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Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE CHEMISTRY B

J258

For first teaching in 2016

J258/02 Summer 2022 series

Version 1

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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 are 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.

Advance Information for Summer 2022 assessments

To support student revision, advance information was published about the focus of exams for Summer 2022 assessments. Advance information was available for most GCSE, AS and A Level subjects, Core Maths, FSMQ, and Cambridge Nationals Information Technologies. You can find more information on our website.

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Paper 2 series overview

This paper is designed to assess the depth of chemical knowledge shown by the candidates. Most candidates were able to attempt most 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 exam included mathematical assessment which was often done better than in previous years. The extended prose required in some questions (Question 4 (c) and Question 6 (c)) was a challenge to some candidates. These questions provide a structure which the best candidates use to good effect.

Practical skills are now assessed in the written examination instead of a coursework assessment. Some candidates showed ability to describe laboratory practice in Questions 2, 4 and 9, but there is scope for improvement here. Questions 8 and 9 were an overlap with the Higher Paper so provided some of the most demanding challenges.

Candidates needed to take careful note of the questions as there is often key information in the stem. Some candidates misread the question or answered a question of their own devising. The language of the examination was inclusive and there was no evidence that any were disadvantaged by this or cultural issues.

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
• Read the question stems carefully. • Note and respond to the command words.	• Did not reach the end of the paper. • Did not recognise important information in the question stems.

Question 1 (a)

1 **Fig. 1.1** shows a model for the arrangement of ions in an ionic compound when it is a solid and when it is a liquid.

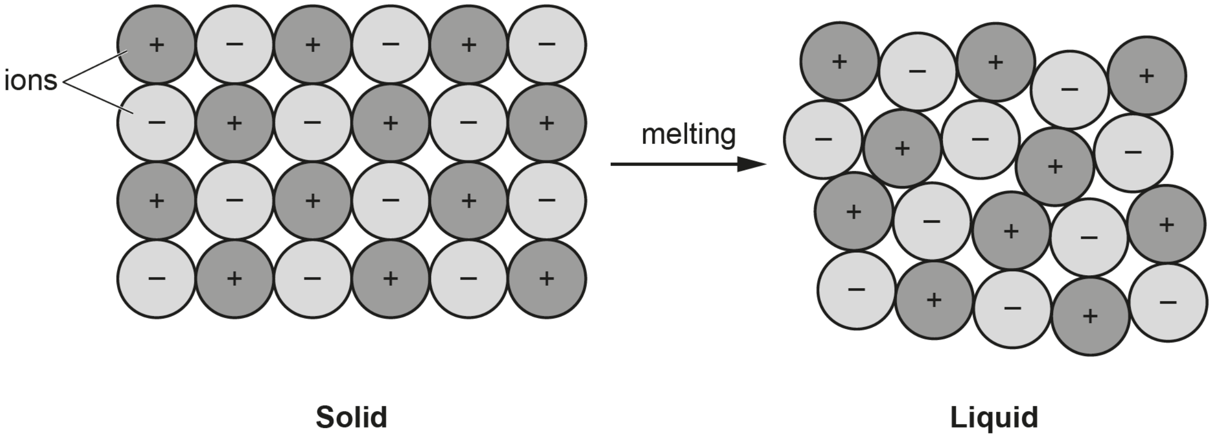


Fig. 1.1

(a) Which of the following statements are true only for the solid, which are true only for the liquid and which are true for both?

Tick (✓) **one** box in each row.

	True only for the solid	**True only for the liquid**	**True for both**
The ions are close together.			
The ions are attracted by opposite charges.			
The ions are in a regular arrangement.			
The ions can move over each other.			

[2]

This was generally well understood and most candidates scored here. Some candidates believed that ions are only close together in the solid, despite the evidence of the diagrams.

Question 1 (b) (i)

(b) Sodium chloride and magnesium chloride are ionic compounds.

The melting points of sodium chloride and magnesium chloride are shown in the table.

	Melting point (°C)
Sodium chloride	801
Magnesium chloride	714

(i) What is the state of sodium chloride and of magnesium chloride at 750 °C?

Put a (ring) around **one** word to complete each sentence.

At 750 °C, sodium chloride is a **solid / liquid / gas**.

At 750 °C, magnesium chloride is a **solid / liquid / gas**.

[1]

Candidates who knew that melting is the transition from solid to liquid did well here, although some reversed the answers.

Question 1 (b) (ii)

(ii) A limitation of the model shown in **Fig. 1.1** is that it does **not** show the reasons why different compounds have different melting points.

Which **two** statements describe the reasons why compounds have different melting points?

Tick (✓) **two** boxes.

Ions in different compounds have different chemical symbols. ☐

Ions in different compounds have different charges. ☐

Ions in different compounds have different colours. ☐

The force of attraction between ions is different in different compounds. ☐

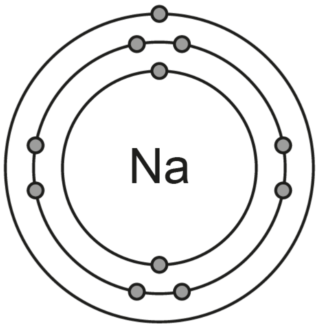
[2]

Most candidates were aware that chemical symbols and colour do not affect melting points.

Question 1 (c) (i)

(c) Sodium chloride contains sodium ions, Na^+, with a single positive charge.

Fig. 1.2 shows the arrangement of electrons in a sodium atom.



Electron arrangement: 2,8,1

Fig. 1.2

(i) Which information from the Periodic Table shows us that a sodium atom contains a total of 11 electrons?

Tick (✓) **one** box.

the atomic number ☐

the chemical symbol for the element ☐

the group number ☐

the relative atomic mass ☐

[1]

The correct answer was generally well known, although a few candidates chose relative atomic mass.

Question 1 (c) (ii)

(ii) Use ideas about electrons to explain why sodium atoms form an ion with a +1 charge.

....

....

