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GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE CHEMISTRY B

J258
For first teaching in 2016

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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. 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 can be downloaded from OCR.

Paper 4 series overview

This is the higher tier paper of two papers for the new revised GCSE examination for Chemistry B. This paper is designed to test the depth of candidate's knowledge. As such, candidates are expected to show that they can develop ideas within a question, often over a narrow range of linked specification statements from a single topic. Some questions further test their ability to further make links or to contrast learning from different specification areas.

The question style is short answer, often using stems of information for candidates to process and use in their answers. There are also two longer level of response questions, where candidates need to organise their ideas to make reasoned arguments to present their views based on provided information. The Science for the Twenty First Century suite of specifications include integral Ideas about Science, which are also assessed through the contextualised and issue based question style, where candidates are expected to process unfamiliar information, make informed decisions and solve problems.

The new specification also includes mathematics in line with national requirements for the mathematical content of GCSE question papers. Some candidates were well prepared to tackle these new requirements. For others, more focus on the newer mathematical content may support their preparation for the examination, for example by ensuring that they are conversant with numbers given in standard form, rearranging equations, working through multi-stage calculations and handling data in different formats.

Candidates who did well on this paper generally did the following:

- read and assimilated information given in question stems and applied this when answering the questions (less able candidates often copy out information without explaining how it applies to the question).
- thought about command words and approached questions accordingly, for example by approaching 'Describe how…..' and 'Explain why…' questions differently.
- answered longer 2 and 3 mark questions by considering the number of clear points necessary and ensuring that their marks matched the mark allocations.
- answered succinctly and clearly.
- came to the examination prepared for the mathematical demands listed in the specification, for example by using or interpreting standard form, algebra and mathematical symbols within the context of the questions.
- considered the information in the level of response questions before starting to write to make sure that they used all available information.
- considered the instructions carefully for the level of response questions and made sure to answer all aspects of the question.

Candidates who did less well on this paper generally did the following:

- gave partial answers to longer questions so that the available number of marks were not all addressed.
- did not always read the question carefully so that the answer given did not always match the instructions in the question. In the level of response questions some candidates only answered one aspect of the question, limiting them to the lower mark ranges.

There was no evidence that any time constraints had led to a candidate underperforming. Candidates typically answered all questions with few gaps.

Key point call out

A significant reason for partial, rather than full marks, for questions is that candidates do not always judge their answer by paying proper attention to the number of marks available. The mark allocation gives a strong indication of the number of separate points it is necessary to make in order to gain full credit. Multi-mark questions often link to provided data or information. Candidates need to extract several pieces of evidence or make several judgements in order to earn all the available marks.

Key point call out

For the level of response questions, it is important that candidates give full attention to the task and perhaps re-read the task before moving on. Many responses which led to Level 1 or Level 2 mark ranges had omitted some of the task instructions and so were incomplete.

Question 1 (a)

1 Alex collects some samples of minerals from a spoil heap near an old mine.

Alex tests two samples of minerals, **A** and **B**, to identify the ions that they contain.

(a) He carries out flame tests on each sample and compares his results (**Table 1.1**) to a reference book of flame colours for some metal ions (**Table 1.2**).

Alex's results

Mineral	Flame colour
A	green
B	orange-red

Table 1.1

Reference book

Metal ion	Flame colour
copper	blue-green
calcium	orange-red
iron	varies with temperature blue/green/yellow/orange
zinc	green

Table 1.2

Use information from **Table 1.1** and **Table 1.2** to explain why Alex cannot be certain which ions are in the samples.

....

....

....

.... **[3]**

Most candidates correctly linked some or all of the ions correctly to minerals A and B. When candidates are asked to 'Use information to explain……' it is important that they reference their reasons from the provided data. Best answers referred clearly to the colours and the lack of certainty due to human judgement of differences between colours. Many candidates did not refer clearly to colours in their response.

	AfL	When asked to 'Use information to explain' it is important that you cite your evidence in your answer. These questions are often accompanied by data or information in a table. You are being asked to show that you can extract that information and use it to support your arguments.

Question 1 (b) (i)

(b) Alex makes a solution of a sample of each mineral in water and does some further tests.

The tests he carries out, and his results, are shown in **Table 1.3**.

Mineral	Test	Result
A	Add dilute sodium hydroxide.	blue precipitate
	Add dilute hydrochloric acid.	fizzes, gas given off turns lime water milky
	Add dilute silver nitrate.	white precipitate
B	Add dilute sodium hydroxide.	white precipitate does not dissolve in excess
	Add dilute hydrochloric acid.	no change
	Add dilute silver nitrate.	white precipitate

Table 1.3

(i) Alex thinks that mineral **A** contains two negative ions.

How can you tell from the results that Alex is right?

....

.... **[1]**

As the identity of the ions in mineral A was tested in Question 1bii, it was not necessary for candidates to identify the ions in this part question, although many correctly did so. Many candidates correctly stated that the positive results from adding dilute hydrochloric acid and dilute silver nitrate indicate that two anions are present. Some candidates only mentioned one reagent; others mentioned all three. These incorrect answers could not earn the mark.

Question 1 (b) (ii)

(ii) Identify the ions in mineral **A** and mineral **B**.

Choose words from this list.

copper calcium iron zinc carbonate chloride sulfate

Ions in mineral A	Ions in mineral B
....	....

[3]

For 3 marks, candidates needed to use the results in Table 1.3 to draw conclusions about the ions in the minerals. This proved challenging. Most candidates did not obey the rubric to 'choose words from….' but attempted to enter all of the ions into the two columns in the table. It was common to see all four metal ions listed in the body of the table.

Exemplar 1

Ions in mineral A	Ions in mineral B
Copper carbonate Chloride	calcium Chloride

[3]

This candidate has followed the rubric to 'Choose words from the list' and has answered fully correctly.

Exemplar 2

Ions in mineral A	Ions in mineral B
Copper Zinc Iron	Calcium Iron

[3]

This response has attempted to include all the metal ions in the two columns.

