reduction are involved in both extraction and corrosion.

Question 3 (a)

3 A scientist works in a laboratory that does research into medicines.

They use distilled water to make different formulations of medicines for testing.

(a) Which statements about formulations are **true** and which are **false**?

Tick (✓) **one** box in each row.

	True	False
Formulations are a mixture of substances.		
Formulations contain elements bonded together to make a single compound.		
The amount of each substance in a formulation is carefully controlled.		

[2]

Almost all candidates were aware that the amounts of substances are carefully controlled, and most were aware that formulations are usually mixtures.

Question 3 (b)

(b) The scientist uses distilled water for their medicines.

They use simple distillation to distil tap water.

What changes happen during simple distillation?

Tick (✓) **two** boxes.

Condensation ☐

Dissolving ☐

Evaporation ☐

Melting ☐

Precipitation ☐

[2]

How many ticks?

A significant number of candidates only ticked one box, despite the clear instruction.

Question 3 (c)

(c) Another worker says that tap water is already pure because it has been treated to kill bacteria.

Explain why tap water is **not** a pure substance.

....

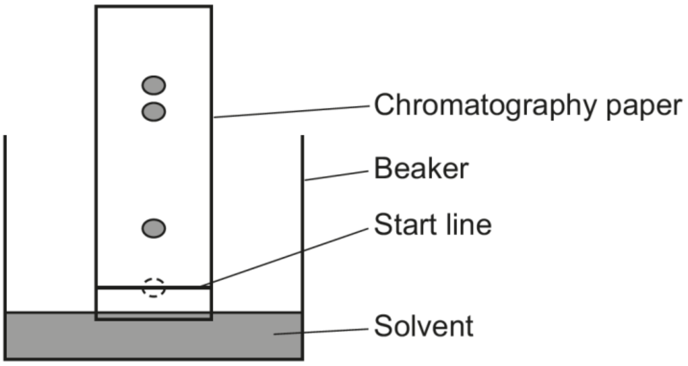
.... **[1]**

Impurities relate to dissolved substances, minerals in hard water and treatments like chlorine.

Question 3 (d)

(d) The scientist uses paper chromatography to separate the substances in one of their medicines.

The diagram shows their results.



Complete the sentences to explain why the substances in the medicine separate during chromatography.

Put a (ring) around the correct options.

The substances in the medicine move up because they dissolve in the **start line / solvent**.

The chromatography paper acts as the **stationary / mobile** phase.

The distance travelled by each substance depends on its **Rf value / melting point**.

[2]

This was fairly well known.

Question 3 (e)

(e) The scientist measures the melting point of some of the substances they use to make medicines.

The table below shows their results.

Substance	Melting point (°C)
A	102
B	151–156
C	2032
D	1040–1056

Which **two** substances are pure?

Explain your reasoning.

Pure substances ....

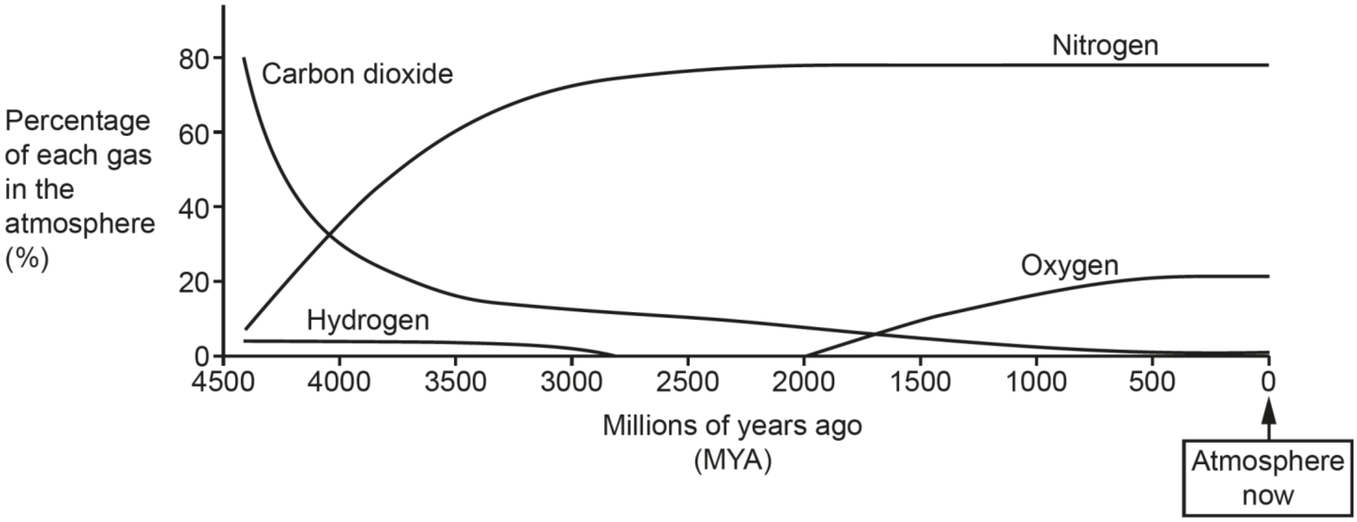
Explanation ....

