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Examiners' report

GCSE

TWENTY FIRST CENTURY SCIENCE CHEMISTRY B

OCR Level 1/Level 2 GCSE (9-1) in Chemistry B (Twenty First Century Science)

J258

For first teaching in 2016

J258/03 Summer 2025 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 responses 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 Teach Cambridge.

Paper 3 series overview

In general, the performance of candidates in these papers shows an improving trend. There were fewer unattempted part questions. Candidates used all available space and remained engaged throughout the paper. They typically engaged with the contexts and processed the information given.

Mathematical skills have also seen an improvement, with most candidates addressing instructions such as those to provide numerical answers to a specific number of significant figures or to a specified number of decimal places. However, one emerging issue this year is that some candidates attempt more than one method in their calculations. Sometimes it is clear which method they think is correct by looking at the final answer. In other cases candidates may attempt to multiply or divide the relevant numbers in the question in two contradictory methods. Where it is unclear which answer the candidate has intended the examiner to mark, such answers cannot be awarded marks. Candidates need to be aware that their answers should be clear and unambiguous so that partial credit may be given if a final answer is not fully correct.

An area for development is practical skills. All practical questions were significantly less well answered than those that relied on knowledge. It appears that many candidates had little familiarity with basic apparatus and techniques (such as displacement reactions and flame tests) that it would be reasonable to expect them to know.

Other areas for focus include ensuring that candidates read questions carefully and address the task fully. This includes taking into account the number of marks available. In some questions, it was apparent that answers given did not address all aspects of the question asked. For example, in Question 1 (b) (ii), it was common for only one factor to be discussed where two were changed. Candidates also need to take care that the points they make are relevant to the question. In some questions, for example Question 5 (b), many candidates made irrelevant statements in addition to the main points required to answer. In some cases, excessively long answers included contradictions that negate previously made correct points.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• set out mathematical methods clearly and cross out working that they do not intend to contribute towards their final answer • used the number of marks as a guide to the number of discrete points to make in each answer • considered information in the questions carefully and made use of all provided data • read the question and make statements that are relevant to the task asked • think about the points to make before starting to write the answer so that it is clear, correct and succinct.	• present multiple methods for a calculation, at least some of which are incorrect without making it clear which method they intend to be marked • made a single point in a question where 2 marks were available. • processed some, but not all, data, for example only looking at one column in a table where there were two columns of information • add extra points that are irrelevant to the question which may contradict correct statements leading to fewer marks awarded. • write excessively long answers that may include contradictions or include points that are not relevant to the question.

Question 1 (a)

1 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:

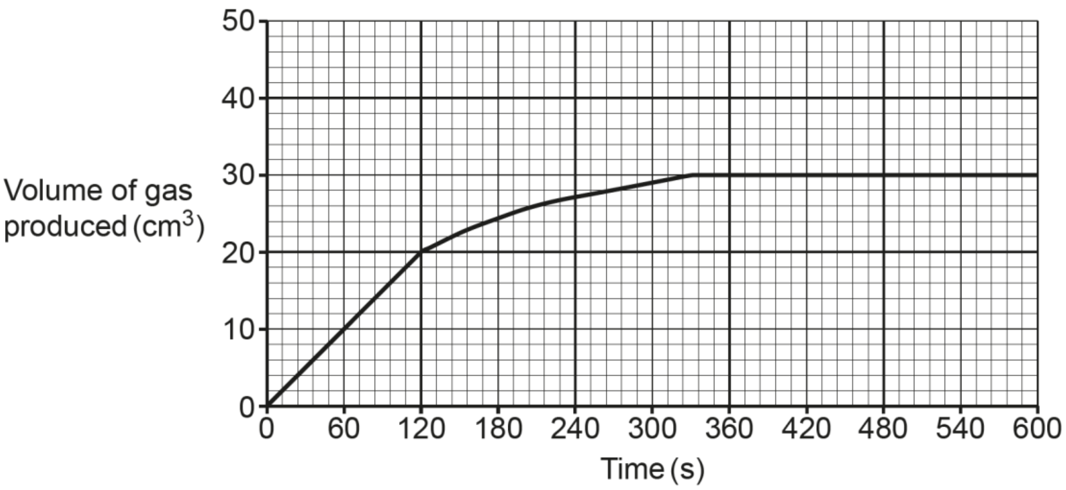
- the mass of limestone
- the volume of acid
- the concentration of acid.

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. 1.1 shows the results of experiment 1.

Fig. 1.1



Calculate the rate of reaction during the first 120 seconds.

Use **Fig. 1.1**.