.... **[2]**

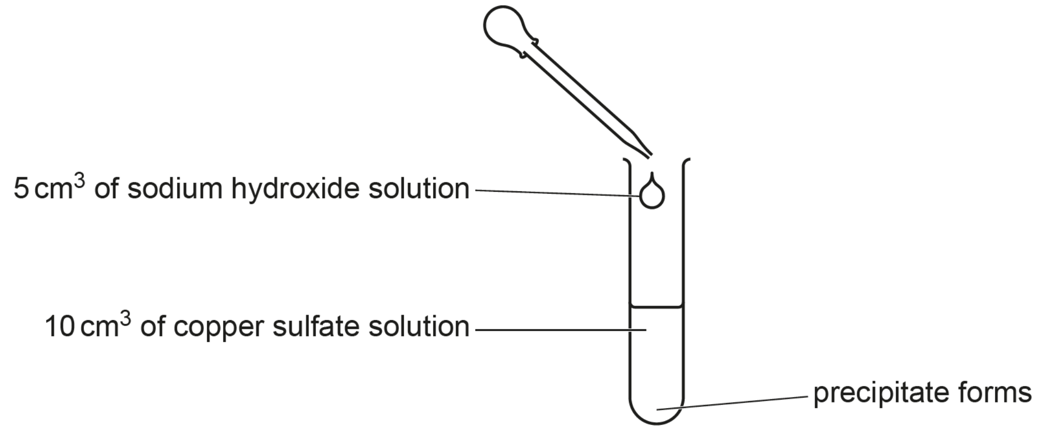
To obtain both marks here, a candidate needed to identify that there is a single electron in the outer shell of a sodium atom and that electron can be lost. Mention of a full outer shell by itself was not specific enough to be given the marks.

Question 2 (a)

2 Jane does an experiment.

She puts 10 cm^3 of copper sulfate solution in a boiling tube.

She adds 5 cm^3 of sodium hydroxide solution. A precipitate of copper hydroxide forms.



(a) What are the correct state symbols for copper sulfate and copper hydroxide in this experiment?

Tick (✓) **one** box in each row.

Substance	**State symbol**		
	(s)	**(aq)**	**(l)**
copper sulfate solution			
copper hydroxide precipitate			

[2]

The distinction between a liquid and an aqueous solution was not appreciated. Similarly, some candidates did not realise that a precipitate is a solid (perhaps due to limited practical opportunities).

Question 2 (b)

(b) At the end of the reaction, the boiling tube contains a mixture of a precipitate of copper hydroxide in a solution.

Describe how Jane can separate pure, dry copper hydroxide from this mixture.

....

....

....

.... **[2]**

Many candidates correctly identified that filtration was the first step in this process. However, using a sieve is not equivalent to filtration. Many who did start with filtration missed the importance of the words **pure, dry** in the stem – so missing the second mark. Some candidates believed that the solution might simply be boiled off, not recognising that it also contained spectator ions which would be left behind to contaminate the precipitate.

Question 2 (c) (i)

(c) Jane does more experiments.

She adds a different volume of sodium hydroxide solution to 20 cm^3 of copper sulfate solution each time.

She records the mass of dry copper hydroxide that forms in each experiment.

Table 2.1 shows her results.

Volume of copper sulfate solution (cm^3)	Volume of sodium hydroxide solution added (cm^3)	Mass of dry copper hydroxide formed (g)
20	5	0.18
20	10	0.52
20	15	0.58
20	20	0.78
20	25	0.98
20	30	0.98
20	35	0.98

Table 2.1

(i) Describe the pattern shown by the results in **Table 2.1**.

....

....

.... **[2]**

To describe the **pattern** shown by the results, a successful response relates how the mass of precipitate changes as the volume of alkali increases. Saying that a volume "goes up by five" is just describing the data.

Question 2 (c) (ii)

(ii) Jane wants to change her experiment to make more than 1.00 g of dry copper hydroxide.

Jane and Alex talk about the results.

Jane says, 'To make more copper hydroxide we need to add more than 35 cm^3 of sodium hydroxide solution.'

Alex says, 'To make more copper hydroxide we need to add more than 20 cm^3 of copper sulfate solution.'

Who is right?

Jane ☐

Alex ☐

Use information from **Table 2.1** to explain your choice.

....

....

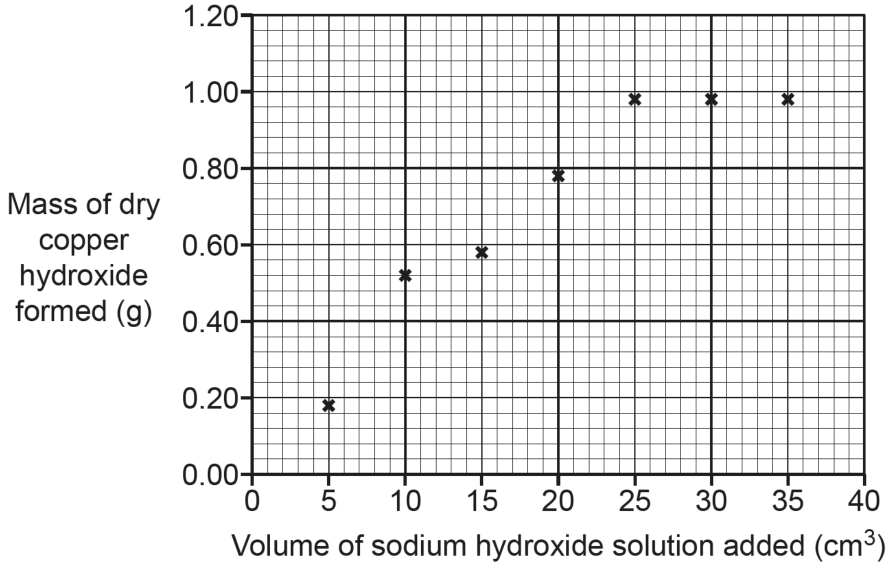
....

.... **[2]**

The marks here are for an **explanation**, **using data** from the table. Simply ticking Alex's name does not explain anything. An explanation should make clear that all the copper sulfate reacted with just 25cm^3 of sodium hydroxide solution using data from the table.

Question 2 (d) (i)

(d) Jane plots her results on a graph.



Jane thinks that one of her results is an outlier.

