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OCR
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GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE CHEMISTRY B

J258

For first teaching in 2016

J258/02 Summer 2023 series

Version 1

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 designed to assess the depth of chemical knowledge shown by the candidates. Most candidates were able to attempt many of the questions, even if they didn't always manage to earn many marks. 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 (Questions 3 (b) and 7(c)) is a challenge to many candidates. However, these questions often provide a structure which the best candidates use to good effect. Some candidates showed ability to describe laboratory practice (Question 7) and experimental design but there is much scope for improvement here. Questions 9 and 10 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. The language of the examination was inclusive and there was no evidence that any were disadvantaged by this. There was little or no indication of time pressure or other constraints for most candidates.

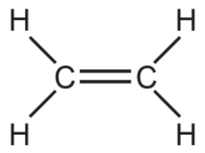
Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• read the questions carefully • responded to all the questions • integrated their knowledge with the information in the question.	• left questions blank (even when a choice was offered) • repeated the question stem in their response • answered a question which was not asked.

Question 1 (a)

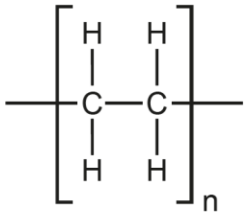
1 Poly(ethene) is a polymer which forms when ethene monomers react together in an addition polymerisation reaction.

The structure of an ethene monomer and the repeating unit of poly(ethene) are shown in **Fig. 1.1**.

Fig. 1.1



Ethene monomer



Repeating unit of poly(ethene)

(a) Which statements are **true** only for an ethene monomer, which are **true** only for the repeating unit of poly(ethene) and which are **true** for both?

Tick (✓) **one** box in each row.

	True only for an ethene monomer	True only for the repeating unit of poly(ethene)	True for both
Contains a double bond			
Contains a single bond			
Contains covalent bonds			
Represents a molecule with a long chain structure			

[4]

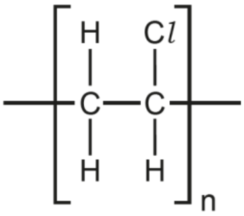
Most candidates seemed to find this a comfortable place to start, although quite a lot of candidates focused solely on the carbon-carbon bond and so thought that only the repeat unit contained a single bond.

Question 1 (b)

(b) PVC is another addition polymer.

The structure of the repeating unit of PVC is shown in **Fig. 1.2**.

Fig. 1.2



Draw the structure of a **monomer** of PVC.

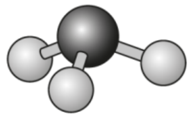
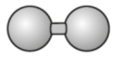
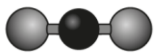
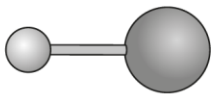
[1]

Many candidates confidently used the exemplars to show what the PVC monomer would look like.

Question 2 (a) (i)

2 Models are used to represent the structure of compounds.

(a) (i) Draw lines to connect each **formula** to the correct **model**.

Formula	**Model**
HCl	
NH_3	
H_2	
CO_2	

[3]

This was largely completed accurately. Candidates were confident and corrections were rare.

Question 2 (a) (ii)

(ii) Which formula contains an atom of a Group 17 (7) element?

.... **[1]**

Some candidates did not notice the requirement to choose a formula and simply named (or gave the symbol of) a halogen.

Question 2 (a) (iii)

(iii) Which formula contains an atom that is in both diamond and graphite?

.... **[1]**

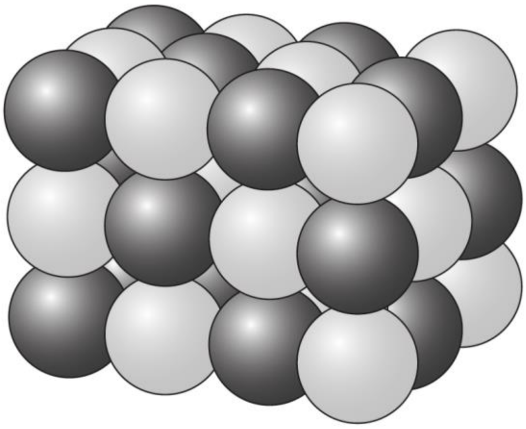
A common mistake here was to choose the formula for ammonia – perhaps linking the almost tetrahedral shape with the structure of diamond.