....
[2]

Many candidates were aware that a mixture will have a melting range rather than a sharp melting point, although some seemed to guess that purity was associated with either a high or a low melting point.

Question 4 (a)

4 The graph shows how the percentages of some gases in the atmosphere have changed from 4400 million years ago (MYA) until now.



(a) Use the graph to predict when living things that photosynthesise first appeared on Earth.

Explain your reasoning.

Living things that photosynthesise appeared .... MYA.

Explanation ....

....

....

.... **[3]**

Most candidates recognised that the key date was 2000 MYA. This marks the date when oxygen *starts* to build up in the atmosphere rather than simply increasing or passing the level of carbon dioxide. Stronger responses also recognised that oxygen is produced during photosynthesis.

Question 4 (b)

(b) Which statements about the graph are **true**?

Tick (✓) **two** boxes.

All of the hydrogen left the atmosphere over 3000 MYA. ☐

The percentage of carbon dioxide has decreased at the same rate for over 4000 million years. ☐

The percentages of gases in the atmosphere have stayed approximately constant for the last 500 million years. ☐

The percentage of nitrogen in the atmosphere today is similar to the percentage of carbon dioxide in the atmosphere 4400 MYA. ☐

[2]

Some candidates again chose only one statement.

Question 4 (c) (i)

(c) Scientists think that the Earth's early atmosphere came from volcanoes.

The table shows the percentage composition of gases from a volcano and in the Earth's atmosphere 4400 MYA.

Gas	**Percentage composition**	
	Volcano gas	**Earth's atmosphere 4400 MYA**
Water vapour	92%	5%
Carbon dioxide	4.6%	80%
Hydrogen	0.5%	4%

(i) Scientists think that water vapour from volcanoes turned into liquid water over 4000 MYA and formed the Earth's oceans.

What does this suggest about the temperature of the Earth at that time?

Explain your reasoning.

....

....

....

.... **[2]**

Many candidates associated the mention of volcanoes with high temperatures; they did not recognise that liquid water generally exists below 100°C.

Question 4 (c) (ii)

(ii) Which of these statements support the idea that the Earth's atmosphere came from volcanoes?

Use the data in the table and the graph.

Tick (✓) **two** boxes.

Hydrogen comes from volcanoes and was in the Earth's atmosphere 4400 MYA. ☐

There was more water vapour in the Earth's atmosphere 4400 MYA than in volcano gas. ☐

The Earth's atmosphere 4400 MYA and volcano gases both contain carbon dioxide. ☐

The percentages of gases in the Earth's atmosphere 4400 MYA are not the same as today. ☐

[2]

For each statement, candidates have to consider whether the statement is consistent with either the graph or the table and, if so, whether the statement supports the idea in the question. Integrating data from the table and the graph was found challenging by some candidates, with the majority being credited one mark.

Question 5 (a) (i)

5

(a) Ammonium sulfate is made in an industrial process for use as a fertiliser.

In this process, aqueous ammonium carbonate reacts with **excess** solid calcium sulfate to make aqueous ammonium sulfate and a solid by-product.

ammonium carbonate + calcium sulfate → ammonium sulfate + a by-product

$(NH_4)_2CO_3(aq) + CaSO_4(s) \rightarrow (NH_4)_2SO_4(aq) + CaCO_3(s)$

(i) Which method can be used to separate aqueous ammonium sulfate from the mixture left at the end of the reaction.

Put a (ring) around the correct option.

Distillation **Evaporation** **Filtration** **Titration**

[1]

Most candidates recognised filtration as the easiest way to separate a solution from a solid by-product.

Question 5 (a) (ii)

(ii) Explain the difference between what happens to by-products and waste products from industrial processes.

....

....

....

.... **[2]**

This distinction depends on the *disposal* of a waste product compared to a *use* for a by-product. Some responses instead suggested that a by-product could be recycled.

Question 5 (b)

(b) Ammonium sulfate can also be made in a laboratory by reacting ammonia with a dilute acid:

ammonia + dilute acid → ammonium sulfate

Which dilute acid reacts with ammonia to make ammonium sulfate?