Question 1 (c)

(c) Alex also has an emission spectroscopy machine to analyse samples of minerals.

Give **one** advantage of using an emission spectroscopy machine, rather than flame tests or chemical tests, to identify samples.

....

.... **[1]**

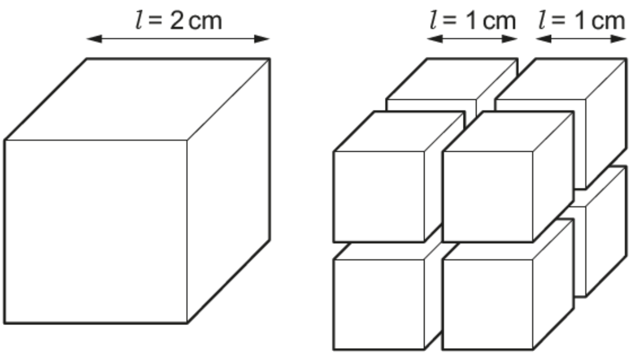
Candidates often gave clear advantages to the use of emission spectroscopy, such as the reduced reliance on human judgement of colour, the unique spectrum of elements and the ability to identify many components in a mixture. However, weaker responses were also often seen. Answers such as 'more accurate' or 'easier and quicker' were not given any credit.

Question 2 (a) (i)

2 Silver nanoparticles are used in some socks to remove the smell of sweaty feet.

Silver nanoparticles have different properties to larger pieces of silver because they have a different surface area to volume ratio.

(a) The diagram shows what happens when a larger cube of silver is cut into eight smaller cubes.



The volume and surface area of a cube can be worked out using these formulae:

volume = $l \times l \times l$

surface area = $6 \times l \times l$

Table 2.1 shows the volume, surface area, and surface area to volume ratio for the larger cube.

Property	**Larger cube**	**Smaller cubes**
Total volume (cm^3)	8	....
Total surface area (cm^2)	24	....
Surface area to volume ratio (per cm)	3	....

Table 2.1

(i) Complete **Table 2.1** by filling in the blank spaces for the eight smaller cubes.

Use this space to show your working.

[3]

Many candidates earned all 3 marks. The most common error was to give the volume, surface area and ratio for a single small cube rather than the total volume and surface area. This led to a response of 1:6:6, which only earned 1 mark for the final ratio.

Question 2 (a) (ii)

(ii) Use ideas about surface area and volume to explain why nanoparticles of silver have a different surface area to volume ratio than larger silver particles.

....

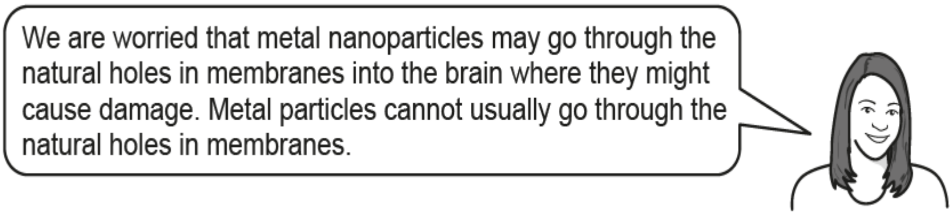
....

.... **[2]**

Although most answers included the point that making the particles smaller increased the surface area, few went on to explain the idea of 'ratio' by stating that the volume is the same as it is unaffected by decreasing the particle size.

Question 2 (b) (i)

(b) New research has shown that nanoparticles may be used to treat cancer. However, some scientists are worried about the negative effects of nanoparticles on the body.



(i) Explain why metal nanoparticles may be able to enter the brain even though metal particles usually cannot.

....

....

....

.... **[2]**

Although it is important to refer to the information given, candidates need to be careful not to merely repeat the statements. The call out box includes information that '…nanoparticles may go through holes in the membrane'. Repeating this verbatim did not earn credit. Best answers related this to the small size of the nanoparticles and the relative size of holes in the membranes compared to both nanoparticles and standard sized metal particles.

Question 2 (b) (ii)

(ii) Use ideas about **risk** and **benefit** to evaluate the use of nanoparticles in socks and to treat cancer.

....

....

....

....

....

.... **[3]**

Best answers evaluated the relative risk-benefit analysis for the two uses, for example by pointing out that the benefit of treating a life-threatening disease outweighed the risk, but that removing the odour of feet was a more trivial benefit so did not necessarily outweigh the risk. An easy 1 mark was to state that the long-term risks of nanoparticles are not yet known (so it is difficult to establish the true risk of their use). Weaker answers discussed vaguely that using nanoparticles in any situation is risky, or that socks post 'no risk' but treating cancer is 'very risky'.

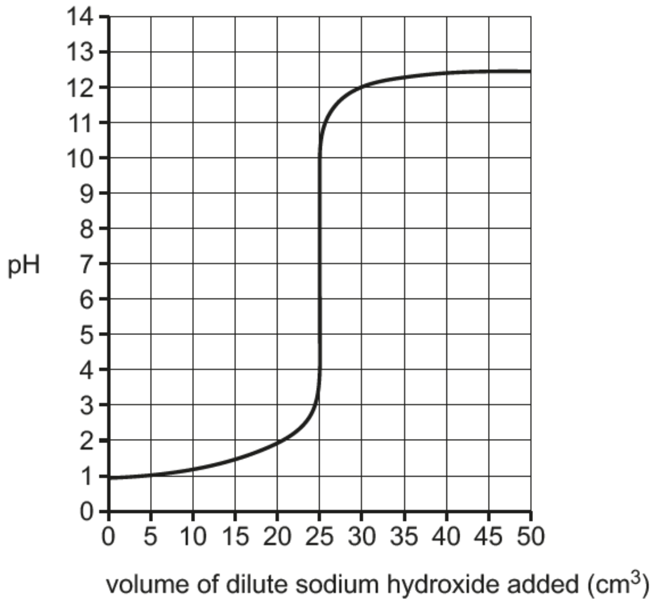
Question 3 (a)

3 Ali investigates how the pH changes when dilute sodium hydroxide reacts with dilute hydrochloric acid.

He puts 20.0 cm^3 of dilute hydrochloric acid in a beaker. He adds dilute sodium hydroxide, 1.0 cm^3 at a time, to the acid.