(i) Draw lines of best fit on the graph. **[1]**

Erratum notice

Turn to **page 7** of the **question paper** and look at **question 2(d)(i).**

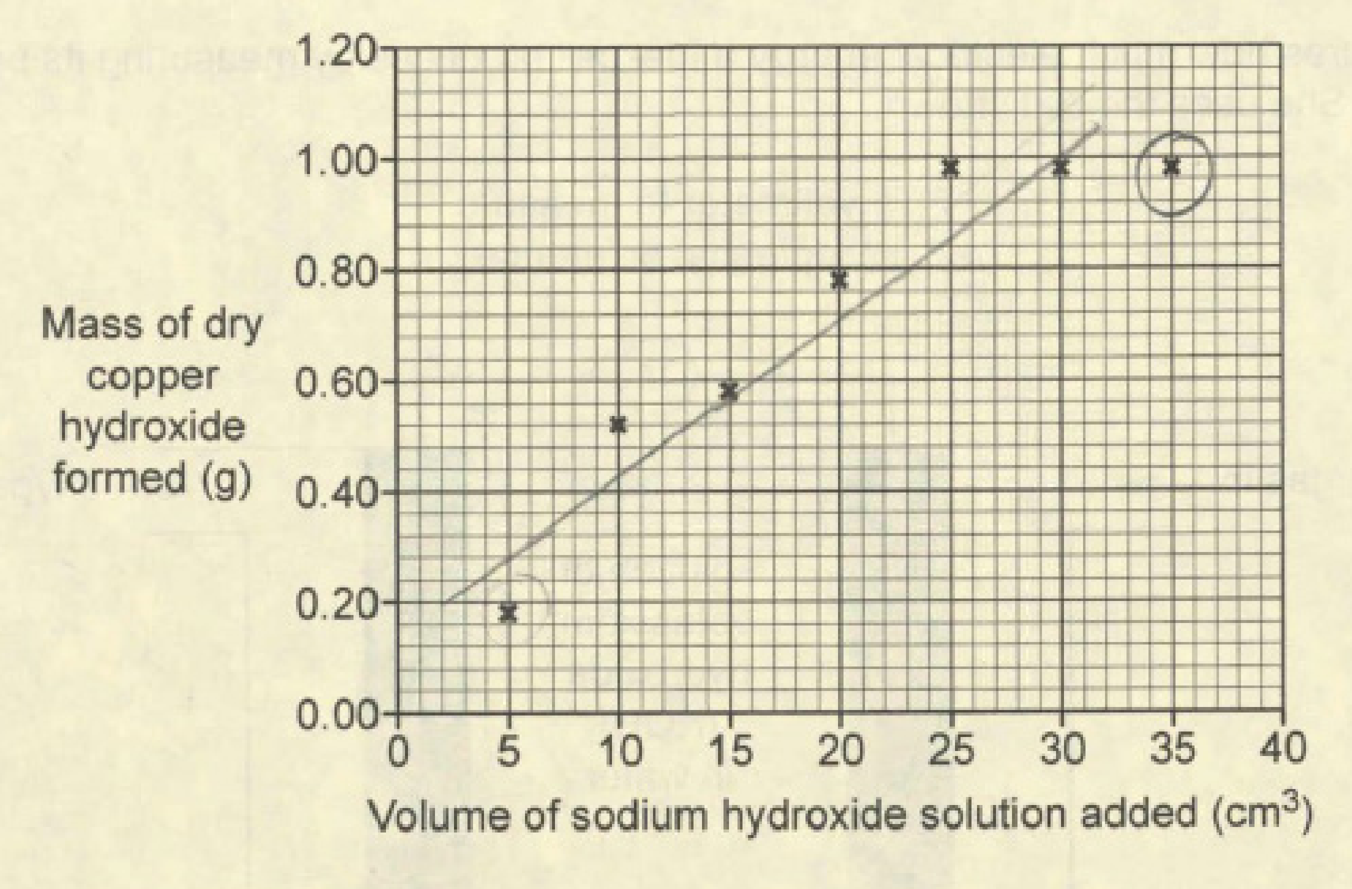
Cross out the word '**lines**' and replace with '**a line**'.

The question should now read:

Draw a line of best fit on the graph.

A line of best fit shows the **pattern** in data. Although it is often a straight line or a smooth curve, there may be two parts to it. In this case the data shows a clear proportionality up to a limit and then a second straight (horizontal) line when the limiting case has been reached.

Exemplar 1



This candidate (and many others) tried to use a single line to show the patterns in the data.

Question 2 (d) (ii) and (iii)

(ii) Put a (ring) around the outlier on the graph. **[1]**

(iii) Suggest what the correct mass reading for the outlier should be.

correct mass reading = ... g **[1]**

The correct mass reading could be determined most reliably from Table 2.1.

Question 2 (d) (iv)

(iv) What is the most likely reason for the outlier?

Tick (✓) **one** box.

Jane did not add enough sodium hydroxide solution.	☐
Some of the copper hydroxide was lost before weighing.	☐
The copper hydroxide contained water when Jane weighed it.	☐
The reaction had not finished.	☐

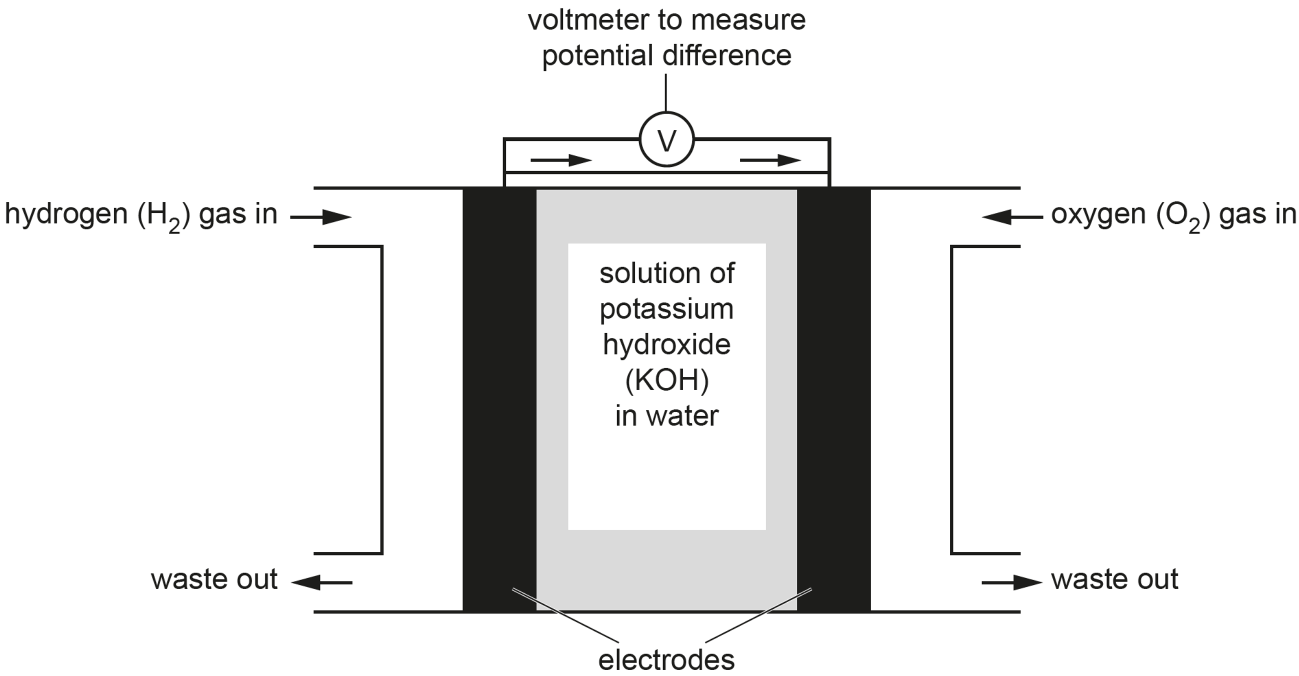
[1]

One response offers a reason for a higher value and the other three explain a lower value.