Question 2 (b) (i)

(b) Solid sodium chloride contains sodium ions, Na^+, and chloride ions, Cl^-.

Fig. 2.1 shows a three-dimensional model of how the ions are arranged in solid sodium chloride.

Fig. 2.1



(i) Calculate the total number of ions in the model in **Fig. 2.1**.

Total number of ions = ... **[2]**

Most candidates were able to infer from the diagram how many ions would be in the model, although only a few who got the answer wrong showed their working to get a mark.

Question 2 (b) (ii)

(ii) Which descriptions about the structure of sodium chloride are **shown** by the model in **Fig. 2.1** and which are **not**?

Tick (✓) **one** box in each row.

Description	**Shown by the model**	**Not shown by the model**
Ions in sodium chloride are arranged in a regular pattern.		
There are two elements in sodium chloride.		
The ions in sodium chloride have positive and negative charges.		

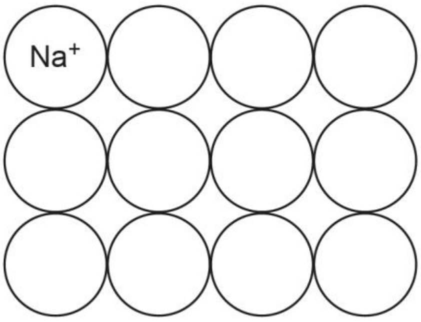
[2]

Most candidates could appreciate that the model showed some aspects of the structure but not the electrical charges.

Question 2 (c)

(c) **Fig. 2.2** shows a two-dimensional diagram of sodium chloride. One ion is labelled.

Fig. 2.2

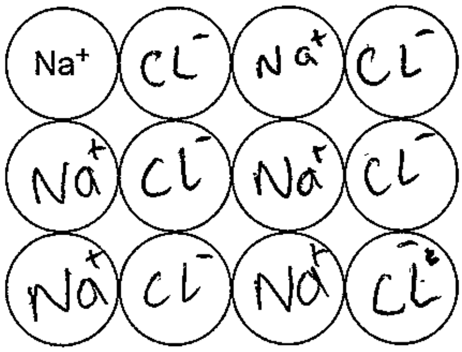


Label the other ions in **Fig. 2.2**.

Use the symbols Na^+ and Cl^-. **[2]**

Perfect answers were common here.

Exemplar 1

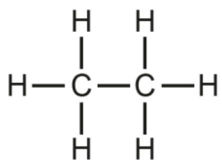
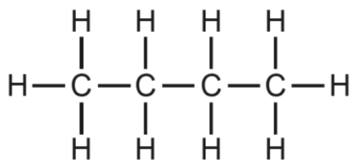


A few candidates thought that the ions were in rows with similar charges together.

Question 3 (a) (i)

3 Crude oil is a mixture of hydrocarbons.

(a) The table shows information about two hydrocarbons.

Structure		
Formula	C_2H_6	....

(i) Complete the table. **[1]**

Most candidates gave the correct response here, although a few saw the table the wrong way round and responded with the structure for ethane.

Question 3 (a) (ii)

(ii) The hydrocarbons shown in the table are alkanes.

The general formula for alkanes is C_nH_{2n+2}.

What is the formula for an alkane that contains **5** carbon atoms?

.... **[1]**

The general formula clearly helped many candidates, but it was unfamiliar and not understood by others.

Question 3 (a) (iii)

(iii) Explain why these molecules are **hydrocarbons**.

....

.... **[1]**

Almost everyone knew that hydrocarbons contained hydrogen and carbon – but relatively few remembered to write down that these are the **only** elements in a hydrocarbon.

Question 3 (a) (iv)

(iv) The alkanes from crude oil can be used in other processes to make more useful molecules.

Which process makes more useful molecules from alkanes?

Put a (ring) around the correct option.