He uses a pH meter to measure the pH after each addition of sodium hydroxide.

Ali plots a graph of his results.



Ali writes an ionic equation for the reaction.

$H^+ + OH^- \rightarrow H_2O$

(a) Use the **ionic equation** and **values from the graph** to explain the pH changes that happen during the reaction.

....

....

....

....

....

.... **[3]**

In common with 1a, candidates were asked to 'Use the ionic equation and values from the graph'. The best answers followed this instruction, for example by quoting pH values and volume from the graph and by linking the ion in the equation to the pH values on the graph. Answers which did not gain all 3 marks typically answered without reference to the information, for example discussing neutralisation from acid to alkali, without clearly linking this either to the graph or the equation. The question also mentioned pH changes. Some answers did not refer to pH at all.

Exemplar 3

At the start PH 1, very strong acid.
It increases from the beginning
at a steady rate. H^+ ions fully
dissociate, ionises completley. At
$25 cm^3$, sudden increase of PH
from PH3 to PH 11. Now an alkali, **[3]**
more sodium hydroxide than hydrochloric
acid. Quite strong an alkali at
pH 11, so more OH^- ions dissociate.
Then it starts to increase more slowly, levels off
between pH 12 – 13.

Although not 'perfect', this response shows that the candidate has used the graph (and quoted pH values) and the equation (linking the ions to acidic/alkaline solutions and their pH) to gain all 3 marks.

Exemplar 4

when a negatively charged ion reacts
with a positively charged ion, it evens out
and becomes neutral. The PH begins at 1 (strong
acid) and as the volume of dilute
sodium hydroxide added increases, the PH
increases going towards neutral (7) and ending as **[3]**
a strong alkali (12.5).

This response gains 1 mark from its reference to values from the graph (the start and end pH). Notice that there is no reference in this response to the equation.

Question 3 (b)

(b) Ali started with **20.0 cm^3** of dilute hydrochloric acid in the beaker.

Explain how his results show that the acid is more concentrated than the dilute sodium hydroxide.

....

....

.... **[2]**

Most gained 1 mark, either for stating that 'more sodium hydroxide' was needed, or for using the graph to state that 25cm^3 was needed. Fewer gave the higher level answer that if the concentrations were equal 20cm^3 of sodium hydroxide would neutralise 20cm^3 of the dilute acid.

Question 4 (a)

4 The repeating unit of some polymers has the structure shown in **Fig. 4.1**.

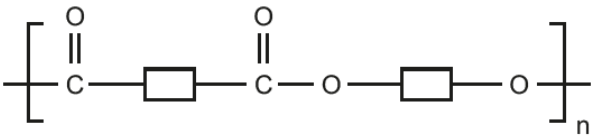


Fig. 4.1

(a) What is the name for this type of polymer?

Put a (ring) around the correct answer.

addition **polyamide** **polyamine** **polyester** **oxidised**

[1]

The identity of this type of polymer (polyester) was not well known. Many candidates thought that the polymer was either an addition polymer or was a polyamide.

Question 4 (b) (i)

(b) One repeating unit of the polymer can be broken down by a reaction with water into its monomers, **molecule A** and **molecule B**, as shown in **Fig. 4.2**.

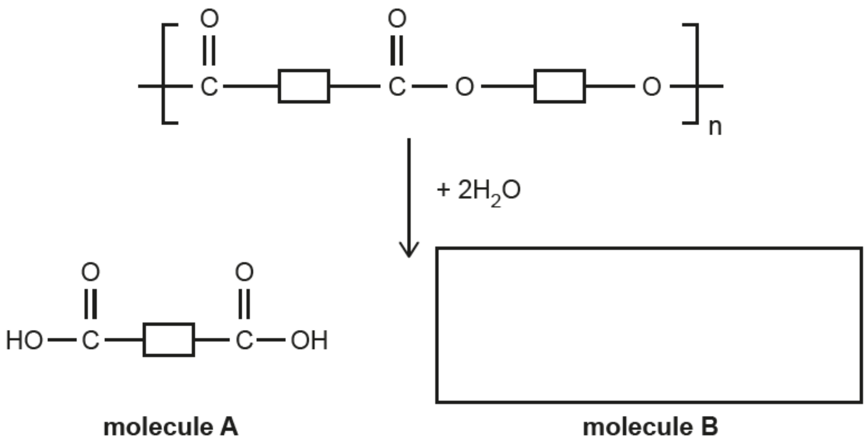


Fig. 4.2

(i) Complete the diagram in **Fig. 4.2** by drawing the structure of **molecule B**. **[1]**

Most candidates knew that molecule B would have a functional group either side of a 'box'. However, it was common to see molecule B represented as a carboxylic acid or with other incorrect groups or additional oxygen atoms.

Question 4 (b) (ii)

(ii) The polymer was originally made by reacting monomers, **molecule A** and **molecule B**, together.

How is the reaction to make the polymer different from the reaction in **Fig. 4.2**?

Explain your answer.

....

....

....

.... **[2]**

Commonly, answers included points such as that the two reactions were the reverse of each other, or that water is given out in a condensation reaction during polymerisation and/or taken in during the break down of the polymer. Some answers only made one of these points.

Question 4 (b) (iii)

(iii) Explain why **molecule A** is called a **dicarboxylic acid**.

....

....

.... **[2]**

Most knew that di meant 'two' but did not necessarily explain the term 'carboxylic'. Best answers stated that the molecule contains two COOH groups. Other answers that gained partial credit included stating that there are two acid groups. Answers such as 'has two carbons' were not given any marks.