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

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

Almost all candidates knew that rate is calculated by volume of gas divided by time. Typically they showed the correct graph readings, 120s and 20 cm^3 in their answers. The instruction to give the answer to two decimal places was sometimes overlooked and some candidates truncated rather than rounded their final answer, leading to the incorrect value 0.16. In common with all other calculations, those who set their working out clearly could gain partial credit if the final answer was incorrect. Answers without working or with contradictory working cannot be given partial credit.

Question 1 (b) (i)

(b) **Table 1.1** shows the conditions used for all three experiments.

Table 1.1

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

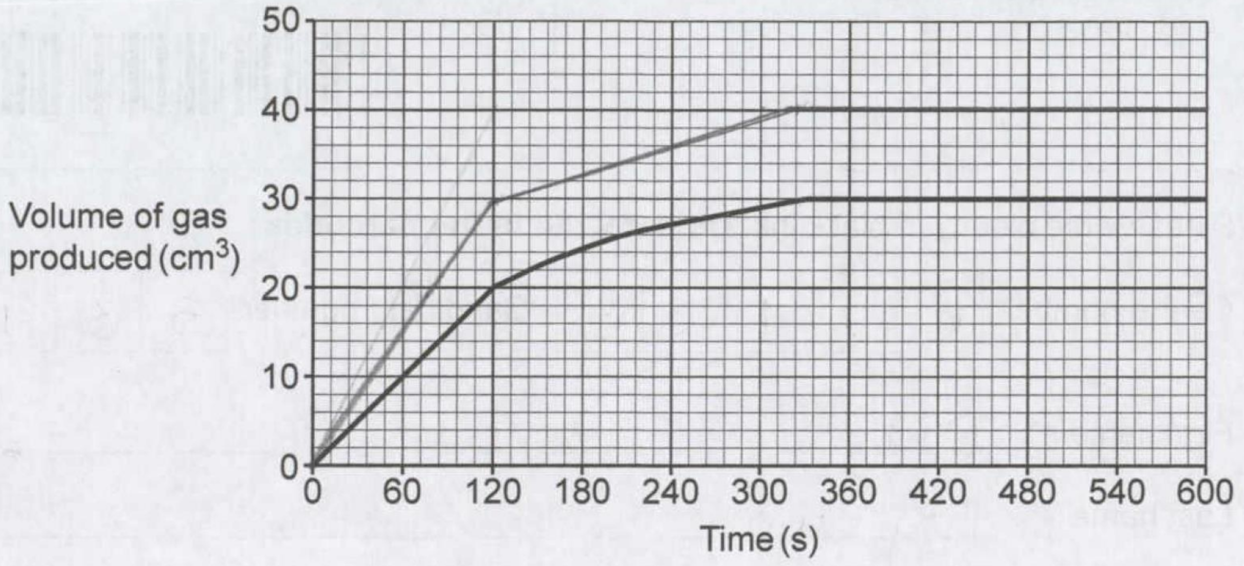
(i) Draw a line on **Fig. 1.1** to show the expected results for experiment 2.

Use the information in **Table 1.1** to help you. **[2]**

Almost all candidates knew that the initial gradient of the line would be steeper, indicating an increased rate. Fewer engaged with the idea that the same amount of limestone was used in each so that the final volume for experiment 2 is the same as for experiment 1.

Exemplar 1

Fig. 1.1



Notice that this candidate has correctly started their new line from the origin of the graph and drawn a steeper initial gradient, indicating a faster rate (1 mark). However, the fact that the total volume of gas should be equal, despite an increase in rate has been missed and so the final levelling of the line is too high. The angled nature of the curve was not penalised in this case because curved nature of the line of best fit was not being assessed. Ideally the curve should be smooth.

Question 1 (b) (ii)

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

Explain why.

Use the information in **Table 1.1**.

Include ideas about collisions in your answer.

....

....

....

.... **[2]**

There are two factors that increase the rate in experiment 3. Firstly, the limestone is in powder form. Secondly the temperature has increased. Some candidates engaged with both factors, but a common reason for partial marks was that many answers only discussed the change in surface area. The increase in temperature impacting the frequency of collisions or the number of particles with the minimum activation energy was often omitted.

It should be further noted that saying only 'more collisions' or 'more successful/effective collisions' is insufficient to explain a rate change, as these do not include a 'per time' factor. Best answers stated that the frequency of (effective) collisions increases or that there are more (effective) collisions per unit time.

Assessment for learning

Collision theory for rate must refer to frequency of collisions, not just 'more collisions' alone. For consistency with the approach at A Level, candidates could be encouraged to use the phrase 'more frequent successful collisions' which is relevant to temperature effects when a greater proportion of collisions are successful due to particles exceeding activation energy.

Question 1 (c) (i)

(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 1.2 shows their results.

Table 1.2

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 1.2**.

Metal ....