Combustion **Cracking** **Filtration** **Neutralisation**

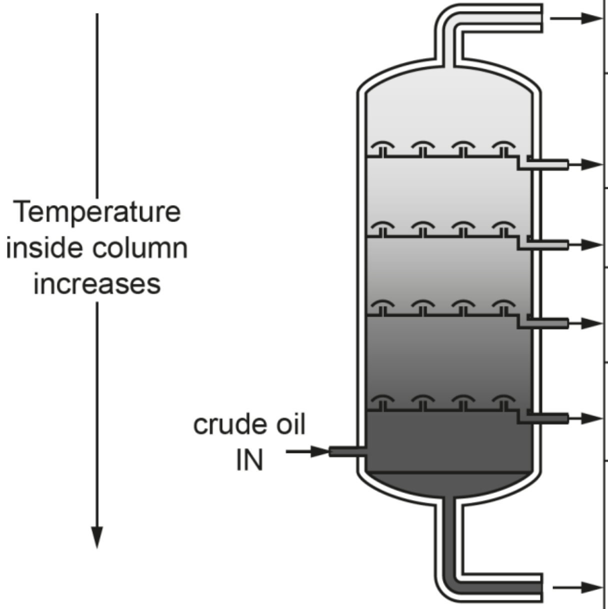
[1]

All four responses were used almost equally.

Question 3 (b)*

(b)* Crude oil is separated into fractions in a fractionating column.

The diagram shows information about a fractionating column and some of the molecules in the fractions that leave the column.



Fractions OUT

Number of carbon atoms in the molecules	**Boiling point (°C)**
1-4	0-30
5-9	30-180
10-16	180-260
14-20	250-350
20-50	350-580
>50	>580

Explain why the molecules leave the column at different heights.

Use ideas about number of carbon atoms and boiling points in your answer.

....

....

....

....

....

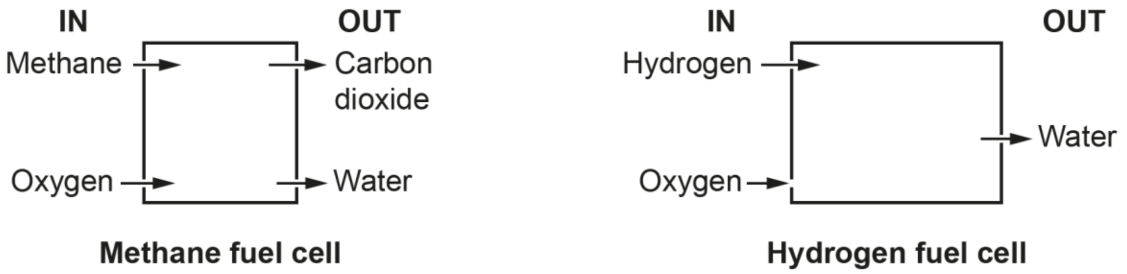
.... **[6]**

Candidates were required to describe the changes in the column and then link these to the structures. Most of the ideas needed were given in the diagram. There was no need to go into details of intermolecular forces. Candidates who did attempt to explain how the bonding worked often stated that covalent bonds between carbon atoms were being broken.

Question 4 (a)

4 Some cars use fuel cells as an energy source. Fuel cells can use methane or hydrogen as fuels.

The diagram shows the substances that go in and the waste products that come out of a methane fuel cell and a hydrogen fuel cell.



(a) Complete the **symbol equations** for the reactions in each fuel cell.

Use information from the diagram.

CH_4 + 2................ → CO_2 + 2................

................H_2 + ... → 2................

[3]

Successful responses saw candidates use the cell diagrams to complete the equations, although some forgot that oxygen is diatomic.

Question 4 (b)

(b) The table shows the sources of methane and hydrogen.

Fuel	**Source**
Methane	Extracted as a fossil fuel
Hydrogen	Electrolysis of water

Explain the **advantages** to the **environment** of using hydrogen rather than methane in fuel cells in cars.

Use the information in the table and the diagram.

....

....

....

....

....

.... **[3]**

Most candidates were keen to write about the greenhouse effect, although this was often attributed to the methane rather than the carbon dioxide produced. The idea that fossil fuels are a finite resource was rarely mentioned.

Question 4 (c)

(c) A mixture of hydrogen and oxygen is very flammable but does **not** explode until it is ignited by a flame.

Which statement explains why?

Tick (✓) **one** box.