Question 3 (a)

3 Beth works for a company that makes hydrogen fuel cells.

She measures how much electrical energy a fuel cell produces by measuring its potential difference. She uses the cell shown.



(a) Before she sets up the cell, Beth tests each gas to check its identity.

Draw lines to connect each **gas** to its correct **test** and **result**.

Gas	Test	Result
	lime water	pops
hydrogen	glowing splint	goes blue
oxygen	lighted splint	goes milky
	damp pH paper	relights

[2]

Most candidates recognised that they were looking for a pop and relighting, but many were less certain which test would yield the right results.

Question 3 (b)

(b) The fuel cell is filled with potassium hydroxide solution rather than pure water.

This is because potassium hydroxide solution is a better electrical conductor than pure water.

Which statement explains why potassium hydroxide solution is a better electrical conductor than pure water?

Tick (✓) **one** box.

Potassium hydroxide is acidic. ☐

Potassium hydroxide is a metal. ☐

Potassium hydroxide is very soluble in water. ☐

Potassium hydroxide solution contains charged ions. ☐

[1]

Electrolysis relies on a current conducted by mobile ions, but not many candidates linked this idea to this question.

Question 3 (c) (i)

(c) This equation shows the reaction that happens in the fuel cell:

$$2H_2 + O_2 \rightarrow 2H_2O$$

Beth does some experiments using different amounts of hydrogen in a fuel cell.

She records the masses of hydrogen and oxygen which are used and the mass of water made each time.

Her results are shown in **Table 3.1**.

Experiment	Mass of hydrogen used (g)	Mass of oxygen used (g)	Mass of water made (g)
1	0.1	0.8	0.9
2	0.4	3.2	3.6
3	0.5	4.0	....
4	1.0	....	....

Table 3.1

(i) Complete **Table 3.1** by predicting the missing amounts for experiments 3 and 4. **[2]**

Many candidates recognised patterns in the data and used these to predict the missing amounts correctly.

Question 3 (c) (ii)

(ii) In each experiment, Beth notices that the potential difference of the cell decreases after a time.

Why does this happen?

Tick (✓) **one** box.

The concentration of potassium hydroxide solution increases. ☐

The hydrogen and oxygen are used up. ☐

The reaction takes in energy. ☐

Waste products are made. ☐

[1]

Few candidates appreciated that the gases would be used up when a current is drawn from the cell.

Question 3 (d) (i)

(d) Beth's company wants to use hydrogen fuel cells to provide power for a car.

Most cars use petrol as a fuel.

Beth looks at the information about hydrogen and petrol in **Table 3.2**.

	Hydrogen	**Petrol**
Energy released by 1 kg of fuel (MJ)	140	50
State at room temperature and pressure	gas	liquid
Volume of 1 kg of fuel (m^3)	12	0.001
Waste products	water	carbon dioxide and water
Other points	usually produced from electrolysis of water which needs electricity	petrol engines also produce carbon monoxide and nitrogen oxides

Table 3.2

(i) Use information from **Table 3.2** to explain **two** advantages of using hydrogen, rather than petrol, as a fuel for cars.

1 ....

....

2 ....

.... **[2]**

The advantages of hydrogen were often understood (especially the lack of polluting waste products) although some responses were not linked to the data in the table (e.g. speculating about cost).

Question 3 (d) (ii)

(ii) Use information from **Table 3.2** to explain **two** reasons why hydrogen is more difficult to use as a fuel for cars than petrol.

1 ....

....

2 ....

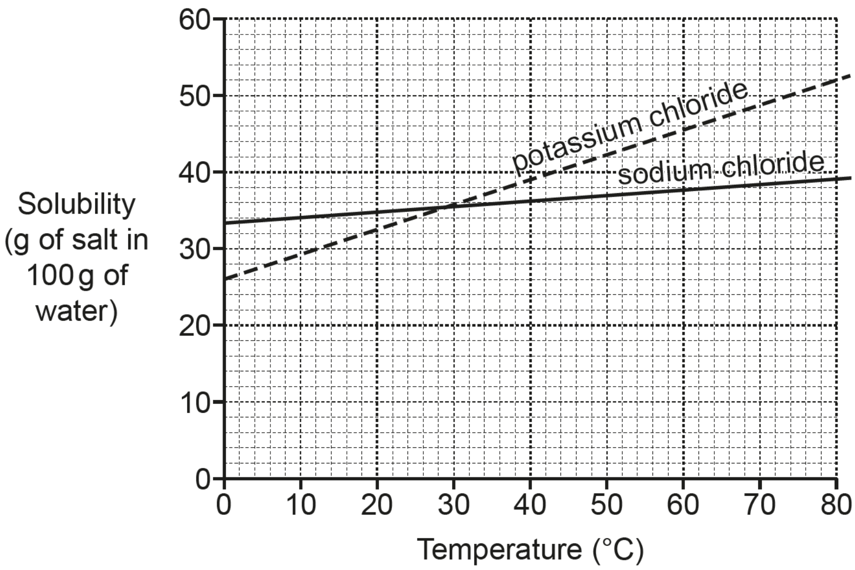
.... **[2]**

Many candidates interpreted this question as requiring a disadvantage compared to petrol although the question requires an **explanation** of why hydrogen is more **difficult to use**. These are aspects of using a gas, like the space needed to store or move it.

Question 4 (a)

4 The solubility of a salt shows how much salt dissolves in 100 g of water.

The graph shows the solubility of some Group 1 salts in water at different temperatures.



(a) Use the graph to describe how temperature affects the solubility of sodium chloride and potassium chloride.

Use values from the graph to support your answer.

....

....

....

.... **[3]**

Most candidates recognised that solubility increased with temperature, but those who **used values from the graph** could score heavily here. Responses that simply described the lines were not usually given all 3 marks.