Tick (✓) **one** box.

Hydrochloric acid ☐

Nitric acid ☐

Phosphoric acid ☐

Sulfuric acid ☐

[1]

The correct acid was usually selected.

Question 5 (c) (i) and (ii)

(c) Chemicals are usually made in industry in continuous processes.

Chemicals are usually made in the laboratory in batches.

(i) State **one** advantage of using continuous processes in industry.

....

.... **[1]**

(ii) State **one** advantage of making chemicals in the laboratory in batches.

....

.... **[1]**

Some candidates considered the speed of these types of reaction. However, more successful responses focused on the amount of product needed and the flexibility of using equipment in different ways.

Question 6 (a)*

6

(a)* A student has samples of two solid compounds.

They think that one compound contains copper and that the other compound contains calcium.

They decide to do a flame test on each compound.

They also decide to make a solution of each compound to do a test using dilute sodium hydroxide.

Describe how the student should do their flame test and their test using dilute sodium hydroxide.

State the results they should expect for a copper compound and a calcium compound.

....

....

....

....

....

.... **[6]**

Many different practical techniques for flame tests were described, not always including the use of a wire loop. Most candidates recognised the concept. In many cases, the sodium hydroxide solution was used instead of hydrochloric acid to 'clean' the loop ignoring the fact that this would provide an intense yellow flame!

Very few responses recognised the possibility for coloured precipitates when sodium hydroxide solution is added to solutions of salts and so did not address this side of the question. A level three mark can only be achieved by considering both types of reaction.

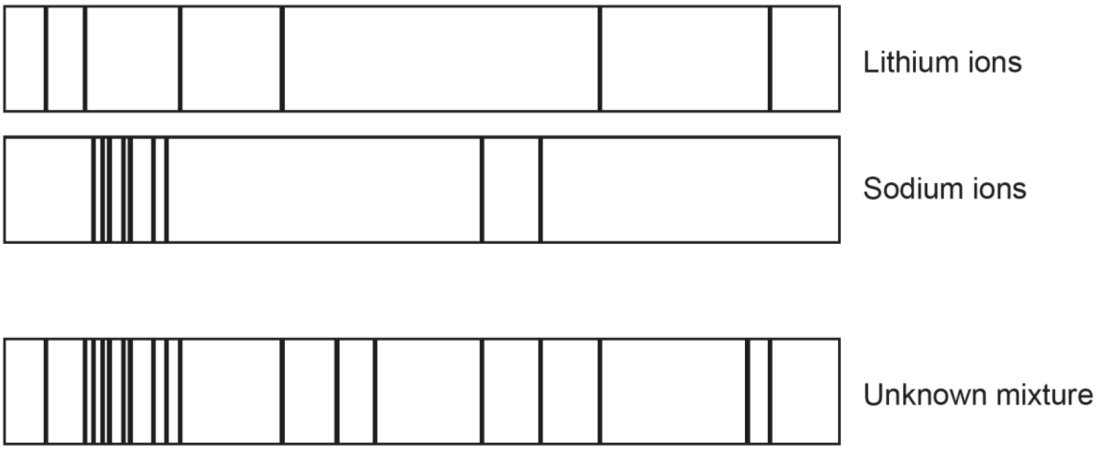
Question 6 (b) (i) and (ii)

(b) The student uses an emission spectroscopy machine to find out the metal ions in some other compounds.

They test a compound that contains lithium ions and a compound that contains sodium ions.

They then test an unknown mixture.

The diagram shows the results of the emission spectrum for each of the substances they test.



(i) Which statements about the unknown mixture are **true** and which are **false**?

Tick (✓) **one** box in each row.

	True	False
The unknown mixture contains both lithium ions and sodium ions.		
The information in the diagram is not enough to identify all the ions in the unknown mixture.		
The results show that the unknown mixture contains more than five different ions.		

[2]

(ii) Which statement about using tests to identify ions is **true**?

Tick (✓) **one** box.

Emission spectroscopy relies on human judgement of colours. ☐

Emission spectroscopy is more sensitive than chemical tests. ☐

Ions cannot be identified using chemical tests alone. ☐

Reactions used in chemical tests are very slow. ☐

[1]

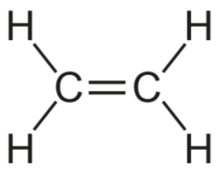
This was generally well done.

Question 7 (a)

7 Ethene is a monomer used to make poly(ethene).

Fig. 7.1 shows the structure of ethene.

Fig. 7.1



The reaction of ethene to make poly(ethene) is addition polymerisation.