The flame brings the gases closer together. ☐

The flame provides activation energy for the reaction. ☐

The flame takes energy in from the hydrogen and oxygen. ☐

[1]

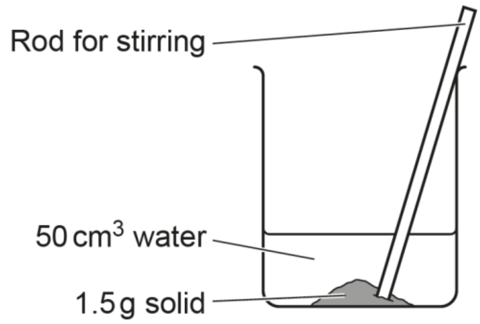
Activation energy was recognised by most candidates.

Question 5 (a) (i)

5 Jamal does an experiment to investigate the energy changes when solids **A**, **B**, **C** and **D**, dissolve in water.

The method for the experiment and some of the apparatus he uses is shown.

Method
1. Measure 50 cm^3 water and put into a beaker.
2. Measure the temperature of the water.
3. Measure 1.5 g of solid and add to the water.
4. Stir until dissolved.
5. Measure the temperature after the solid dissolves.



(a) (i) Name **two** pieces of measuring equipment Jamal needs to use in his experiment.

1 ....

2 ....
[2]

A thermometer is essential to measure temperature change. A measuring cylinder for the water and a balance for the solid could score the second mark. A beaker would not be sufficient. Many candidates were unsure what to call the device for measuring mass.

OCR support

The Practical support guide has suggestions for alternative practicals to support the delivery of each practical activity group. In addition, there are links for videos to demonstrate equipment that could be used to reinforce the learning in the classroom.

Question 5 (a) (ii)

(ii) Which **two** variables does Jamal need to control in his experiment?

Tick (✓) **two** boxes.

The final temperature. ☐

The mass of the solid. ☐

The time taken to dissolve the solid. ☐

The volume of water. ☐

[2]

The concept of a 'controlled' variable was well understood by some candidates.

Question 5 (b) (i)

(b) **Table 5.1** shows Jamal's results.

Table 5.1

Solid	Temperature at the start (°C)	Temperature after solid dissolves (°C)
A	18	23
B	20	12
C	19	15
D	17	27

(i) Jamal thinks that the temperature changes in his experiment are too small.

Which **two** changes could Jamal make to increase the temperature **changes** in his experiment?

Tick (✓) **two** boxes.

Add more solid. ☐

Stir more slowly. ☐

Use boiling water at the start. ☐

Use less water. ☐

[2]

Most candidates realised that more solid and less water might produce a larger change in temperature.

Question 5 (b) (ii)

(ii) Which **two** solids shown in **Table 5.1** dissolve in an exothermic reaction?

Tick (✓) **two** boxes.

Explain your answer.

A ☐ **B** ☐ **C** ☐ **D** ☐

Explanation ....

....

.... **[2]**

Although a lot of candidates realised that exothermic reactions gave out heat, many incorrectly thought the temperature would drop as a result.

Question 5 (c)

(c) Jamal measures the temperature change when solid **E** dissolves in water.

He repeats his experiment three times.

Table 5.2 shows his results.

Table 5.2

Experiment	Temperature at the start (°C)	Temperature after solid E dissolves (°C)
1	20	22
2	21	24
3	19	22
4	18	20

Calculate the mean temperature change when solid **E** dissolves.

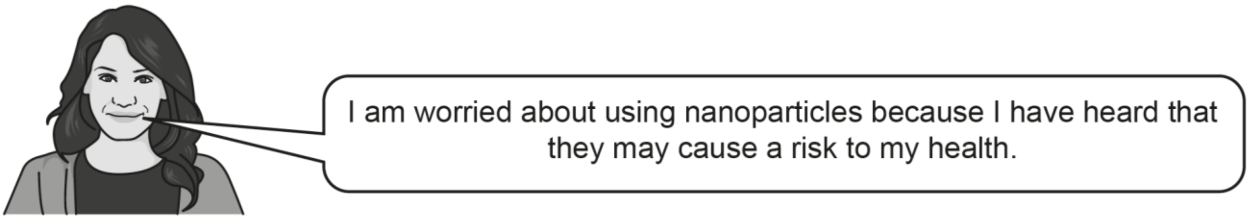
Mean temperature change = ... °C **[3]**

Calculation of a mean was well understood, but far more candidates calculated the **mean final temperature** (for 1 mark) rather than the **mean temperature change**.