Explanation ....

....

.... **[2]**

Many candidates selected the correct metal, D, but not all justified their choice. There are two key points to identify the catalyst. Firstly, a catalyst increases the rate and secondly it is not used up. Some misinterpreted the data and gave incorrect statements such as 'D makes the most metal'.

Assessment for learning

When candidates are given two columns of data, they should double check their answer to make sure they have used both in their explanations.

Question 1 (c) (ii)

(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]

The incorrect statements in this question test common misconceptions about catalysts. Many candidates thought that catalysts change the overall energy change of a reaction. The last two sentences were usually judged correctly to be 'true'.

Misconception

?

Many candidates think that a catalyst changes the overall energy change for a reaction.

Question 2 (a)

2 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]

Almost all candidates identified the particles as a proton and a neutron and also know that the relative mass of a neutron is 1. The most common reason for a partial mark was to give the relative charge of a proton as '1' without the positive sign '+1'.

Question 2 (b)

(b) **Fig. 2.1** shows information about fluorine.

Fig. 2.1

9
F
Fluorine
19.00

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

Protons = ...

Neutrons = ...

Electrons = ...

[3]

Another very well answered question. Some included 19 as one or more of the numbers, but most could correctly process the atomic number and mass data to work out the number of each subatomic particle.

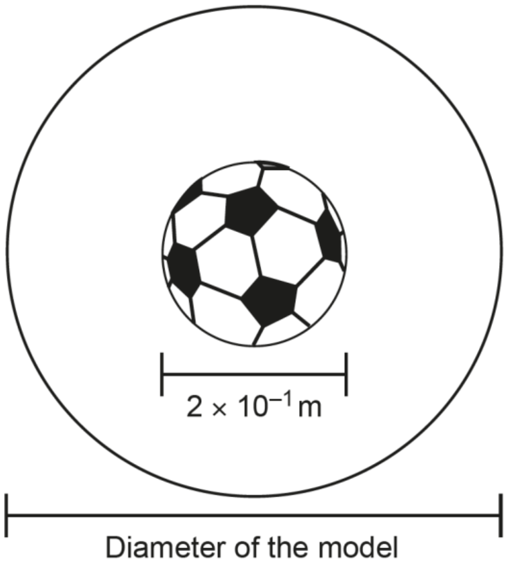
Question 2 (c)

(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. 2.2 shows their model.

Fig. 2.2



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]**

This question was very well answered. Candidates are now familiar and comfortable with the use of standard form, including to negative integers. Correct answers that were expressed in numbers but not in standard form were given 1 mark.

Question 3 (a) (i)

3

(a) Iron reacts with oxygen in the presence of water to form hydrated iron oxide (rust).

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

$$4Fe(s) + 3..........(g) \rightarrow .... Fe_2O_3(s)$$

[2]

Almost all candidates knew the formula for oxygen and most were able to balance the equation by adding a '2' on the right hand side.

Question 3 (a) (ii)

(ii) This reaction can be called rusting.

What is another name for this reaction?

.... **[1]**

Candidates typically recognised the answer as oxidation, but mis-spelling of the term meant that some answers were incorrect. Phonetically correct answers such as 'oxiddasion', etc. were accepted, but incorrect terms such as oxidisation were not given a mark.

Question 3 (b) (i)

(b) Rusting can be prevented by sacrificial protection.

(i) Explain why zinc can be used as sacrificial protection for iron.

....

....

....

.... **[2]**

A common issue here was that candidates discussed zinc forming a barrier to oxygen and water. Although not incorrect, this is irrelevant to the question which specifically asks about sacrificial protection. It is important that candidates make sure that they engage with the question asked.

Many knew that zinc reacts in preference to or instead of iron or stated that zinc is more reactive than iron. For 2 marks, both statements needed to be given. Many candidates gave one part of the answer but not both. Another common shortcoming was to state that zinc rusts. The only metal that rusts is iron, so candidates need to take care to use the term 'corrode' or 'react' when discussing the oxidation of other metals.

Question 3 (b) (ii)

(ii) Which **half** equation shows the oxidation of zinc?

Tick (✓) **one** box.

$Zn \rightarrow Zn^{2+} + 2e^-$	☐
$Zn \rightarrow Zn^{2+} + e^-$	☐
$Zn^{2+} + e^- \rightarrow Zn$	☐
$Zn^{2+} + 2e^- \rightarrow Zn$	☐

[1]

Many chose the correct answer, although there was some evidence of guesswork as all answers were seen. The most common incorrect choice was the 4th option, which shows the reduction of zinc ions rather than the oxidation of zinc metal.

Question 3 (b) (iii)

(iii) What is meant by the term reduction?

....