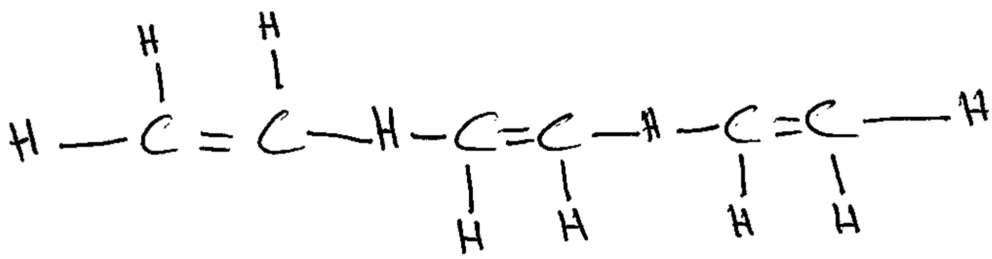
(a) **Draw** the structure of a section of poly(ethene) formed from **three** ethene monomers.

[2]

Some candidates simply drew three monomers here instead of a section of polymer.

Exemplar 1

(a) **Draw** the structure of a section of poly(ethene) formed from **three** ethene monomers.



[2]

A sound response would have every carbon atom showing four bonds and every hydrogen just one bond. This answer did not score any marks.

Question 7 (b) (i) and (ii)

(b)

(i) 12 000 ethene monomers join together to make a poly(ethene) molecule.

Calculate the number of carbon and hydrogen atoms in this poly(ethene) molecule.

Number of carbon atoms = ...

Number of hydrogen atoms = ... **[2]**

(ii) Another poly(ethene) molecule forms when 10 000 ethene monomers join together.

Calculate the relative formula mass of this poly(ethene) molecule.

Use the Periodic Table to help you.

Relative formula mass = ... **[2]**

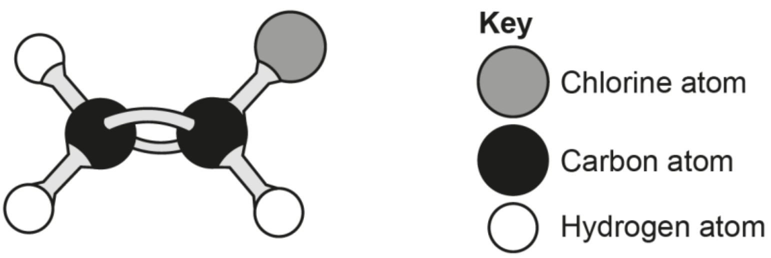
These questions investigated understanding of the process of polymerisation and showed that many candidates understand well beyond the familiar diagrams of repeat units.

Question 7 (c) (i)

(c) Chloroethene is another monomer that forms an addition polymer.

Fig. 7.2 shows a three-dimensional model of a chloroethene monomer.

Fig. 7.2



(i) The molecular formula of ethene is C_2H_4.

Write the molecular formula of chloroethene.

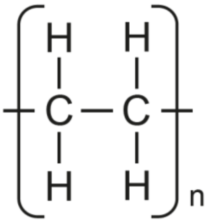
.... **[1]**

Most candidates identified the molecular formula as C_2H_3Cl, although the elements were accepted in any order.

Question 7 (c) (ii)

(ii) **Fig. 7.3** shows the structure of the repeating unit of **poly(ethene)**.

Fig. 7.3



Draw the structure of the repeating unit of **poly(chloroethene)**.

[2]

Many candidates were unclear about the answer to this question, with the majority scoring 0 marks. A few candidates used the example in the question, replacing a hydrogen atom with chlorine to obtain two marks. However, some structures contained no chlorine and many others were missing aspects like the continuation bonds or the subscript 'n'.

Question 7 (d) (i)

(d)
(i) Explain why ethene is considered to be an alkene and chloroethene is **not** an alkene.

....

.... **[2]**

Very few candidates tried to define an alkene, although some were able to gain a mark by stating that it should not contain chlorine.

Question 7 (d) (ii)

(ii) Use ideas about functional groups to explain why both ethene and chloroethene can form addition polymers.

....

.... **[1]**

Few candidates stated that an addition polymer requires a carbon-carbon double bond.

Question 8*

8* A student does some experiments to find out the order of reactivity of some metals.

They add the same size pieces of five different metals to separate samples of water and record the time taken to make 10 cm^3 gas.

They stop timing after 5 minutes if 10 cm^3 gas have not been made.

They repeat their experiments for some of the metals but this time they use a dilute acid instead of water.

The table shows their results.