Question 6 (a)

6 Mia uses sunscreen on her skin when she is in the sun. The sunscreen contains nanoparticles. The nanoparticles block harmful radiation from the sun.

Mia talks about using nanoparticles.



(a) Give **two** reasons why using nanoparticles may cause a risk to health.

1 ....

....

2 ....

....

[2]

Nanoparticles here were blamed for everything from 'spots' and allergies to cancer. Small particles may enter the body without significant harm. Problems arise when they are small enough to cross membranes and enter cells. As with any new technology, the lack of evidence of long-term effects is also an issue.

Question 6 (b)

(b) Which statements about nanoparticles are **true** and which are **false**?

Tick (✓) **one** box in each row.

	True	**False**
Fullerenes are examples of nanoparticles.		
Nanoparticles are larger than atoms.		
The properties of nanoparticles are related to their very small size.		
The surface area of a nanoparticle is always equal to its volume.		

[3]

The most common error here was to assume that nanoparticles are smaller than atoms.

Question 6 (c)

(c) The table shows some data about the diameter of nanoparticles **A**, **B**, **C** and **D**.

Nanoparticle	Diameter (m)
A	8.25×10^{-9}
B	2.10×10^{-9}
C	9.18×10^{-9}
D	8.26×10^{-9}

Put the nanoparticles **A**, **B**, **C** and **D** in order from largest to smallest.

Largest ....

....

....

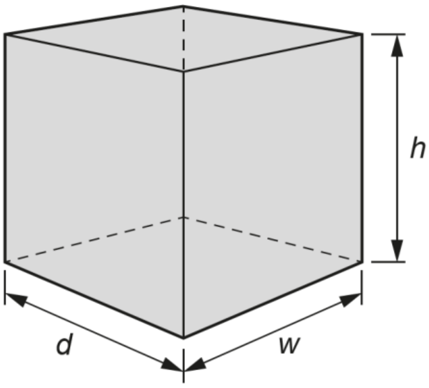
Smallest .... **[2]**

Most candidates scored well here, although a significant minority listed the sizes in reverse order (smallest to largest). Candidates should always read the question carefully.

Question 6 (d) (i)

(d) Mia makes a 3D model of nanoparticle **B** in the shape of a cube.

She makes each side of her model 2.10 cm long.



(i) Calculate the volume of the model.

Give your answer to **one** decimal place.

Use this formula:

volume = $h \times w \times d$

Volume = ... cm^3 **[2]**

Many candidates lost a mark by giving more than one decimal place in their response.

OCR support

In Questions 6 (c) and (d) (i) candidates appeared to have missed marks by not spotting what was required in the response (i.e. the order of the sizes or the number of decimal places). The candidate exemplars, like this from June 2022 (Maths), could be shared with students to reinforce the importance of reading the question more carefully.

Question 6 (d) (ii)

(ii) Calculate the surface area of the model.

Use this formula:

surface area = 6 × (*h* × *d*)

Surface area = ... cm^2 **[2]**

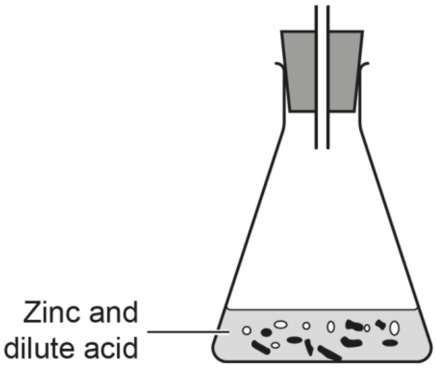
Most candidates were confident and got the right answer.

Question 7 (a)

7 Eve does an experiment to find out the rate of reaction when solid zinc reacts with dilute acid.

She adds the zinc to the dilute acid and measures the time taken to collect 10 cm^3 of gas.