Question 4 (c)

(c) PET is a type of polymer used to make drinks bottles.

PET has the repeating unit shown in **Fig. 4.3**.

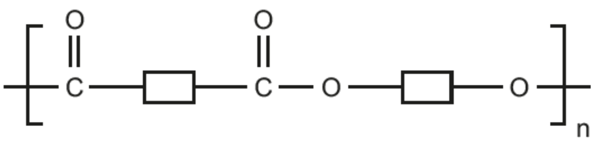


Fig. 4.3

In molecules of PET, ▭ represents C_2H_4.

The average relative formula mass of polymer molecules in a sample of PET is 55 000.

How many repeating units does each polymer molecule contain?

Give your answer to the **nearest whole number**.

Number of repeating units = ... **[2]**

Most divided 55 000 by relative formula mass. However, often the relative formula mass was calculated incorrectly. Some used 28 (the RFM for ethene). Some used 56 (28x2). Both of these errors omitted the ester linkage in the calculation for the RFM. These answers were credited a single mark.

Question 5 (a)

5 Malachite is an ore of copper that contains copper carbonate, $CuCO_3$. It is mined on a large scale all over the world.

The flowchart in **Fig. 5.1** shows how copper can be made from copper carbonate, either in industry, or on a small scale in the laboratory.

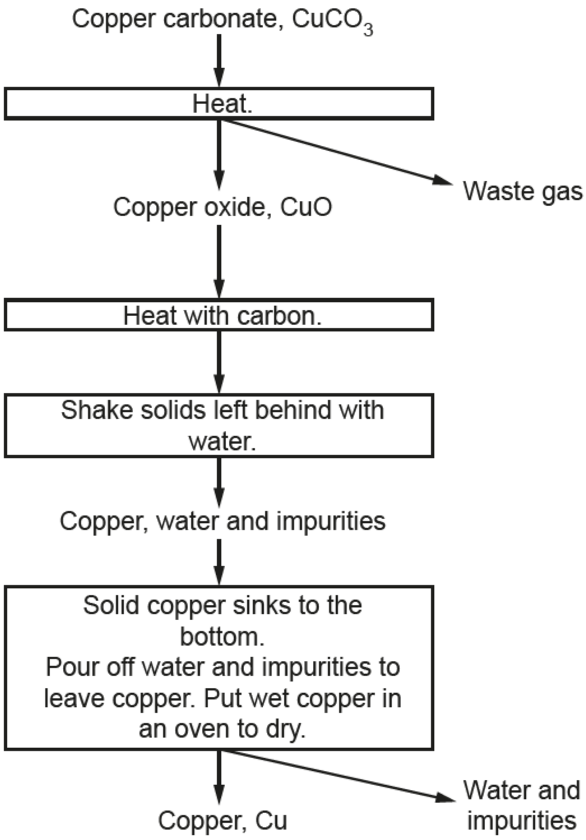


Fig. 5.1

(a) Write a **symbol equation** for the reaction that happens when copper carbonate is heated.

.... **[2]**

Most correctly gave the formulae for copper oxide and carbon dioxide. Some added water either to the reactants or products.

Question 5 (b)

(b) Copper made by the method in **Fig. 5.1** contains solid impurities.

Name **two** solid impurities that the copper may contain.

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

Most correctly stated carbon. Fewer gave a correct second impurity. Calcium and/or copper were common incorrect answers.

Question 5 (c) (i)

(c) Jane uses the flowchart in **Fig. 5.1** as a method in the laboratory.

Jane's teacher gives her this equation to help her to work out her theoretical yield of copper.

theoretical yield = 0.51 × mass of copper carbonate at start

(i) Jane uses the equation to work out what mass of copper carbonate she should use to make a theoretical yield of 5.0 g of copper.

Calculate the starting mass of copper carbonate she should use.

Give your answer to **2** significant figures.

Mass of copper carbonate = ... g **[3]**

Best answers began by rearranging the equation, then substituted in and followed the instruction to report their final answer to two significant figures. Some did not rearrange the equation but multiplied 5.0 by 0.51. Some did not give their answer to two significant figures, as the question asked.

Question 5 (c) (ii)

(ii) When Jane follows her method, she only makes 2.4 g of copper.

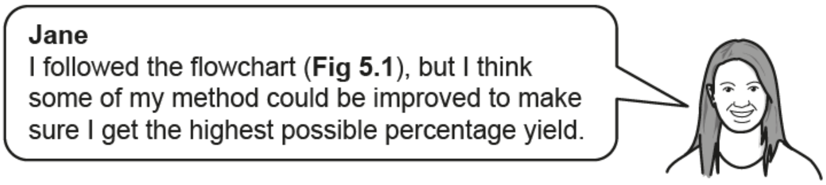
Calculate Jane's percentage yield.

Percentage yield = ... % **[2]**

This was well answered. Almost all candidates knew how to calculate percentage yield.

Question 5 (c) (iii)

(iii) Jane comments on her method.



Suggest what Jane could do to make sure she gets the highest possible percentage yield.

Use the flowchart in **Fig. 5.1** to support your answer.

....

....

.... **[2]**

Although high quality responses were seen, many candidates gave a single idea rather than working through the flowchart to look for at least two ideas. Working through the flowchart, copper can be lost during each stage. Best answers gave ways of reducing this at two or more stages. For questions with a 2 mark allocation, candidates should tailor their responses to make sure that they are making two separate and distinct points to earn the number of marks.

	AfL	It is good examination technique to look at the number of marks available when you plan your response to a question. 2 marks needs two separate points. Read the question again and check that you have answered every aspect before moving on.

Exemplar 5

She could repeat the step of oning off solids and impurities again. And makes sure to heat the copper oxide for long enough **[2]**

This response clearly refers to two stages in the process and explains how to recover more copper.

Exemplar 6

when pouring off solid impurities, make sure none are copper and see if you can separate **[2]** copper in the impurity, maybe using electrolysis.