Metal	**Time taken to make 10 cm^3 gas (s)**	
	When added to water	**When added to dilute acid**
Calcium	35	did not test
Magnesium	small amount of gas collected after 5 minutes	20
Iron	no gas collected after 5 minutes	190
Zinc	no gas collected after 5 minutes	50
Sodium	15	did not test

Use the information to put the metals in order of reactivity from most reactive to least reactive.

Explain your reasoning.

Include in your answer:

- how you used the information in the table to work out the order of reactivity
- why the student did not test all of the metals with dilute acid.

....

....

....

....

....

.... **[6]**

A clear response would recognise that a reactive metal would take less time to react.
The reactions with water allow sodium, calcium and magnesium, to be ranked. The reactions with acid allow iron and zinc to be compared to magnesium. Considering why the reactive metals are not used with acid completes a full response.

Exemplar 2

Sodium is the most reactive because it was able to produce the gas the fastest with the water, calcium is next because it was able produce gas with the water, magnesium is next because it produced the gas the fastest with the dilute acid, next is zinc because it is the second fastest of produceing the gas with the dilute acid and last is Iron because it was the slowest at produceing the gas with the dilute acid. the student didn't test all the metals with the dilute acid because they had allready gotten times for calcium and Sodium So it would not have been needed to be tested again with the dilute acid.

This response identifies the correct order of reactivity for all the metals tested. It also explains how the data is used to establish this. An explanation of why sodium and calcium did not need to be tested with acid meets the definition of a Level 3 response and achieves full marks.

Question 9 (a) (i)

9

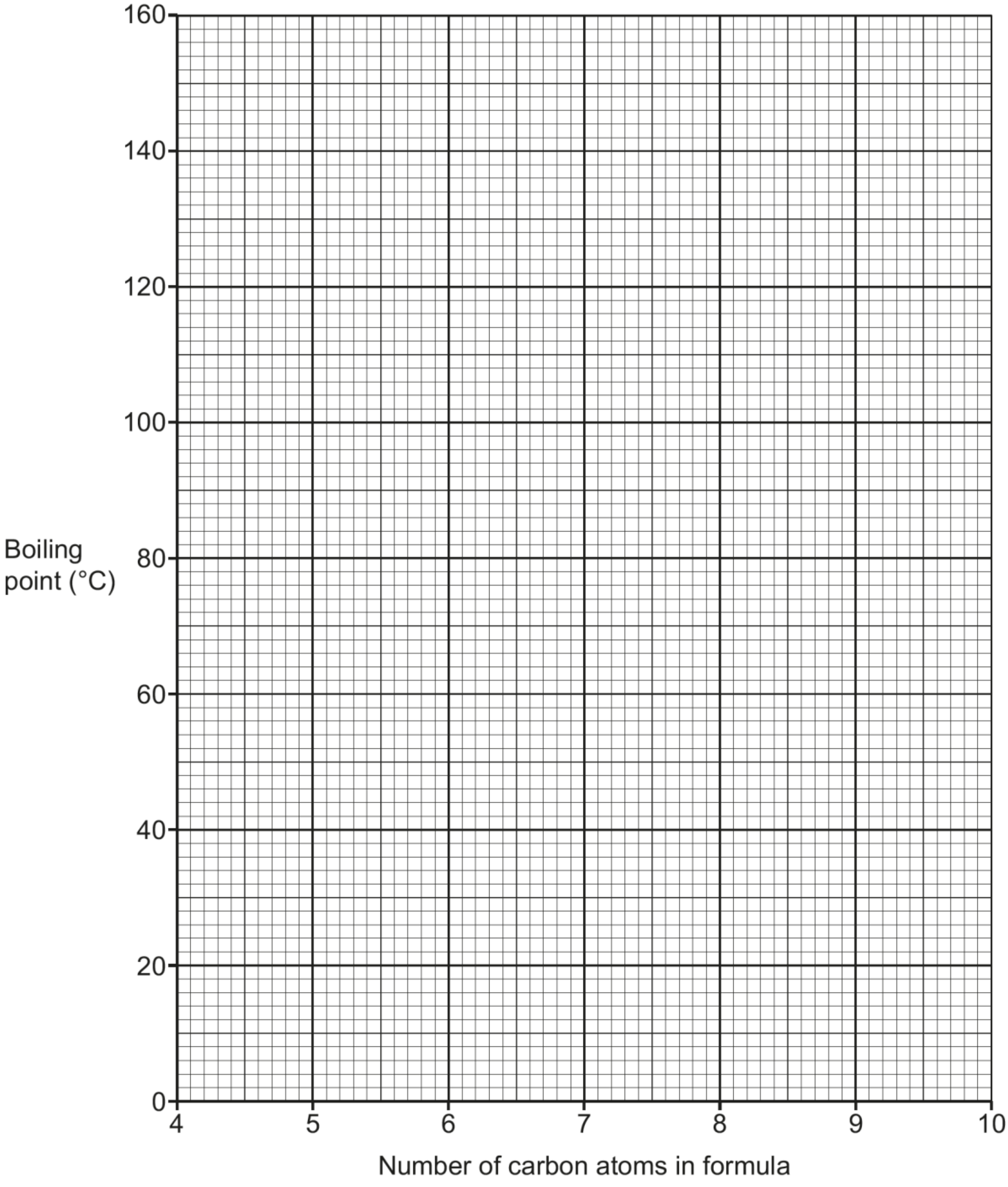
(a) **Table 9.1** shows the formulae and boiling points of some alkanes.