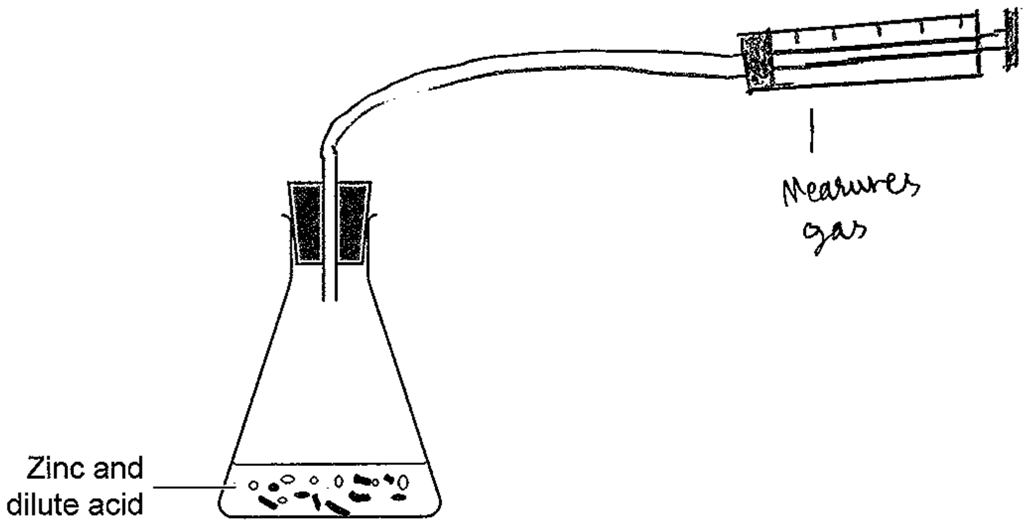
(a) Complete the diagram by drawing **and** labelling the apparatus she needs to collect and measure 10 cm^3 gas.



[2]

High quality diagrams were rare and many candidates left this blank.

Exemplar 2



Some respectable diagrams of gas syringes were marred by a lack of a suitable label.

OCR support

The Practical support guide has suggestions for alternative practicals to support the delivery of each practical activity group. In addition, there are links for videos to demonstrate equipment that may be less available in centres, like the gas syringe.

Question 7 (b) (i)

(b) Eve repeats her experiment at different temperatures using zinc, copper, metal **X** and iron.

She adds the same amount of each metal and the same volume and concentration of acid each time.

Her results are shown in the table.

Metal	Time taken to collect $10\,cm^3$ gas at 20 °C (s)	Time taken to collect $10\,cm^3$ gas at 40 °C (s)
Zinc	18	9
Copper	no gas collected	no gas collected
Metal **X**	7	3
Iron	26	15

(i) What conclusion can you make about the effect of changing the temperature on the rate of the reaction?

Explain your answer.

....

....

....

.... **[2]**

Stating that 'it' (i.e. changing temperature) would increase the rate of reaction was not clear enough. This only happens with an increase in temperature.

Question 7 (b) (ii)

(ii) Suggest why no gas is collected when copper is used in the experiment.

....

.... **[1]**

A large number of candidates felt that this was related to the melting point of copper rather than its reactivity.

Question 7 (b) (iii)

(iii) Suggest the name of metal **X**.

Explain your answer.

Name ....

Explanation ....

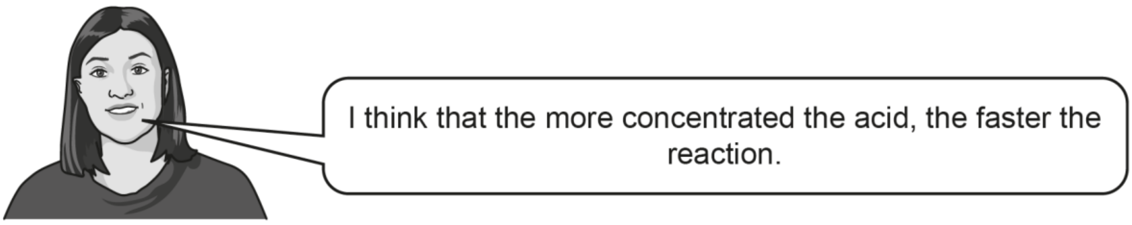
....

.... **[2]**

Many candidates chose random metals from the same transition series as iron, copper and zinc.