Question 4 (b) (i) and (ii)

(b) Jack works out a way to predict the solubility of potassium chloride.

He uses this formula:

solubility (g in 100 g of water) = 26 + (0.3 × temperature)

(i) Use Jack's formula to predict the solubility of potassium chloride at 80 °C.

predicted solubility of potassium chloride at 80 °C = ... g in 100 g water **[2]**

(ii) Does this value agree with the solubility of potassium chloride at 80 °C shown on the graph?

Yes ☐

No ☐

Use data from the graph to explain your answer.

....

....

....

.... **[2]**

The formula yields a value of 50 g and most candidates worked this out. However, the graph shows about 52 g, so the response could be that it is not precisely correct – or that it is usefully close. Either response required a comparison of values.

Question 4 (c)*

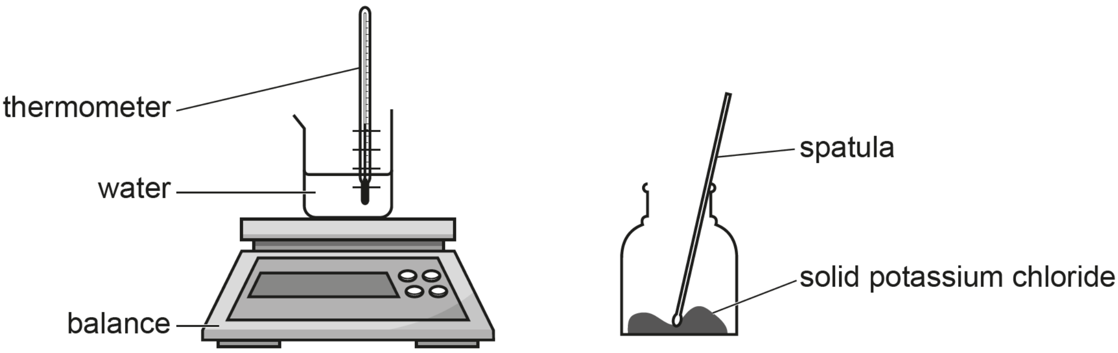
(c)* Jack decides to check the data given on the graph.

He adds small amounts of solid potassium chloride to water at room temperature (20 °C).

He stirs until the solid dissolves and then adds more.

He stops adding when no more solid dissolves.

The diagrams show **some** of the apparatus he uses.



Jack wants to find out how much solid potassium chloride dissolves in 100 g of water at different temperatures.

Describe the method Jack should use. Include what he needs to measure, what he needs to control, what he needs to change and what results he should expect.

....

....

....

....

....

.... **[6]**

Many candidates missed the idea that Jack intended to measure the solubility **at different temperatures**. Many candidates achieved Level 1 by noting what could be measured or controlled. However, higher scores needed work at **different temperatures** and also an indication of what **results Jack would expect**.

Assessment for learning

Questions requiring an extended prose response demand that the candidate reads the stem thoroughly, noting command words and phrases**.** Underling the key words in the stem is a good exercise to practice.

Question 5 (a)

5 Some metals are extracted from their ores by heating with carbon.

Other metals are extracted from their ores by electrolysis.

Fig. 5.1 shows the order of reactivity of some metals, compared to carbon.

most reactive	potassium	extracted by electrolysis
↓	sodium	
↓	calcium	
↓	[carbon]	
↓	zinc	extracted by heating with carbon
least reactive	copper	

Fig. 5.1

(a) Which statement explains why calcium must be extracted from its ore by electrolysis?

Tick (✓) **one** box.

Calcium does not conduct electricity. ☐

Calcium is a non-metal. ☐

Calcium is more reactive than carbon. ☐

Calcium is too unreactive to be extracted using carbon. ☐

[1]

This was quite well known.

Question 5 (b) (i)

(b) (i) Which metal, not listed in **Fig. 5.1**, is less reactive than carbon?

Put a (ring) around the correct answer.

lithium **magnesium** **potassium** **silver**

[1]

Most candidates correctly identified silver.

Question 5 (b) (ii)

(ii) Mia makes this statement:

'The information in **Fig. 5.1** shows that all metals which are more reactive than carbon are in Group 1.'

Use information from **Fig. 5.1** to help explain why Mia's statement is only partly correct.

....

....

.... **[2]**

Many candidates recognised the distribution of Groups I and II in Fig. 5.1.

Question 5 (c) (i)

(c) **(i)** How are iron and aluminium extracted from their ores?

Tick (✓) **one** box in each row.

Metal	**Extracted by heating with carbon**	**Extracted by electrolysis**
iron		
aluminium		

[1]

Many did not seem to know this.

Question 5 (c) (ii)

(ii) After extraction, iron is mixed with other elements to make steel.

Complete the sentences about steel.

Use words from the list.

carbon	**chlorine**	**sulfur**	**harder**	**softer**	**weaker**

To make steel, iron is mixed with small amounts of ....

This makes the steel .... **[1]**

It was well known that steel is harder than iron and usually that this was achieved by mixing with carbon.

Question 5 (d) (i)

(d) Copper is extracted from copper oxide by heating it with carbon.

This is the equation for the reaction that happens:

$$2CuO(s) + C(s) \rightarrow 2Cu(s) + CO_2(g)$$

(i) Write the **word** equation for the reaction between copper oxide and carbon.

[2]

Many candidates answered this correctly, but a significant minority assumed that (s) referred to sulfur and some did not even recognise the formula for carbon dioxide.

Question 5 (d) (ii)

(ii) What is oxidised and what is reduced during the reaction between copper oxide and carbon?

Explain your reasons.

oxidised ....

reduced ....

reasons ....

....

[2]

The idea that oxidation and reduction related to gain or loss of oxygen was easily described by some candidates but not always explained clearly.

Question 5 (d) (iii) and (iv)

(iii) What would you expect to happen to the total mass of solids during the reaction between copper oxide and carbon?

Tick (✓) **one** box.

mass of solids becomes zero ☐

mass of solids decreases ☐

mass of solids increases ☐

mass of solids stays the same ☐

[1]

(iv) Explain how you decided your answer to **(d)(iii)**.