.... **[1]**

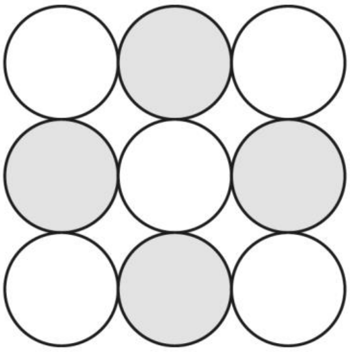
Almost all candidates knew the meaning of reduction, either in terms of loss of oxygen or gain of electrons.

Question 4 (a) (i)

4 Potassium bromide, KBr, is an ionic compound.

Potassium bromide is an example of a giant ionic lattice.

(a) The diagram shows a **2D model** for the arrangement of ions in potassium bromide.



(i) Complete the diagram by writing the correct charge onto each ion.

[2]

Almost all candidates correctly entered labels on the diagram to show their understanding of the alternating nature of positive and negative ions in the lattice structure.

The few errors that were seen included labelling the ions as 2+ or 2-, which is incorrect for potassium bromide. Another less common error was to assume that this was a metallic structure, leading to one of the particles being labelled as an electron.

Question 4 (a) (ii)

(ii) State **one** limitation of the model of potassium bromide shown in the diagram.

....

.... **[1]**

Again, this is an example of a type of question that has seen an improving trend. Many discussed that the diagram does not differentiate the size of the ions or that ions are not (inelastic) spheres. In this type of question, candidates need to make sure that they are not merely repeating information they have been told. The information says that the diagram is a '2D model' so stating that 'it is 2D' or 'it is not 3D' is too close to a restatement of the question to be given a mark.

Question 4 (a) (iii)

(iii) Which statements about the bonds in potassium bromide are **true** and which are **false**?

Tick (✓) **one** box in each row.

	True	False
A bromine atom gains an electron to form a positive ion.		
A potassium atom loses an electron to form a positive ion.		
Potassium bromide is held together by a sea of delocalised electrons.		
Strong electrostatic forces of attraction hold ions together.		

[3]

Many candidates correctly categorised the statements as true or false. Candidates found statement 1 the most challenging. Part of this sentence is correct (a bromine atom gains an electron) and part of it is incorrect (to form a positive ion). Candidates who thought this was correct had not evaluated both parts of the statement.

Question 4 (b)

(b) The properties of potassium bromide can be explained in terms of the behaviour of its ions.

Draw lines to connect each **property** with its correct **explanation**.

Property	**Explanation**
High melting point	Ions are arranged in a regular lattice
Forms crystals	Ions are free to move
Conducts electricity when molten	Oppositely charged ions are strongly attracted to each other

[2]

Almost all candidates linked the properties to the correct explanations.

Question 5 (a) (i)

5 The Periodic Table arranges the elements into groups.

(a) Group 1 of the Periodic Table contains reactive metals.

(i) Which statement about Group 1 metals is **true**?

Tick (✓) **one** box.

Group 1 metals are hard. ☐

Potassium is the most reactive Group 1 metal. ☐

Reactivity increases down the group. ☐

[1]

The increase in reactivity down Group 1 was recognised as correct by almost all candidates. This is clearly a well understood part of the specification.

Question 5 (a) (ii)

(ii) Sodium is a Group 1 metal.

Sodium reacts with water, moist air and chlorine.

Draw lines to connect each **reaction** with its correct **observation**.

Reaction	**Observation**
Heated with chlorine	Burns with a bright yellow flame
Left in moist air	Fizzes
Put in cold water	Forms a white coating

[2]

Most gained all 3 marks. Almost every candidate knew that sodium fizzes in cold water. The other two reactions were sometimes confused leading to incorrect choices.

Question 5 (a) (iii)

(iii) Caesium reacts with water to make hydrogen and one other product.

Complete the **word** equation for the reaction.

caesium + water → hydrogen + ... **[1]**

Candidates did not typically know that the metal hydroxide is the product of the reaction of Group 1 metals with water. Caesium oxide was the most common incorrect answer.

Question 5 (b)

(b) The table shows information about some Group 7 elements.

Element	Melting point (°C)	Boiling point (°C)	State at room temperature
Fluorine	–220	–188	Gas
Chlorine	–102	–35	Gas
Bromine	–7	59	Liquid
Iodine	114	184	Solid

Explain the trend in boiling point of the Group 7 elements.

Use ideas about intermolecular forces.

....

....

....

....

....

.... **[3]**

Candidates were asked to explain the trend in boiling point of the Group 7 elements. The first step in this answer is to state that the boiling points increase down the group, followed by an explanation with reference to intermolecular forces. This is a challenging question because it is an open ended response with 3 marks available in a challenging specification area.