Question 7 (c)*

(c)* Eve says:



Write a **method** for Eve to use to find out if her idea is correct.
Include in your answer:

- what variables to control and to change
- what results to expect.

....

....

....

....

....

.... **[6]**

This was not answered successfully. Few candidates described the method in any detail. Concepts like controlling and changing variables were far from clear. Many candidates continued to change the temperature and/or the metals, even if they also changed the concentration of the acid.

There were lots of vague statements about keeping everything the same and seeing which experiment reacted 'fastest'. The idea that a fast reaction resulted in a shorter time to collect the gas was rarely mentioned.

OCR support

In addition to the Practical support guide, Teach Cambridge also hosts the Student booklet, Student extension tasks, Student extensions book, and Supplement student booklet to provide lots of opportunities to reinforce learning and apply PAG knowledge and skills to different contexts.

Question 8 (a)

8 Ammonia is made on an industrial scale by the reaction between nitrogen and hydrogen.

The equation to make ammonia is shown.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(a) Which **two** statements explain why the atom economy of this reaction is 100%?

Tick (✓) **two** boxes.

All of the atoms in nitrogen and hydrogen are used to make ammonia. ☐

All the substances involved in the reaction are gases. ☐

The reaction makes only one product. ☐

There are two nitrogen atoms on both sides of the equation. ☐

[2]

Characteristics of 100% atom economy were usually identified.

Question 8 (b) (i)

(b) Ammonia is used to make fertilisers.

Using fertilisers has both risks and benefits to the environment and to people.

(i) Fertiliser from fields can get into rivers.

How does this cause a **risk** to the environment?

....

.... **[1]**

Many candidates assumed that fertilisers were toxic and would directly poison wildlife (and sometimes human beings too). A few clear descriptions of eutrophication provided far more detail than was necessary for 1 mark.

Question 8 (b) (ii)

(ii) Give one **benefit** of using fertilisers.

....

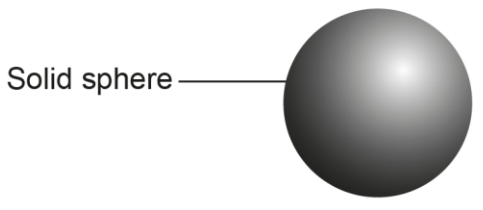
.... **[1]**

Wrong responses often described herbicides or pesticides rather than fertilisers.

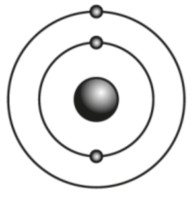
Question 9 (a)

9 Scientists use models to represent atoms. These models have changed over time.

Dalton's model and a modern model of an atom are shown in the diagrams.



Dalton's model



Modern model

(a) Give **two** differences between the modern model and Dalton's model.

1 ....

....

2 ....

....

[2]

This was often successfully answered. Descriptions of the complexity of the modern model showed that it was often well understood.

Question 9 (b)

(b) Which element is represented by the modern model in the diagram?

Explain your answer.

Use the Data Sheet.

Element ....

Explanation ....

....

.... **[2]**

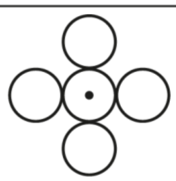
Lithium could be identified from its electronic structure – but not just its atomic number.

Question 9 (c) (i)

(c) Dalton used symbols for atoms to write formulae.

Each symbol represented a different type of atom.

Some of Dalton's formulae are shown in the table.

	Dalton's formula
Carbon dioxide	
Chlorine	

(i) Explain how Dalton's formula for carbon dioxide **agrees** with its modern formula.

....

.... **[1]**

Most candidates could see that there were the right number of elements and atoms in Dalton's formula.

Exemplar 3

There is one carbon molecule and two oxygen molecules

Many candidates did not gain the mark because they used terms incorrectly – e.g. atom/molecule.

Question 9 (c) (ii)

(ii) Give **two** reasons why Dalton's formula for chlorine **disagrees** with its modern formula.

1 ....

....

2 ....

.... **[2]**

Candidates were less clear that the formula did not show a diatomic molecule.

Question 9 (d)

(d) Put the particles in order from largest to smallest.