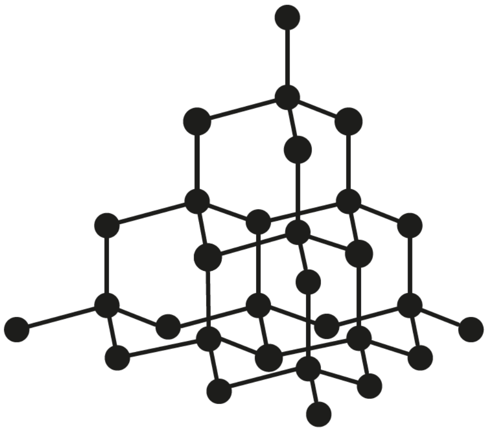
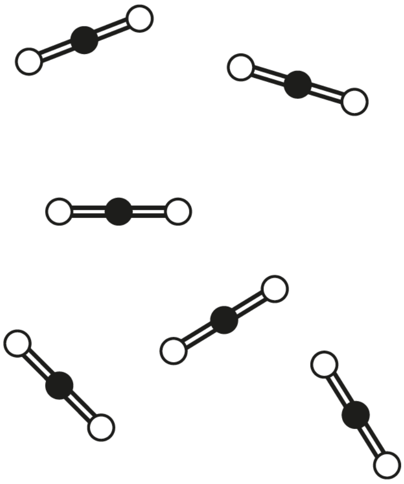
....

.... **[1]**

Candidates often invoked the Law of Conservation of Mass here, completely ignoring the heavy emphasis on the **mass of solids** in the stem.

Question 6 (a)

6 The diagram shows the structures of diamond and carbon dioxide.

Diamond	**Carbon dioxide**
	
giant covalent	simple molecules

(a) The atoms in diamond are held together by single covalent bonds.

How is a single covalent bond formed?

Use ideas about electrons in your answer.

....

.... **[2]**

Only a few candidates recognised that covalent bond involved sharing **two** electrons.

Question 6 (b)

(b) Which of these statements are only true for diamond, which are only true for carbon dioxide and which are true for both?

Tick (✓) **one** box in each row.

	Only true for diamond	**Only true for carbon dioxide**	**True for both**
It is a compound.			
Each carbon atom has four bonds.			
It is an allotrope of carbon.			
It is found in the air.			

[2]

The final statement was the only one known by almost all candidates.

Question 6 (c)*

(c)* The melting point is the temperature at which a solid changes to a liquid.

Table 6.1 shows the structures and melting points of diamond and carbon dioxide.

	Structure	**Melting point (°C)**
Diamond	giant covalent	4700
Carbon dioxide	simple molecules	–57

Table 6.1

Explain why diamond and carbon dioxide change from a solid to a liquid at different temperatures.

Use ideas about energy, bonds and forces between molecules in your answer.

....

....

....

....

....

.... **[6]**

The types of structure were sometimes noted and covalent bonds were well known to be strong, and requiring a lot of energy to break. However, the existence of weak intermolecular forces between molecules of carbon dioxide were often largely missed. Some candidates thought that covalent bonds were broken here too.

The instruction to refer to **energy, bonds and forces** was overlooked by many candidates.

Exemplar 2

• Carbon dioxide is a simple molecular structure meaning it has strong covalent bonds but weak intermolecular forces
• this means it requires less energy for a change in state
• However Diamond is a giant covalent structure meaning all the atoms are held together by covalent bonds
• ~~[illegible]~~ this means it requires a lot more energy to break these bonds in order to change state. **[6]**

This candidate has used the structure of the question to create a response which deals with bonds, forces and energy for each of the substances concerned.

Question 7 (a)

7 **Fig. 7.1** shows the change in carbon dioxide concentration in the Earth's atmosphere over the last 575 million years.

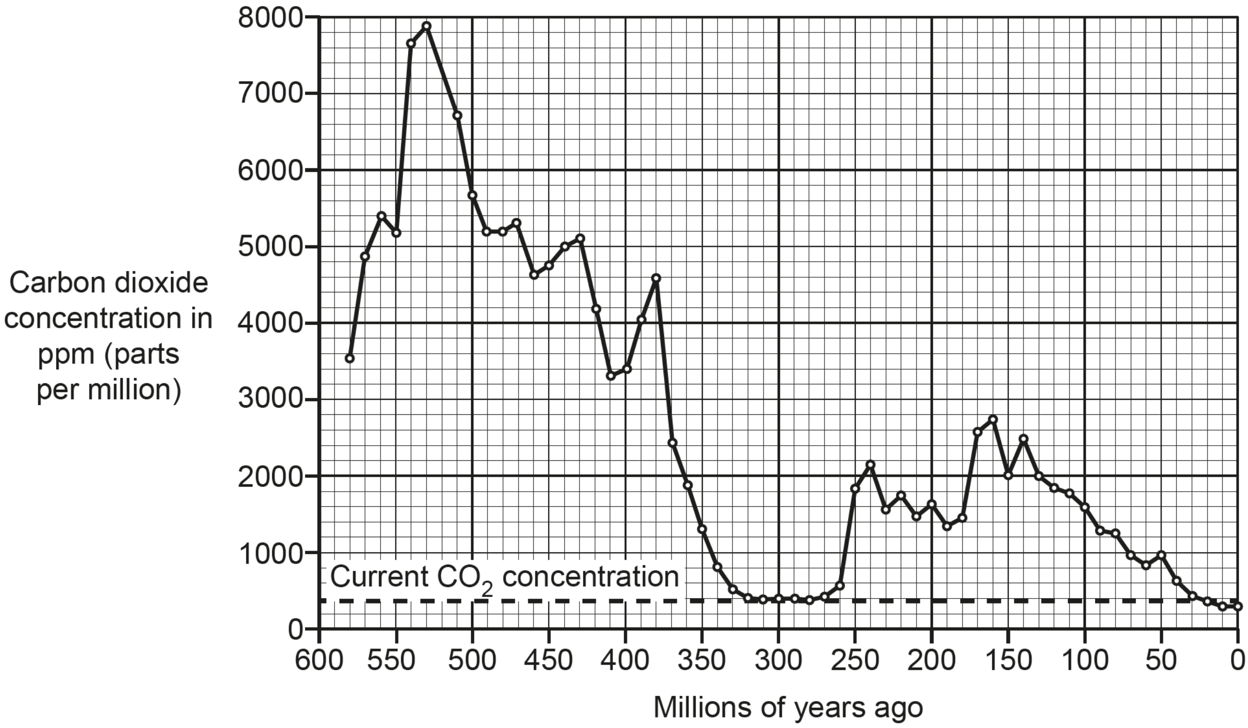


Fig. 7.1

(a) Carbon dioxide concentration was at its highest about 530 million years ago.

What was the value of the concentration of carbon dioxide 530 million years ago?

concentration of carbon dioxide = ... ppm (parts per million) **[1]**

Most candidates were close to the correct value.