Some candidates gave answers revealing a secure understanding.

Of those who did not, there were key themes seen in answers that were not fully correct. This is an area of confusion for candidates.

- Some answers did not clearly state the rising trend in boiling point.
- Some discussed melting points, which were not relevant to the question.
- Some stated that covalent bonds are broken when the elements boil.

A common issue was to state that intermolecular forces are between elements, atoms (or ions) rather than molecules.

Some stated that 'more energy is needed to boil' without linking this to the energy needed to break the forces between molecules.

Another very common issue was that candidates often included irrelevant points that were unrelated to the question asked, for example discussing trends in reactivity.

Exemplar 2

Explain the trend in boiling point of the Group 7 elements.

- increases down group
- reactivity decreases down group
- stronger IMF's

Use ideas about intermolecular forces.

boiling point increases going down group 7 because reactivity decreases down group 7. This is because the intermolecular forces get stronger down group 7, because the outershell gets further away from the nucleus, making it harder to gain an electron **[3]**

This answer starts well with the candidate clearly identifying the trend on the boiling point (increases down Group 1). This earns the first mark.

Then the answer explains that intermolecular forces get stronger down the group. Another clear mark.

However, the candidate then links boiling point to reactivity, and describes the trend in reactivity down the group. Both of which are incorrect and not relevant to the question. In addition, there is an incorrect statement about boiling points depending on ease of reduction (gaining electrons). Both of these additional statements were ignored as they are irrelevant to the question. However, candidates should take care to make sure that they read the question carefully and address the task asked. In many cases adding additional incorrect statements may contradict correct answers and lead to fewer marks being awarded.

Question 5 (c) (i)

(c) Chlorine displaces bromine from its compounds.

(i) Describe an experiment to show that this statement is **true**.

Include in your answer:

- the names and physical state of each reactant
- the observation you expect.

....

....

....

.... **[2]**

This question was only answered well by a minority of candidates. Best answers stated that aqueous potassium bromide and aqueous chlorine should be mixed and a brown solution would be observed.

It should be noted that, in questions where bullets are provided, these are intended to support candidates to structure their answers. It is important that candidates check and re-read the bullets after answering. In this case, candidates were expressly asked to state the names and physical state of each reactant and to describe the observations expected.

It was relatively common for candidates to omit the identities of the reactants or to omit their states. It was also common that no observations were provided. Typically answers such as 'do a displacement reaction' or 'react chlorine and bromine together' were very common.

Assessment for learning

In questions with bullets, candidates need to make sure that they address every bullet in order to access all marks.

Question 5 (c) (ii)

(ii) Aqueous chlorine is corrosive.

State **one** safety precaution that can be taken when handling aqueous chlorine.

.... **[1]**

All candidates were able to suggest a relevant safety precaution such as to wear gloves, goggles or use a fume cupboard when handling aqueous chlorine.

Question 6 (a) (i)

6 The Earth, including its atmosphere and its oceans, is made up from elements and compounds in different states.

(a) The particle model can be used to describe the states of these substances and what happens to the particles when they change state.

(i) Water, H_2O, can be present on earth as a solid, liquid or gas.

Explain the changes in the movement and arrangement of particles when water changes from liquid to solid.

[3]

Most candidates gained partial marks for a description of this state change. The question asks about the change between liquid and solid and specifically asks for reference to be made to the movement and arrangement of particles. Best answers described the movement and arrangement in a liquid as being randomly arranged with particles moving over each other or using other words to express the idea that the particles were close together. The most common misconception was that particles in a liquid are spaced apart. Some, but not all, described the movement of particles in a solid as being only able to vibrate in position. Again, only some candidates stated that particles in a solid are arranged in a regular pattern. In some cases vague responses such as 'particles in liquid move more' were also seen.

Misconception

Many candidates think that particles are significantly further apart in liquids compared to solids. Some stated that the particles 'fill the container' in a liquid.

Question 6 (a) (ii)

(ii) State **one** limitation of the particle model.

....

.... **[1]**

In common with Question 4 (a) (ii) this was well answered with almost all candidates able to describe a limitation of the particle model.

Question 6 (b) (i)

(b) The greenhouse effect is an essential process for maintaining life on earth.

Carbon dioxide and methane cause the greenhouse effect.

(i) Which statements about greenhouse gases are **true** and which are **false**?

Tick (✓) **one** box in each row.

	True	False
They absorb infrared radiation from the Earth.		
They come only from anthropogenic sources.		
They emit radiation in all directions.		
They prevent all radiation from the Sun passing through the atmosphere.		

[3]

This question was well answered, although some incorrect choices revealed that some candidates think that the greenhouse effect is only caused by gases from anthropogenic sources and that they prevent radiation from the Sun from reaching the Earth.