Table 9.1

Alkane	Formula	Number of carbon atoms in formula	Boiling point (°C)
Pentane	C_5H_{12}	5	36
Hexane	C_6H_{14}	6	69
Octane	C_8H_{18}	8	125
Nonane	C_9H_{20}	9	151

(i) Use the data in **Table 9.1** to complete the graph.

You need to:
- plot the boiling point of each alkane
- draw a line of best fit.



[3]

Candidates were allowed a tolerance of ± half a small square for plotting the points – and many did this well. The best fit line should go close to all four plotted points – but does not go through the bottom-left corner of the graph paper as lower attaining candidates often assumed.

Question 9 (a) (ii)

(ii) Use your graph to predict the boiling point of heptane, C_7H_{16}.

Show your working on the graph.

Boiling point of heptane = ... °C **[2]**

A wide range of possible values was accepted, although some candidates tried to estimate the value by taking the mean of the values for hexane and octane rather than using their graph as directed.

Question 9 (b)

(b) The empirical formula of an alkane is the simplest ratio of hydrogen atoms to carbon atoms.

Table 9.2 shows the molecular formula and empirical formula of some alkanes.

Complete **Table 9.2** by filling in the empirical formula for butane.

Table 9.2

Alkane	Molecular formula	Empirical formula
Ethane	C_2H_6	CH_3
Propane	C_3H_8	C_3H_8
Butane	C_4H_{10}	....

[1]

The idea of empirical formula was quite well known, but some candidates seemed to see this as a 'spot the pattern' question, giving a variety of incorrect answers.

Question 9 (c)

(c) Alkanes come from crude oil.

Why is crude oil important to modern life?

Tick (✓) **two** boxes.

Chemicals in crude oil have different boiling points. ☐

Crude oil contains molecules with single bonds. ☐

Crude oil is a feedstock for the petrochemical industry. ☐

Crude oil is a main source of hydrocarbons. ☐

[2]

This was found more challenging because the distractors are accurate statements which do not address the question.

Question 10 (a)

10 Millions of tonnes of carbon dioxide (CO_2) are added to the air in the UK every year.

Carbon dioxide is produced when fossil fuels are burned in power stations to generate electricity.

(a) Schemes are being developed to remove carbon dioxide from power station waste gases. These schemes add to the cost of electricity.

Explain why it is important to remove carbon dioxide, despite the cost.

Use ideas of risk and benefit.

....

....

....

....

....

.... **[3]**

Carbon dioxide was usually identified as a greenhouse gas and the adverse effects of climate change were sometimes specified. However, the balance of short-term cost against long-term benefit was not usually well explained.

Question 10 (b)

(b) The UK government says that the mass of carbon dioxide added to the air during the year 2020 decreased by 400 million tonnes compared to 1990. This is a decrease of 49%.

Calculate the mass of carbon dioxide added to the air during 1990.

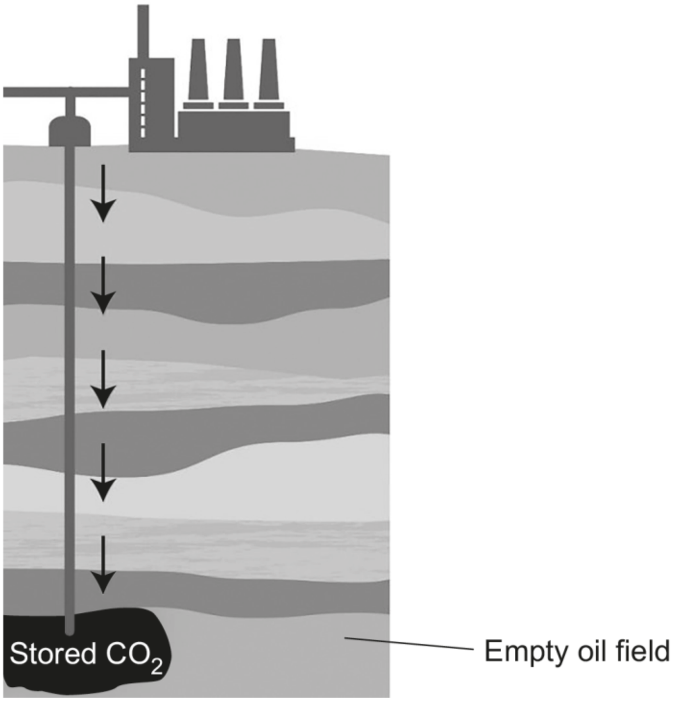
Use the formula: $\text{percentage decrease} = \dfrac{\text{decrease in mass}}{\text{mass added to the air during 1990}} \times 100$