This response only refers to one stage of the process. The candidate needs to adjust the response to fit the number of available marks.

Question 5 (d)

(d) New methods of copper extraction have been developed.

One of these methods uses bacteria to extract copper from the ground around old mines.

Evaluate the effects on the environment of using bacteria to extract copper compared to the method in the flow chart.

....

....

....

....

.... **[3]**

In common with the previous question, candidates who judged their response by looking at the number of marks and referring back carefully to the flow chart, as the question asked, gained higher marks. Common points that were well expressed included identifying that bacterial methods do not produce high levels of greenhouse gases, uses waste to produce useful metals but uses acids which may cause environmental damage. It was common, however, for responses to only address a single idea, rather than go through the whole flow chart to 'evaluate the effects' as the question asked. Common points that were well expressed included identifying that bacterial methods do not produce high levels of greenhouse gases, uses waste to produce useful metals but uses acids which may cause environmental damage.

Question 6 (a)

6 Ammonium sulfate is a fertiliser. It is usually sold to farmers as a solid in large sacks.

Different industrial processes can be used to make ammonium sulfate, as shown in **Table 6.1**.

Process	Equation	How the process works	Other points
1	$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$	Reactor kept at 60 °C. Uses concentrated sulfuric acid. A solution of ammonium sulfate is made.	Reaction is exothermic. Atom economy 100%.
2	$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$	Sulfuric acid is sprayed into dry ammonia gas. Any water in the mixture evaporates. Dry powdered ammonium sulfate is made.	Reaction is exothermic. Atom economy 100%.
3	$(NH_4)_2CO_3 + CaSO_4 \rightarrow (NH_4)_2SO_4 + CaCO_3$	Calcium carbonate forms as a precipitate in a solution of ammonium sulfate.	Calcium carbonate is a waste product.

Table 6.1

Use information from **Table 6.1** to answer these questions.

(a) Both **process 1** and **process 2** are exothermic.

Explain why an exothermic reaction has a positive effect on how each process works.

....

....

....

....

....

.... **[3]**

Again, candidates who answered well took care to address three points to gain all 3 marks. Most knew that exothermic reactions release energy. Fewer related this clearly to process 1 (in which energy otherwise needs to be used because a temperature of 60 °C needs to be maintained) or process 2 (in which energy is needed for evaporation of water). A very common error was to link exothermic reactions with increased atom economy.

Question 6 (b)

(b) **Process 1** and **process 3** both need to go through further separation after the main reactions.

How can pure, solid ammonium sulfate be separated from the reaction mixtures in **process 1** and **process 3**?

Process 1 ....

....

Process 3 ....

.... **[2]**

Most knew that process 1 would require evaporation and process 2 filtration. A relatively common error was to contradict a correct separation process by adding additional incorrect ideas. For example, in process 1 some candidates said 'evaporation and distillation' or 'evaporation and condensation' which implies that they were collecting the water rather than the solid salt from the mixture.

Question 6 (c)

(c) Use relative formula masses to calculate the **atom economy** of **process 3**.

Give your answer to **1** decimal place.

Atom economy = ... % **[3]**

Almost all candidates correctly recalled the correct formula to calculate atom economy. Where full marks were not credited, this was usually due to errors being made in the calculation of the relative formula masses of the complex formula of the three compounds necessary.

Question 6 (d) (i)

(d) The **sustainability** of each process in **Table 6.1** is different.

(i) Explain what **sustainability** means.

....

.... **[1]**

Candidates have often learnt definitions of sustainability which can be used to explain that sustainable processes can be used to manufacture current products without compromising the environment or the needs of people in the future. However, some candidates confuse renewable resources or recycling with sustainability. Answers such as 'can be reused in the future' (untrue for a batch of fertiliser) or 'more can be made in the future' were not judged sufficient to earn any credit.

Question 6 (d) (ii)

(ii) Give **two** examples from **Table 6.1** to explain why some processes are more sustainable than others.

....

....

.... **[2]**

Where candidates are asked to 'give examples' it is important that they do so. Best answers began with 'Process 1….' or 'Process 3….'. Some answers clearly expressed ideas that Process 1 and 2 require an energy input for heating and that Process 3 produces a solid waste product which will need a disposal strategy.

Question 6 (e)

(e) **Process 3** can be carried out as a batch process in the laboratory.

In industry, **process 3** is carried out as a continuous process.

Explain why batch processes are more suitable for use in the laboratory, but continuous processes are more suitable for industry.

....

....

.... **[2]**

Most answers identified the difference in scale between batch and continuous processes. However, it was common for candidates to give a description of the processes without answering the question which asked why batch are suitable for use in the laboratory and why continuous are suitable for industry. Hence, answers such as 'continuous go on all the time' do not clearly explain why this is an advantage. Best answers discussed how continuous processes can be automated or lead to no break in production.

Question 7

7* Li is planning a presentation on sodium chloride.

She looks for a diagram to show the bonding, structure, movement and arrangement of particles in solid sodium chloride.

She finds these diagrams.