Atom **Electron** **Molecule of oxygen** **Polymer** **Proton**

Largest ....

....

....

....

Smallest ....

[2]

Around half of candidates found it challenging to put all five into the correct sequence.

Question 10 (a) (i)

10 Ali works in a laboratory that tests food to make sure it is safe to eat.

He tests some sweets. The sweets are sold to shops in large boxes which each contain 100 packets of sweets.

(a) **(i)** Describe how Ali should choose sweets to test to make sure that his sample is **representative**.

....

.... **[1]**

Few candidates identified the idea that a random sample was required. Many mentioned safety (which was in the question stem).

Question 10 (a) (ii)

(ii) Explain why it is important that the sample Ali tests is representative.

....

.... **[1]**

The idea that the sample has to show consistency across the entire sample was rarely appreciated. The traditional ideas of accuracy and reliability were commonly offered.

OCR support

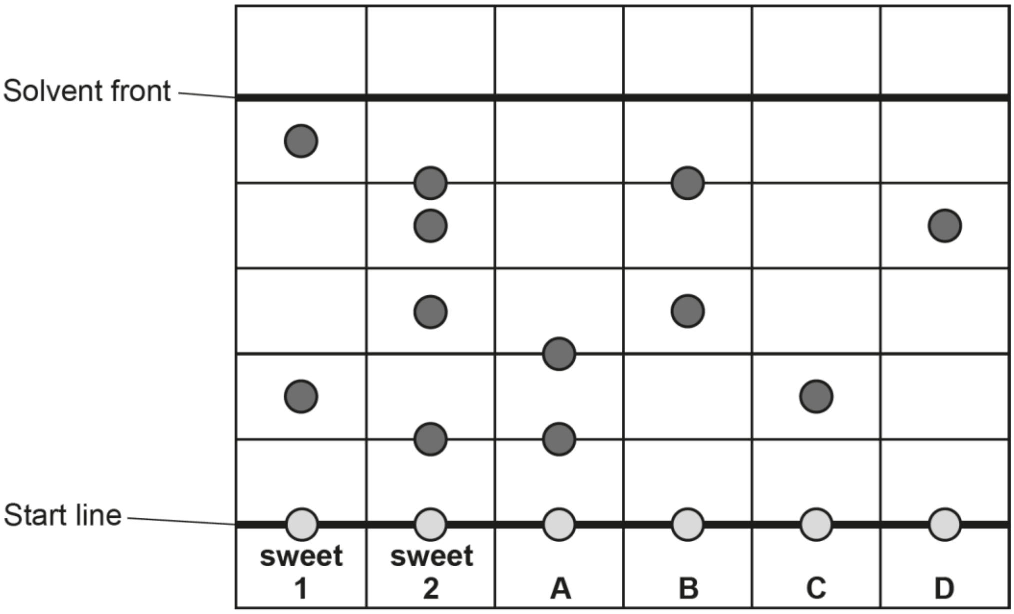
Our Language of measurement in context resource can be used with candidates to help reinforce the correct application of words like reliability and accuracy.

Question 10 (b) (i)

(b) Ali uses paper chromatography to test two sweets, sweet 1 and sweet 2.

He also tests some samples of safe food colours, **A**, **B**, **C** and **D**.

The diagram shows Ali's results.



(i) Calculate the Rf value of food colour **D**.

Rf value = ... **[2]**

Very few candidates knew how to calculate the Rf value with a very wide range of responses offered.

Question 10 (b) (ii)

(ii) Which safe food colours, **A**, **B**, **C** and **D**, are pure?

Explain your answer.

Food colours ....

Explanation ....

....

.... **[2]**

The idea that a pure substance is not a mixture was not well understood.

Question 10 (b) (iii)

(iii) Which **two** safe food colours have been used to make sweet 2?

Tick (✓) **two** boxes.

A ☐

B ☐

C ☐

D ☐

[2]

This was understood by many candidates.

Question 10 (b) (iv)

(iv) Ali says that he **cannot** be sure that the food colours used in sweet 1 are safe.

Explain why Ali is correct.

....

.... **[1]**

Few candidates appreciated that the presence of a colour which was not one of the four 'safe' ones was a risk. Some assumed that being near the solvent line might make a colour unsafe.

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