Question 6 (b) (ii)

(ii) Increased carbon dioxide and methane cause climate change.

State **two** possible consequences of climate change.

1 ....

....

2 ....

....
[2]

This is a well-known area of the specification and most candidates earned 2 marks. The common reasons that full marks were not earned included that some candidates repeated the question by giving answers that described climate change rather than identify consequences. Some gave multiple answers that were all the same point, for example more extreme weather events and more hurricanes. Such answers were given 1 mark. Some incorrectly stated natural disasters such as tsunamis or earthquakes as being a result of climate change.

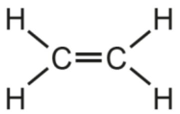
Question 7 (a) (i)

7 Polymers are long chain molecules.

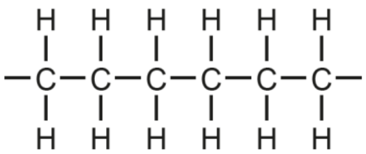
(a) Ethene is a monomer that is used to make an addition polymer.

Fig. 7.1 shows a molecule of ethene.

Fig. 7.1



(i) The table shows the addition polymer formed from ethene.

Addition polymer formed from ethene	Repeating unit of addition polymer formed from ethene
	

Complete the table to show the repeating unit of the addition polymer. **[2]**

Candidates found the identification of the repeating unit challenging. Although many drew the structure correctly, with continuation bonds, many included a double bond, drawing a structure similar to the monomer shown in Fig. 7.1. Others thought the repeating unit was CH_2.

Question 7 (a) (ii)

(ii) Suggest the name of the addition polymer shown in the table.

.... **[1]**

Again, candidates found this more challenging than expected. Names of alkanes such as pentane, hexane or propane were often seen rather than the correct answer poly(ethene).

Question 7 (b)

(b) Describe what happens when an addition polymer forms from its monomers.

....

....

....

.... **[2]**

Many candidates earned one of the available 2 marks. Some said that the 'single bonds form' without stating clearly that the double bond breaks to join monomers together. The idea of 'polymer' is that a long chain is formed from the reaction of many monomers. This idea was not always well expressed. It was common to see answers such as 'monomers join together' alone without expressing the idea of a large chain molecule being created.

Question 7 (c)

(c) Some synthetic polymers are condensation polymers.

Which statements about condensation polymers are **true** and which are **false**?

Tick (✓) **one** box in each row.

	True	False
Condensation polymers contain repeating units.		
Condensation polymers form from monomers that contain two functional groups.		
Some condensation polymers are hydrocarbons.		
The polymer is the only product in a condensation polymerisation reaction.		

[3]

Most candidates gained 2 marks. The most common incorrect answer was that many candidates thought that condensation polymers do not contain repeating units.

Question 8 (a) (i)

8 A student investigates the law of conservation of mass.

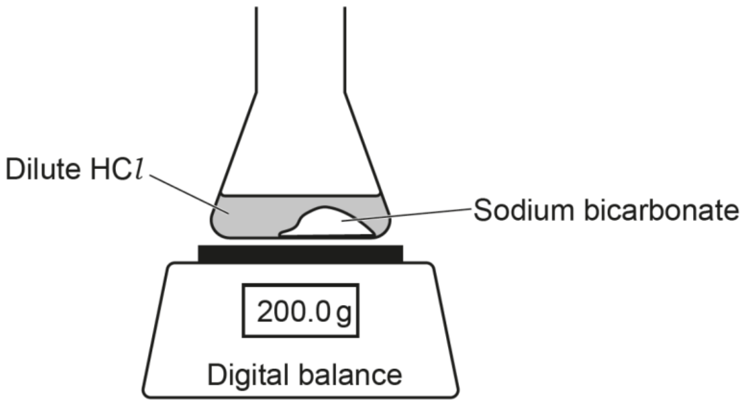
(a) In one experiment, the student reacts sodium bicarbonate with dilute hydrochloric acid.

The equation shows the reaction.

$NaHCO_3(s) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l) + CO_2(g)$

Fig. 8.1 shows the apparatus the student uses at the start of the experiment.

Fig. 8.1



The mass of the flask and contents at the start of the experiment is 200.0 g.

(i) The student uses 40.0 g of dilute hydrochloric acid.
The empty conical flask weighs 150.0 g.

Calculate the number of moles of sodium bicarbonate the student adds to the flask at the start of the reaction.