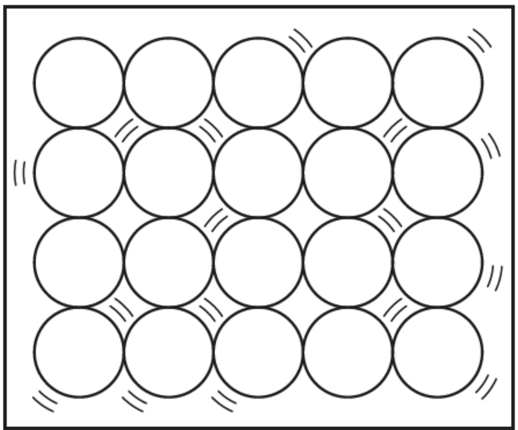


Diagram A

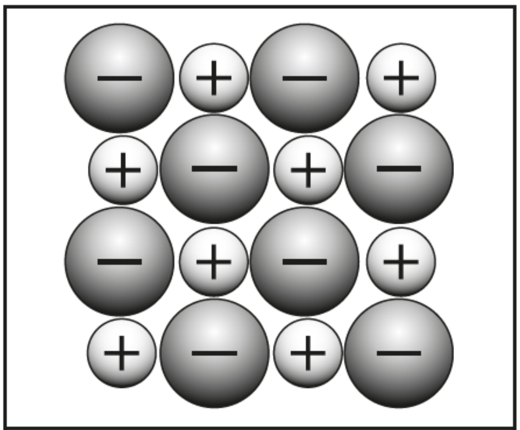


Diagram B

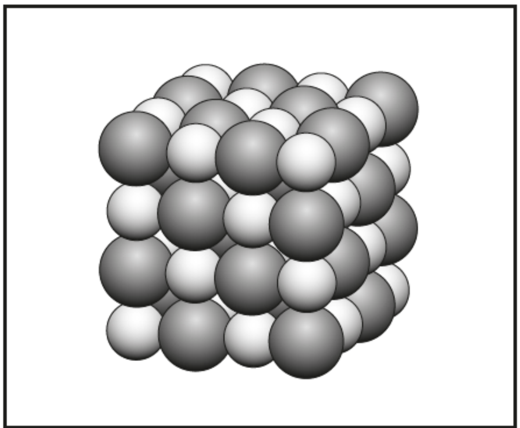


Diagram C

Discuss the **advantages** and **disadvantages** of using each diagram to represent solid sodium chloride **and** outline the features that an ideal diagram should have.

....

....

....

....

....

.... **[6]**

The evaluation of models is a relatively new specification area for assessment. In this question candidate were asked to evaluate three diagrammatic models and describe the features an ideal diagram should show. 6 mark answers addressed all aspects of the task and gave both positive features ('advantages') and negative features ('disadvantages') of each model. The most common reason for candidates earning marks in the Level 2 or Level 1 mark bands was that they did not address all aspects of the task. The second characteristic of lower scoring responses was the use of vague points which were not unique to a particular diagram. These included saying that the diagram 'shows the structure' or 'shows the arrangement' of particles (which is true for all three). Best answers focused on the differences between the diagrams and hence gave a clear discussion of the benefits and drawbacks of each.

Exemplar 7

Diagram A shows the basic formation of the solid but is 2D, doesn't show the bonds, the size or the charge of the ions. Diagram B shows the size and charge and arrangement of the atoms, but not the bonds ~~or~~ and its in 2D. Diagram C shows the arrangement and sizes in 3D, but doesn't show the charges or bonds. ~~or~~

An ideal diagram would be in 3D, with different sized atoms with labelled charges. Sticks would connect them to show the bonds and it'd be accurately arranged.

Notice how this response discusses the advantages and disadvantages of all three diagrams and includes the features of an ideal diagram. A clear and concise 6 mark response.

Exemplar 8

Diagram A is good because it shows how the individual molecules interact with eachother. It's bad because it doesn't show anything else such as the charges. Diagram B is good because it shows the charges and it lets the person know what type of bonding it has (ionic) but it's also bad because it doesn't show how the molecules interact with eachother.

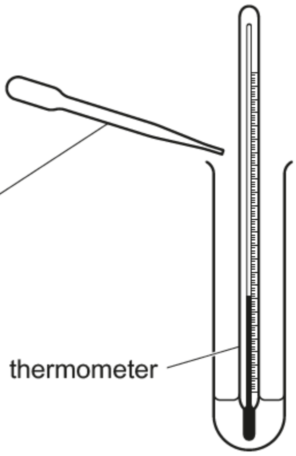
Diagram C is good because it shows how close the molecules are together (meaning it's a solid) and that it has two different ions. It's bad because it doesn't label the ions so we don't know which is which and it doesn't show interaction. **[6]**

This response uses incorrect terminology ('molecules' rather than ions) and also gives vague points that are not specific to each diagram (saying that the particles 'interact with each other' without explaining what this means). Notice also that the response omits part of the task. The features of an ideal diagram are not discussed. However, on a positive note, the response does attempt to give an advantage and disadvantage of each diagram. This earns a partial match to Level 2 - 3 marks.

Question 8

8* Mia wants to investigate the trend in reactivity for Group 7 elements.

She adds chlorine water to a solution of potassium bromide.



She looks for a temperature change and a colour change.

She also has access to these solutions.

iodine water	potassium iodide
bromine water	potassium bromide
chlorine water	potassium chloride

Describe what Mia needs to do to find out the trend in reactivity of the Group 7 elements **and** describe what observations and conclusions she should expect.

....

....

....

....

....

.... **[6]**

In common with Question 7, for all 6 marks the candidates needed to fully answer all parts of the question. This included describing the experimental procedure ('what to do'), with the expected observations and also stating what conclusions would be expected. Best answers were selective and stated clearly which solutions needed to be mixed, for example a combination of chlorine with potassium bromide and bromine with potassium iodide would be enough to establish the order. Acceptable observations were either a temperature increase (the apparatus is shown with a thermometer) or the correct colour change. The colour changes were not well known.

Vague descriptions which mixed every solution with every other were not given experimental procedure marks (for example 'mix every solution with every other solution). It was expected that candidates would be clear about naming the reagents they were mixing. Those answers which could not predict any correct observations were limited to Level 2.

Exemplar 9

Sheneeds todo displacementreactions to find which Group 7elements aremore reactive thanothers, tofindapattern inthegroup. Her conclusion shouldbe the elements areless reactive thefurther you godownthegroup. whenSheadds Chlorinewater to potassium bromide, SheShouldsee a displacement of bromine. Thiswill make the Solutionorange, as bromine is on its own. Potassium iodidewith iodine, noreaction. Potassium [6]
iodide with bromine water, iodine is displaced, as asolid is dull, grey, gives off purple vapour. Chlorinewater also displaces it. (Pale greengas) Thenwiththe others sheShould seetheelements above in ~~the periodictable~~ group 7 always displace the ones below. Inthis test nothing ~~will~~ will displacechlorine.