Mass added to the air during 1990 = ... million tonnes **[3]**

The formula seemed unfamiliar and rearranging it to give the mass of gas added to the air gave plenty of scope for some extreme answers. The majority of candidates were not given any marks here.

Question 10 (c) (i)

(c) Scientists are developing a new scheme to remove carbon dioxide from the air and store it in empty oil fields.



Scientists make two predictions:

1. Burning fossil fuels in the UK will add 230 million tonnes of carbon dioxide to the air each year.
2. There is enough space in UK oil fields to store all this carbon dioxide for at least the next 100 years.

(i) Which is the best estimate of the amount of carbon dioxide that can be stored in UK oil fields?

Tick (✓) **one** box.

$< 2.3 \times 10^3$ million tonnes ☐

$> 2.3 \times 10^4$ million tonnes ☐

$< 2.3 \times 10^6$ million tonnes ☐

$> 2.3 \times 10^6$ million tonnes ☐

[1]

Using standard form and the symbols for 'greater than' and 'less than' made this seemingly challenging for candidates.

Typical Assessment for Learning should include the use of standard form to represent both large and small numbers.

OCR support

The Mathematical skills handbook and linked check in tasks can be used to help candidates become familiar with the maths skills required in GCSE Sciences, such as using standard form.

Question 10 (c) (ii)

(ii) The demand for energy for electricity is one factor that affects the amount of fossil fuels we burn.

State **one other** factor that affects the amount of fossil fuels we burn.

....

.... **[1]**

Candidates could score here with many other uses of fossil fuels but not vague answers about costs or environmental issues.

Question 11 (a) (i)

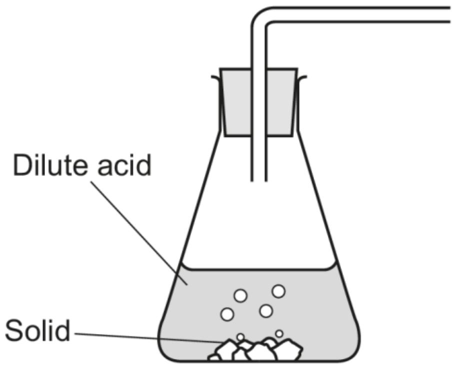
11 A student investigates the rate of reaction when a solid reacts with a dilute acid.

(a) The reaction makes a gas.

The student collects the gas in a measuring cylinder over water.

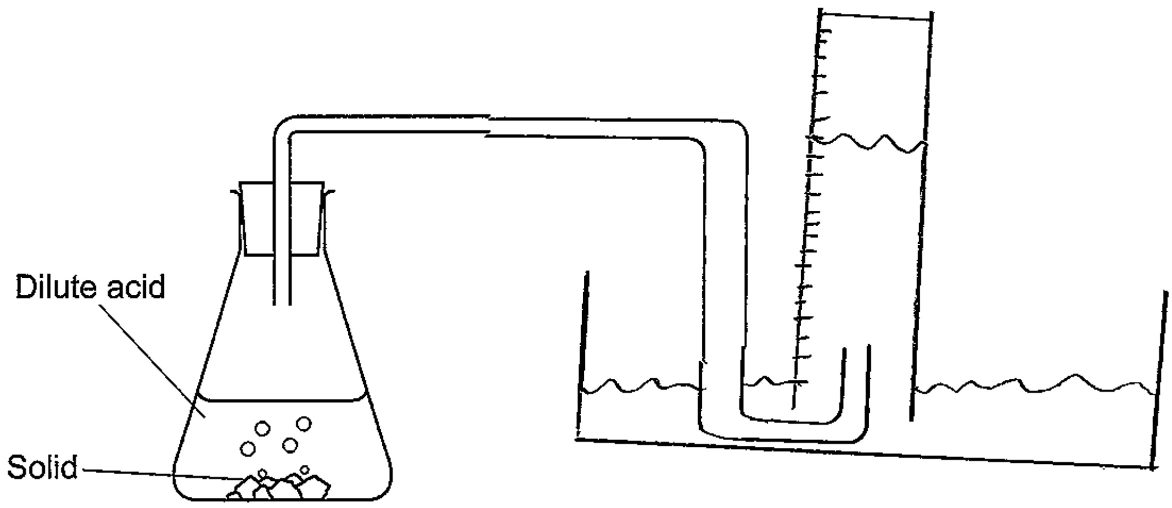
(i) **Complete** the diagram to show how the student sets up their measuring cylinder to collect the gas over water.