Number of moles = ... **[4]**

The initial part of this calculation involves the relative formula mass of sodium bicarbonate (84) and the mass added at the start of the reaction (10g). Some, but not all, candidates calculated both numbers correctly. At this point, the number of moles is calculated by dividing 10 by 84 to get the correct answer 0.119. At this stage of the calculation, many candidates seemed unsure how to proceed. It was common to see expressions such as (84x10) or (84÷10). Sometimes candidates did several different calculations and it was unclear which answer they intended to be their final answer. Where possible, and where working was clear enough to follow, error carried forward was allowed for a correct method based on the use of numbers other than 84 or 10.

Assessment for learning

It is very important that candidates set out their working clearly so that error carried forward or partial credit may be given for an answer that is not fully correct.

Question 8 (a) (ii)

(ii) The student also measures the mass of the flask and contents at the end of the reaction.

The table shows their results.

Mass of flask and contents at **start** of reaction (g)	200.0
Mass of flask and contents at **end** of reaction (g)	194.8

The student says that the law of conservation of mass does **not** apply to this experiment.

Explain why the student thinks this **and** why the student is **not** correct.

....

....

....

....

....

.... **[3]**

The 3 marks here require a carefully structured response to address the three different areas of the question. Firstly, the answer needs to explain the law of conservation of mass and then say why the student thinks it does not apply, with a final explanation of why they are incorrect.

It was common for answers to address some but not all aspects of the question. Most identified from the table that 'mass is lost'. Some explained that this is due to the evolution of a gas which leaves the system. Few explained that mass is conserved because no mass is gained or lost.

Question 8 (b) (i)

(b) In another experiment the student reacts copper oxide with dilute hydrochloric acid.

$CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$

The mass of the flask and contents at the start of the reaction is 250.0 g.

(i) Predict the mass of the flask and contents at the end of the reaction.

Explain your reasoning.

Mass = ... g

Explanation ....

....

....
[2]

Most were able to predict that the mass would stay constant at 250.0g. Fewer linked this to the equation, which shows that all products remain as liquids or aqueous solutions or do not leave as gases. 'No mass is lost' was a common answer that was judged to be insufficient.

Question 8 (b) (ii)

(ii) Complete the sentences to describe the reactants at the end of a reaction.

A reaction ends when one of the reactants is used up.

The reactant that is used up is called the .... reactant.

The reactant that is left over is described as being in ....
[2]

This question tested knowledge of the specific vocabulary 'limiting' and 'excess'. Some candidates knew both terms but it was common to see incorrect words such as main, abundant, soluble, equilibrium, finite or complete.

Question 9 (a) (i)

9 Qualitative analysis can be used to identify the elements in compounds.

(a) A student does a flame test on some unknown samples.

The table shows their results.

Sample	Flame Colour
A	bright red
B	bright yellow
C	lilac
D	blue-green

(i) Describe the method for using a flame test to identify metal ions.

....

....

....

....

....

.... **[3]**

Answers testing practical skills are challenging for many candidates. Few gave complete answers. There are two procedures that are generally used for flame tests. Some use a nichrome wire dipped in acid and then in the sample. Some use a splint soaked in a solution of a compound. In either case, it is important a blue flame is used and that the colours are compared to a reference in order to identify the elements present. It was very common for candidates to suggest holding samples in the flame using tongs and to hold the sample in a yellow flame.

Exemplar 3

Have bunsen burner on a safety flame to be able to better see colours. With metal tongs, hold unknown sample over bunsen burner flame. Observe colour change if there is one.

This answer contains common errors that were frequently seen. The candidate has stated that a 'safety' flame (a yellow flame) is used and is holding the sample in tongs. Although 'observe colour' is stated, there is no mention of comparing this to known colours or a reference.

Question 9 (a) (ii)

(ii) The student says:

"Sample D contains **sodium** metal ions."

They are **not** correct.

Explain why.

....

.... **[1]**

Many knew that sodium ions do not give a blue-green flame colour, some correctly stated that the colour seen is yellow.

Question 9 (a) (iii)

(iii) Name the metal ion in Sample D.

....

.... **[1]**

Many correctly stated 'copper' but many other elements from all groups were suggested.

Question 9 (b)

(b) In qualitative analysis, chemists make sure that a sample is **representative**.

Describe the purpose of representative sampling in qualitative analysis.

....

....

....