Although rather lengthy, this response contains all the necessary and correct information. The response describes and names which reagents to mix, predicts correct observations (iodine in the solid state was accepted, as it is a concentration dependent effect) and also states the order or reactivity. Level 3 – 6 marks.

Exemplar 10

Mia needs to repeat this experiment with iodine water, bromine water and chlorine water and add potassium iodide, potassium bromide and potassium chloride. She should expect to see yellow precipitate form when she puts iodine water into potassium iodide solution. She will then repeat the experiment and put bromine water with potassium bromide solution. This should form a cream precipitate. Lastly she needs to add chlorine water to potassium chloride solution. She should expect to see a white precipitate form. Mia should also record what the temperature of each solution is before and after she has added the different waters to the solutions. **[6]**

She should expect to find that the reactivity goes down the further down the group 7 elements. She should find that chlorine is more reactive than iodine.

Although this response has incorrect descriptions of the reactions and observations expected, it is clearly expressed and includes the point near the end of the response which shows that the candidate knows the order of reactivity of the three elements (which is the expected conclusion). Hence Level 1 – 2 marks.

Question 9 (a)

9 The table shows information about some transition elements.

Metal	Melting point (°C)	Colour of metal oxide	Common positive ions
mercury	–39	red	Hg_2^{2+} Hg^{2+}
vanadium	1910	orange-brown	V^{2+} V^{3+}
copper	1100	black or red	Cu^{+} Cu^{2+}
chromium	1900	dark green or black	Cr^{2+} Cr^{3+}
zinc	420	white	Zn^{2+}

(a) Which two statements about the melting points are true?

Tick (✓) **two** boxes.

The melting point of mercury is > room temperature (20 °C). ☐

The melting point of chromium ~ the melting point of vanadium. ☐

The melting point of copper >> the melting point of mercury. ☐

The melting point of chromium < the melting point of zinc. ☐

[2]

Most candidates interpreted the data to gain at least 1 mark.

Question 9 (b)

(b) Mercury and zinc are **not** typical transition metals.

Use information from the table to explain why.

....

....

.... **[3]**

The idea that transition elements are coloured was well known. Fewer stated that they typically have one type of ion with the same, rather than multiple or different, charges. Although many said that mercury and zinc had 'lower' melting points (which is true for many of the metals) fewer stated that mercury is a liquid at room temperature. In common with other multi-mark questions, a common error was to make insufficient points to gain all 3 marks.

Question 9 (c)

(c) Copper can form **two** oxides with different formulae. In both formulae, the oxide ion is O^{2-}.

Write the formulae for the **two** oxides.

Use information from the table to help you.

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

Although marks were usually earned, almost all candidates left the ionic charges in the formulae they gave. Thus $Cu^{2+}O^{2-}$ was commonly seen. Although on this occasion such answers were given full credit, it is not good practice to do this.

Question 9 (d)

(d) Chromium also forms an **oxyanion** with the formula CrO_4^{2-}.

Suggest why this ion is known as an **oxyanion**.

....

.... **[2]**

Most realised that chromate ions are oxyanions because they are negatively charged ions which contain oxygen.

Question 9 (e)

(e) Which statement describes another correct property for transition metals?

Tick (✓) **one** box.

Transition metals make good catalysts. ☐

Transition metal oxides are usually gases. ☐

Transition metal compounds conduct electricity when solid. ☐

Transition metals are less dense than other metals. ☐

[1]

This question was also well answered.

Question 10 (a) (i)

10 Over the last 20 years there have been a series of agreements between governments to limit the emission of greenhouse gases. These gases include carbon dioxide, methane and nitrous oxides.

(a) Governments are more concerned about reducing the emissions of carbon dioxide than reducing the emissions of the other gases.

The table shows some measurements of the concentrations of these gases in the atmosphere now.

Gas	Concentration in the atmosphere
carbon dioxide	0.04%
methane	1800 ppb (parts per billion)
nitrous oxides	1400 ppb (parts per billion)

(i) Calculate the **percentage** of methane in the atmosphere.

$1.0\,ppb = 1.0 \times 10^{-7}\%$

Methane = ... % **[2]**

This calculation was well attempted. The use of numbers in standard form is a recent addition to the mathematical requirements. Candidates handled these values well and usually responded correctly. A common error was to calculate the percentage of nitrous oxide rather than methane.

Question 10 (a) (ii)

(ii) Use your answer to **(a)(i)** to explain why governments are more concerned about carbon dioxide emissions than emissions of the other gases in the table.

....