Question 7 (b)

(b) During what period was the concentration of carbon dioxide similar to its concentration today?

from .... to .... millions of years ago **[1]**

Despite the dashed line on the graph, candidates often found the axis difficult to interpret.

Question 7 (c)

(c) **Fig. 7.1** shows the most recent value for the concentration of carbon dioxide to be 380 parts per million (ppm).

Do a calculation to convert 380 ppm into a percentage.

Use this formula:

$$\text{concentration in \%} = \frac{\text{concentration in ppm}}{10\,000}$$

.... % **[2]**

Many candidates substituted correctly in the formula, although some felt that 0.038% was unreasonably small and multiplied it by a further 100.

Question 7 (d)

(d) **Fig. 7.2** shows the amount of oil burned and the change in the Earth's temperature between 1850 and 2010.

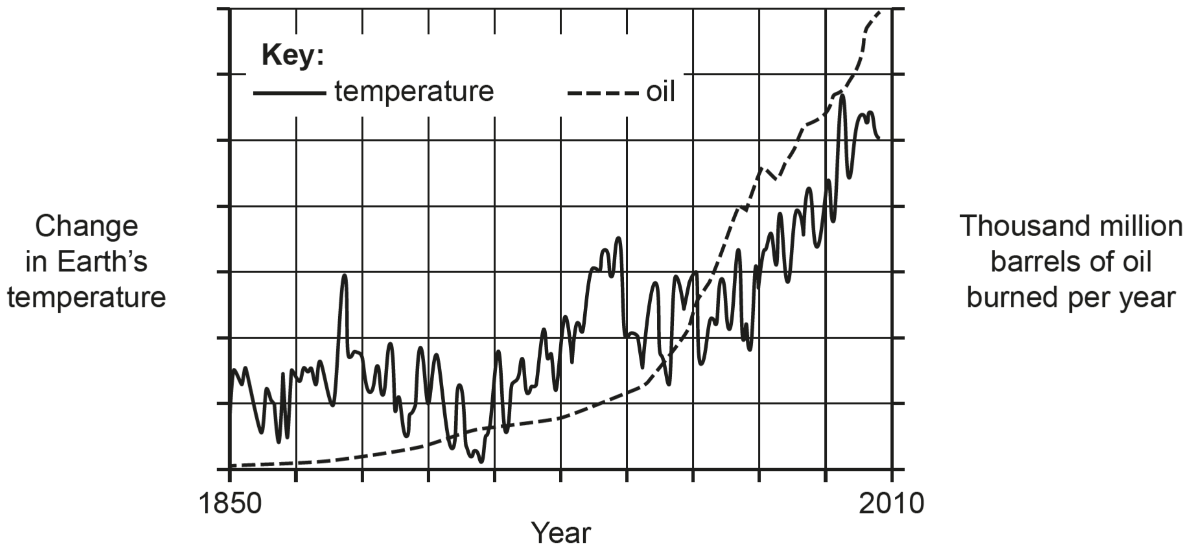


Fig. 7.2

Ben says that the graph shows a correlation between the total amount of oil burned per year and the change in global temperature.

Explain why Ben is right.

....

.... **[1]**

The concept of following a similar pattern was well understood.

Question 7 (e)

(e) Some scientists fear that climate change may cause other long-term environmental problems.

Describe **two** other long-term environmental problems caused by climate change.

1 ....

....

2 ....

....

[2]

There are a range of possible **environmental problems** which could be given here – although melting ice-caps, sea-level rise and habitat loss were the most common. Global warming is a description of the change and not an environmental problem.

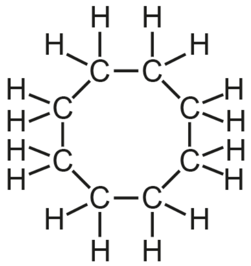
Question 8 (a) (i)

8 **Fig. 8.1** shows the uses, properties and structure of some substances which contain carbon atoms.

Cyclo-octane

Added to petrol

Very flammable

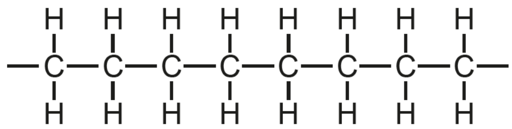


Carbon atoms bonded to other carbon atoms in rings and to hydrogen atoms

Polyethene

Used to make carrier bags

Flexible, softens at 1200 °C, stretches and breaks easily

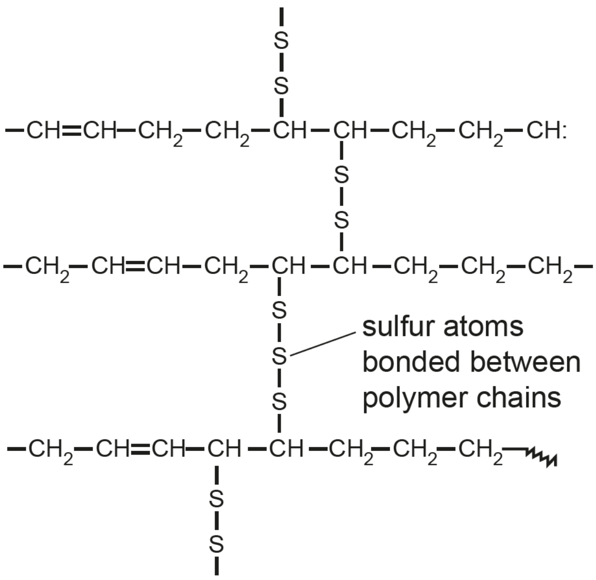


Carbon atoms bonded to other carbon atoms in long chains and to hydrogen atoms

Synthetic rubber

Used to make car tyres

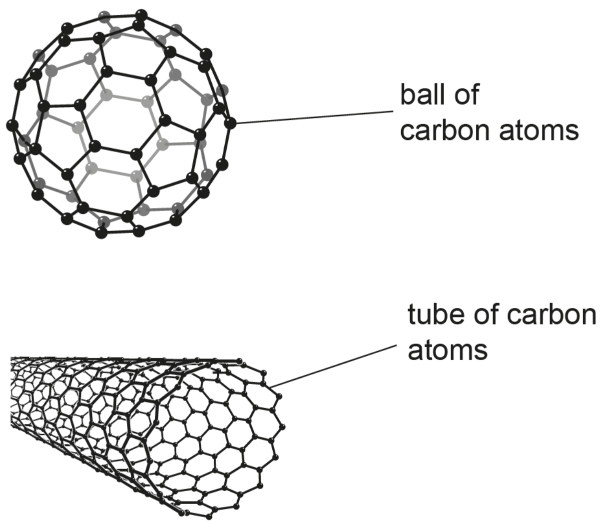
Stronger and harder than most polymers and has a higher melting point



Carbon atoms bonded to other carbon atoms in long chains with sulfur atoms bonded between the polymer chains

Nanoparticles

Used to carry medicine molecules into the body



Carbon atoms bonded to other carbon atoms to form balls and tubes

Fig. 8.1

(a) Petrol contains cyclo-octane.