Include labels on your diagram.



[3]

Exemplar 3



A few candidates offered excellent cross-sectional diagrams. This example scores both marks for the drawing and could have had another mark if properly labelled.
Despite the question stem stating that the candidate used an inverted measuring cylinder, gas syringes were often attempted along with some unconventional glassware (like several side-arm measuring cylinders).

Question 11 (a) (ii)

(ii) The student finds it difficult to measure the volume accurately in the measuring cylinder.

Suggest another method they could use to get more accurate readings.

....

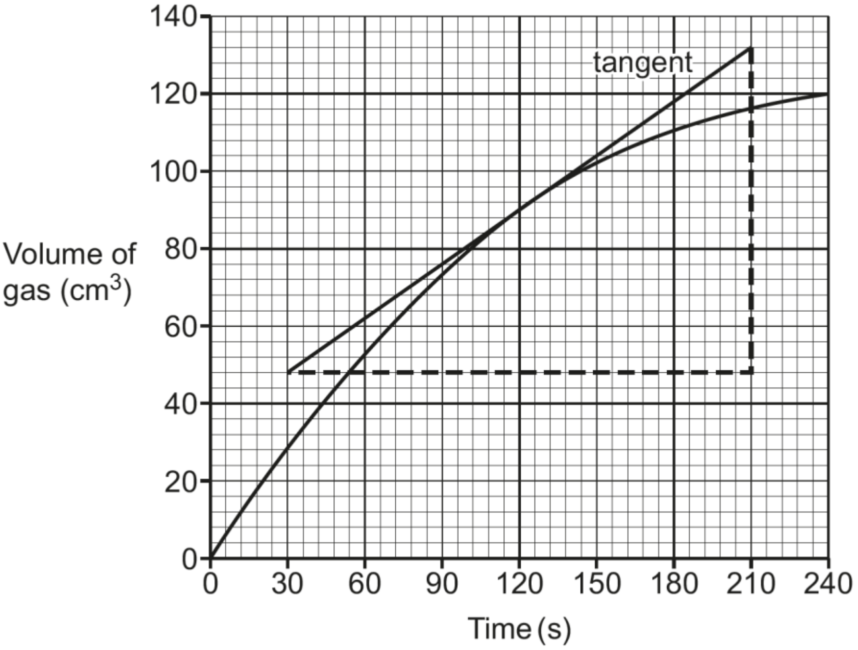
.... **[1]**

A top-pan balance could give accurate data but does not relate to the *volume* of gas and was an answer that was not credited.
Some candidates were familiar with the use of a gas syringe. Other answers included almost all types of measuring device (stopwatch, ruler etc).

Question 11 (b) (i)

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

The student draws a tangent to the curve at the point where time = 120 s.



(i) Calculate the gradient of the tangent shown on the graph.

Gradient = ... cm^3/s **[3]**

Some candidates scored by working out the dimensions of the triangle on the graph, although fewer were certain about what to do with the numbers once they had been obtained.

Question 11 (b) (ii)

(ii) What information does your answer to **(i)** give about the reaction?

Tick (✓) **one** box.

The increase in volume and time at 180 s. ☐

The rate of reaction at 120 s. ☐

The time taken to make 90 cm^3 gas. ☐

The volume of gas made in the first minute of the reaction. ☐

[1]

Many candidates knew that this would yield the rate of reaction.

Question 11 (c)

(c) The student repeats their experiment using different conditions.

The rate of the reaction increases each time.

Draw lines to connect each **change in condition** with its correct **explanation** for the increase in rate.

Change in condition	Explanation
Increased concentration of acid	Frequency of particle collision increases because surface area increases.
Increased temperature	Frequency of particle collision increases because particles are closer together.
Smaller pieces of solid	More particle collisions are successful because the energy of the particles increases.

[2]

This was usually well done. Linking increased concentration with extra energy was a common misconception seen. It is worth emphasising that the energy and thus speed of movement of the particles depends only on temperature and not concentration.

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