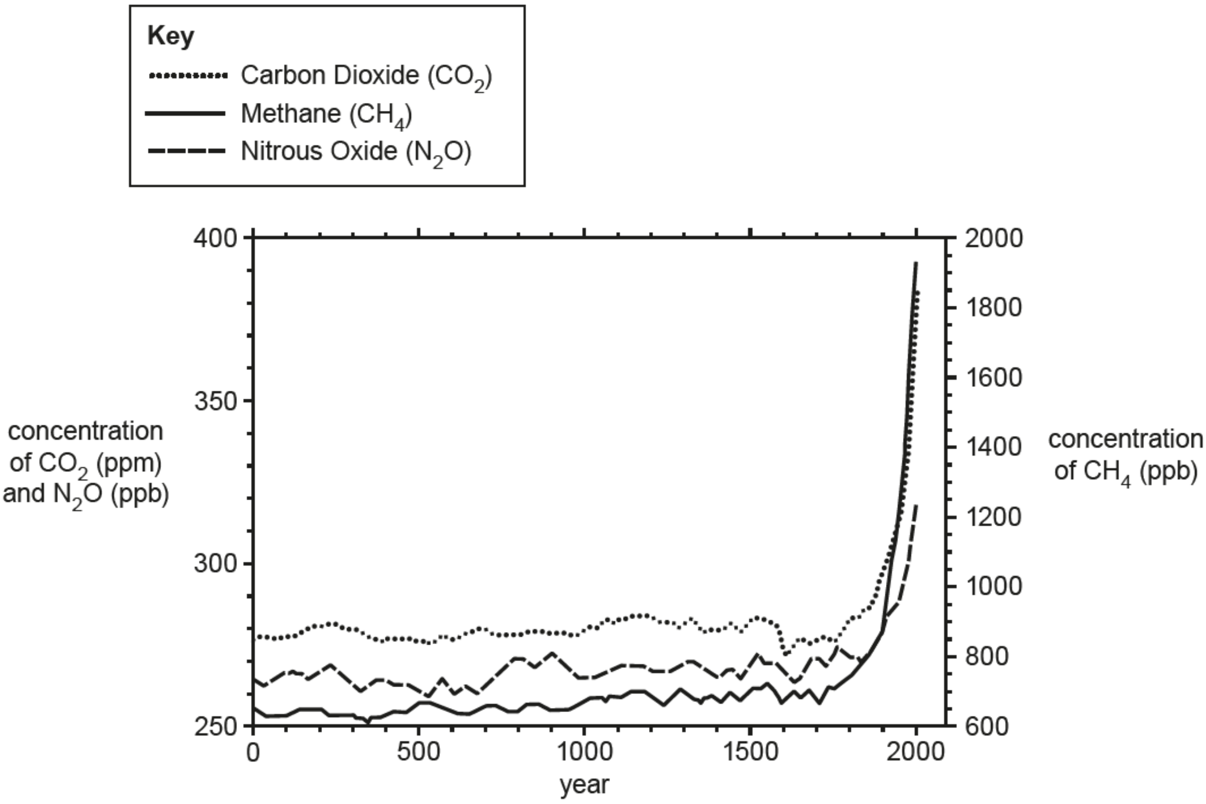
....

.... **[2]**

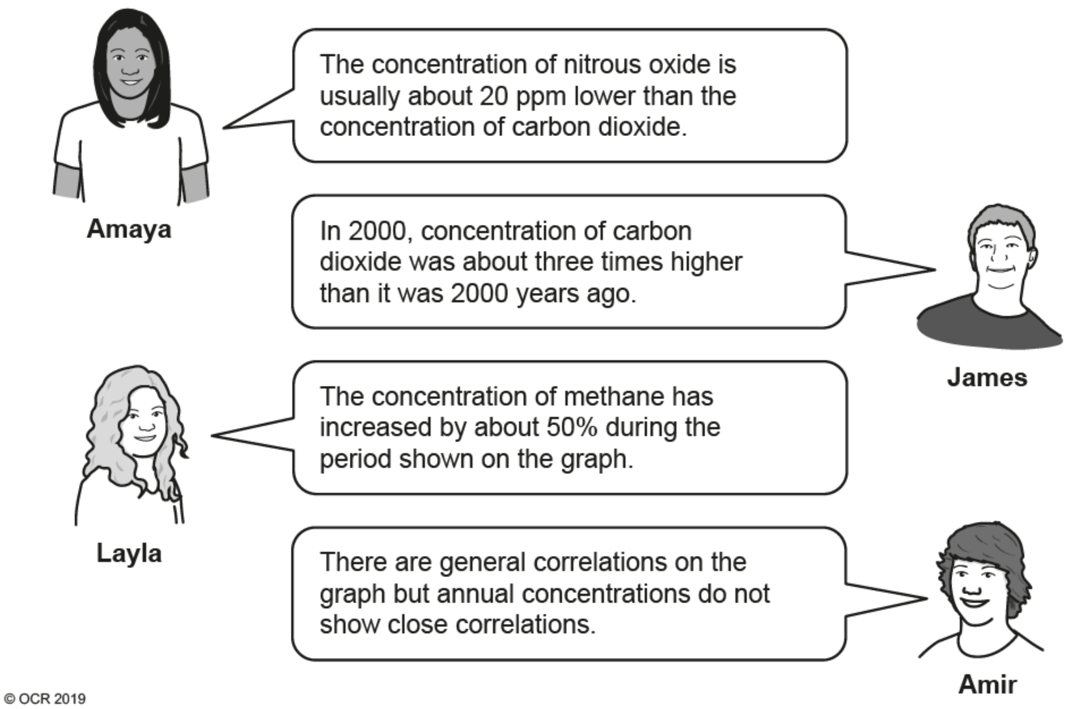
Most answers correctly identified that carbon dioxide concentration is much higher. The second mark was a 'quality' mark linked to the instruction to 'explain' in the question. Answers worth 2 marks justified the answer by processing or comparing the concentration of carbon dioxide to the other gases to show that it is a very large effect, for example by stating that it is over 200 times higher.

Question 10 (b)

(b) The first major agreement between countries was the 1997 Kyoto Protocol.
This graph shows the concentration of some greenhouse gases in the atmosphere before the Kyoto Protocol was introduced.



Some people discuss the graph.



Does the data in the graph support each person's point of view?

Use data from the graph to explain each answer.

Person	Explanation
Amaya	....
James	....
Layla	....
Amir	....

[6]

Almost all candidates correctly processed information for at least one person's point of view. To gain marks the candidates needed to think about the view expressed and compare this to the values shown on the graph.

For James, it was necessary to recognise that there are different units on each side of the graph for the gases. For James, the key idea was that the vertical axis does not start at 0. Many candidates justified their 'no' for James by correctly quoting values.

For Layla, candidates needed to read values from the right-hand axis. Many of them did so.

For Amir, candidates who answered correctly made it clear that the patterns are the same for all three gases.

Reasons for not gaining credit included reading values incorrectly from the graph or, in answering Amir's point, stating only that 'the graph increases' rather than making the point that the pattern is the same for all. Some candidates did not realise that the axes were different for the gases, with a separate axis on the right for methane.

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