.... **[1]**

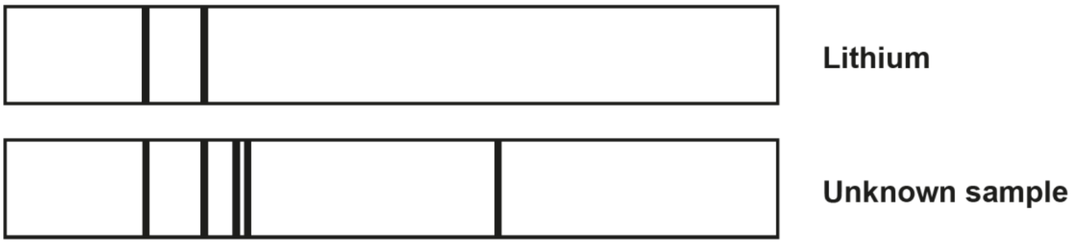
This question was tricky for candidates due to the language they attempted to use. It was difficult for them to find words to explain the term 'representative'. Best answers stated that representative sampling is chosen so that results can be generalised to the bulk of a material, they can be generalised across a larger range or that they can be used to show that the results identify any variation. Common incorrect answers included 'so an average can be taken' or 'to make sure it's accurate'.

Question 9 (c) (i)

(c) Emission spectroscopy is an instrumental method of analysis.

Fig. 9.1 shows the spectrum for lithium and the spectrum for an unknown sample.

Fig. 9.1



(i) What conclusions can be made about the ions in the unknown sample?

Explain your reasoning.

Use **Fig. 9.1**.

....

....

....

....

....

.... **[3]**

This question was well answered. Many candidates stated that lithium is in the unknown sample because of the match between spectra. Many said that there are also unknown ions because there are additional lines. Common misunderstandings included that one line represents one element or that multiple lines identify that the sample is impure.

Question 9 (c) (ii)

(ii) State **two** advantages of instrumental methods of analysis rather than flame tests to identify the ions in unknown samples.

1 ....

....

2 ....

....

[2]

This was again well answered, although some candidates only knew one advantage. Many stated that instrumental methods are more sensitive and can be used to identify multiple ions.

Question 10 (a) (i)

10 Acids react with hydroxides and metals to produce salts.

(a) A student uses a titration experiment to investigate the volume of dilute hydrochloric acid that reacts with aqueous sodium hydroxide.

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

$HCl + NaOH \rightarrow$ .... + ...

[2]

Another well answered question. Many candidates were able to give the correct formulae for sodium chloride and water. A few had hydrogen as a product.

Question 10 (a) (ii)

(ii) The student uses phenolphthalein indicator.

They complete the titration four times.

The table shows their results.

Titration number	**1**	**2**	**3**	**4**
Volume of acid used in each titration (cm^3)	30.0	28.9	29.1	29.7

The student thinks the data in the table is **not** accurate.

Describe **one** change the student can make to their titration experiment to make the data more accurate.

.... **[1]**

The question asked for 'a change to the titration experiment'. Some candidates discussed taking an average or excluding outliers. These are not experimental changes. Many knew that the acid should be added slowly, particularly near the end point. A relatively common incorrect answer was to 'use the same amount of acid every time' which reveals a fundamental misunderstanding of the procedure.

Question 10 (a) (iii)

(iii) The salt formed in the reaction is **soluble** in water.

Suggest **one** way to prepare pure dry crystals of the salt produced in the titration.

....

.... **[1]**

As there is only one mark here, it was important that the correct separation technique was identified. This is evaporation. The most common reason that some candidates did not gain a mark was because they tried to describe the process in detail and made errors. Heating to dryness or 'until you get crystals' is incorrect because any heating should stop when the solution is saturated.

Question 10 (b) (i)

(b) Hydrochloric acid is a **strong** acid.

(i) Which **two** statements about strong acids are **true**?

Tick (✓) **two** boxes.

Strong acids contain only covalent bonds. ☐

Strong acids have a pH <7. ☐

Strong acids have OH^- ions. ☐

Strong acids ionise completely. ☐

[1]

This question was well answered although 'strong acids contain only covalent bonds' was a common incorrect choice.

Question 10 (b) (ii)

(ii) An acid with a pH of 1 has a hydrogen ion concentration of 0.1 mol / dm^3.

What is the pH of a solution with a hydrogen ion concentration of 0.0001 mol / dm^3?

.... **[1]**

This is a difficult question and many candidates answered it fully correctly. The link between concentration and pH is well understood.

Question 10 (c)

(c) A student measures the reaction time when magnesium reacts with two different acids, dilute hydrochloric acid and a dilute weak acid.

The student keeps the same mass of magnesium and the same volume and concentration of acid in each reaction.

They record the time it takes for the magnesium to disappear.

The reaction with dilute hydrochloric acid finishes after 25 seconds.

Predict the reaction time with the dilute weak acid.

Explain your answer using ideas about hydrogen ions.

Reaction time with the dilute weak acid = ... s

Explanation ....

....

....

....

[2]

Most correctly predicted a time greater than 25s. Fewer were able to justify this with a correct explanation. Many stated that 'weak acids contain fewer hydrogen ions' or 'they have fewer hydrogen atoms' or 'they are less concentrated'. Best answers stated clearly that weak acids are not fully dissociated.

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