(i) Which symbol should be used to warn people of the main hazard when handling cyclo-octane?

Tick (✓) **one** box.

☐ ☐ ☐ ☐

[1]

Most candidates recognised the fire hazard for cyclo-octane.

Question 8 (a) (ii)

(ii) Write down **two** safety precautions people should take when filling their cars with petrol.

1 ....

....

2 ....

....

[2]

Safety precautions were generally well known, including switching off the engine and not smoking, although these were sometimes poorly explained – with ideas like not wearing anything flammable surprisingly common. Many candidates intended to wash their hands after dispensing petrol.

Question 8 (b)

(b) Carbon makes a much bigger range of different types of molecules than any other element.

Give **one** reason why carbon atoms can form so many different types of molecules.

Use **Fig. 8.1** to help you to answer.

....

.... **[1]**

Carbon's ability to form four covalent bonds is a key to this, but many candidates also referred to the different types of structure given in Fig 8.1.

Question 8 (c)

(c) Explain why polyethene and synthetic rubber have different properties.

Use ideas about structure from **Fig. 8.1** to help you to answer.

....

....

....

.... **[2]**

There are two parts to this answer, identifying a difference in properties and linking it to the structure. Candidates often described the different properties of the two materials, but this was rarely related to the structures.

Question 8 (d) (i)

(d) **(i)** How are nanoparticles different to the other substances in **Fig. 8.1**?

....

.... **[1]**

Fig 8.1 shows nanoparticles as being distinctively shaped – but also being the only structure of pure carbon shown. Many candidates also remembered that the particles are very small.

Question 8 (d) (ii)

(ii) Explain why the structure of carbon nanoparticles helps them to carry medicine molecules into the body.

....

.... **[2]**

The ability to enter into cells and tissues to deliver medicines was hinted at but not always well described. The concept that the hollow structures fitted the medicine molecules was less well explained.

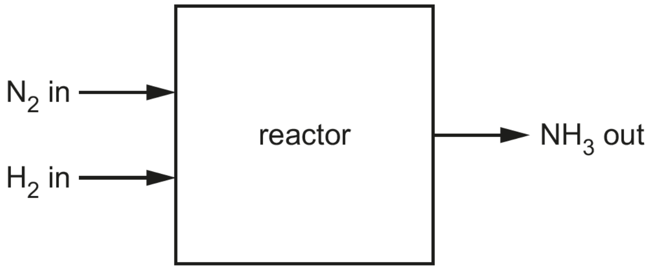
Question 9 (a) (i)

9 Ammonia is used to make fertilisers. It is produced in a large-scale process.

The equation shows the reaction that happens in the process:

$$N_2 + 3H_2 \rightleftharpoons \underset{\text{ammonia}}{2NH_3}$$

The process happens in a reactor.



(a) The percentage yield of ammonia is usually between 10% and 20%.

(i) Use the equation to explain why it is not possible to get 100% yield of ammonia.

....

.... **[1]**

Many candidates did not recognise the reversible arrow in the equation.

Question 9 (a) (ii)

(ii) The gas that leaves the reactor contains ammonia mixed with two other gases.

Use the equation to help you to give the names of the other **two** gases.

.... **and** .... **[1]**

However, most candidates could recognise and name the other two gases involved.

Question 9 (b)

(b) An ammonia factory tests a new reactor.

The table shows the theoretical yield and actual yield for a process in the new reactor.

Theoretical yield (tonnes)	150
Actual yield (tonnes)	19.5

Calculate the percentage yield for the process in the new reactor.

Use the equation: $\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$

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

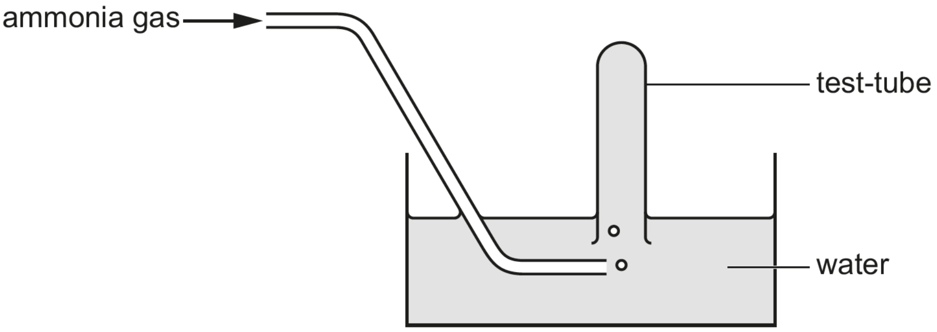
Once again, many candidates scored both marks by successfully substituting in the formula given. Some candidates who had successfully done this in earlier questions did not respond to this item.

Question 9 (c) (i)

(c) Ammonia is very soluble in water.

Kofi does an experiment to make some ammonia.

He tries to collect it using the apparatus shown.



(i) Bubbles of ammonia gas enter the water but no gas collects in the test-tube.

What happens to the ammonia gas when it enters the water?

....

.... **[1]**

Ammonia is very soluble in water is in the stem of the question, but many assumed that it would collect over the water like other experiments that they may have seen.

Question 9 (c) (ii)

(ii) Which apparatus should Kofi use to collect ammonia?

Tick (✓) **one** box.

burette ☐

gas syringe ☐

measuring cylinder ☐

volumetric flask ☐

[1]

Many wanted to use a gas syringe, although some who did not see a problem with solubility chose other solutions.

Question 9 (d) (i)

(d) Ammonia is an alkaline gas.

The pH of ammonia solution can be measured using a pH meter.

(i) Predict the pH of ammonia.

pH .... **[1]**

Ammonia is an alkaline gas, so this question becomes which part of the pH scale is alkaline.

Question 9 (d) (ii)

(ii) Describe another method you could use to measure the pH of ammonia solution.

....

....

.... **[2]**

Most candidates knew that an indicator was required, but many indicators do not give a pH value. Candidates needed to specify a universal indicator and then to compare the resulting colour with a suitable reference chart. The second mark was often missed.

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