

**GCSE (9-1)**

**Examiners' report**

**GATEWAY SCIENCE  
COMBINED  
SCIENCE A**

**J250**

For first teaching in 2016

**J250/03 Summer 2023 series**

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## Introduction

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

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

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

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

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## Paper 3 series overview

J250/03 is the first of two foundation tier papers for the Chemistry content of Gateway Combined Science A. This component assesses topics C1-C3 and CS7 (PAGs C1-C5).

To do well on this paper, candidates need to demonstrate knowledge and understanding of scientific ideas, techniques, and procedures across all four topics. They need to be able to apply their knowledge and understanding to unfamiliar contexts as well as displaying the ability to analyse information. Candidates also need to be familiar with a range of experimental procedures.

J250/03 has an equal emphasis on knowledge and understanding of the assessment outcomes from the specification and application of this knowledge.

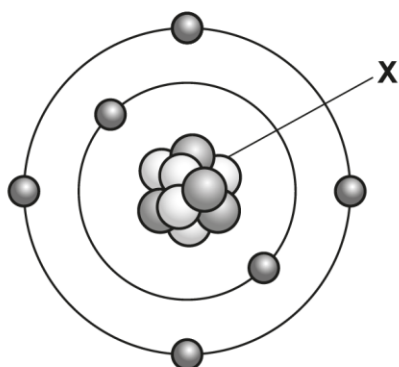
Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
<ul style="list-style-type: none"> <li>• attempted all the questions</li> <li>• read all instructions clearly to make sure they answered all parts of the question</li> <li>• followed the instructions carefully in Question 14 and included clear, labelled diagrams which used science apparatus</li> <li>• showed clear working in calculations in order to gain marks even if the final answer was incorrect</li> <li>• used a sharp pencil and a ruler to enable them to draw an accurate graph</li> <li>• used the charges on ions to correctly determine the formula of an ionic compound</li> <li>• had a good knowledge of scientific terminology and could use it correctly</li> <li>• were able to correctly complete dot and cross diagrams to show both covalent and ionic bonding</li> <li>• were familiar with the colours given by Universal Indicator for acids, alkalis, and neutral solutions.</li> </ul>	<ul style="list-style-type: none"> <li>• omitted some questions or did not answer all parts of the question</li> <li>• did not include the required diagrams in Question 14, drew unlabelled diagrams or used kitchen equipment</li> <li>• did not correctly name scientific processes such as evaporation or crystallisation, even though they could describe them</li> <li>• did not show any working in calculations, or gave unclear working, so did not gain any marks when the final answer was incorrect</li> <li>• did not draw an accurate graph, often due to use of a blunt pencil</li> <li>• did not realise that a line of best fit on a graph should exclude anomalous points</li> <li>• did not understand how to complete correct dot and cross diagrams</li> <li>• did not appreciate that Universal Indicator showed different colours rather than directly giving a pH value.</li> </ul>

## Section A overview

Almost all candidates attempted all the questions. Candidates should be reminded to write the answer letter clearly as B and D can be confused if writing is unclear. If candidates change their mind about an answer they must remember to cross it out clearly and write the new answer next to the answer box, rather than overwriting the old answer. Marks cannot be awarded if the answer is not clear.

### Question 1

1 What is the part of the atom labelled **X** called?



- A Core
- B Ion
- C Nucleus
- D Shell

Your answer

[1]

The majority of the candidates could name the nucleus, but a few selected core or ion.

## Question 2

2 The table shows the properties of four different substances.

Which substance is a metal?

Substance	Appearance at room temperature	Melting point and boiling point	Conducts heat?
A	green gas	low	no
B	colourless solid	high	no
C	shiny red-orange solid	high	yes
D	white solid	high	no

Your answer

[1]

The majority of candidates correctly selected C. Common incorrect answers were B and D.

## Question 3

3 Which is an example of a **neutralisation** reaction?

- A A metal reacting with an acid
- B A non-metal reacting with oxygen
- C A salt dissolving in water
- D An acid reacting with an alkali

Your answer

[1]

Many candidates recognised an acid reacting with an alkali as neutralisation, but a range of other answers were seen.

## Question 4

4 Lead has a melting point of 328 °C. Mercury has a melting point of –39 °C.

Which row describes the state of lead and mercury at 100 °C?

	State of lead	State of mercury
<b>A</b>	liquid	liquid
<b>B</b>	liquid	solid
<b>C</b>	solid	liquid
<b>D</b>	solid	solid

Your answer

[1]

Many candidates correctly chose C, with B as a common incorrect answer.

## Question 5

5 Which element forms compounds with covalent molecules consisting of chains and rings?

- A Argon
- B Carbon
- C Hydrogen
- D Oxygen

Your answer

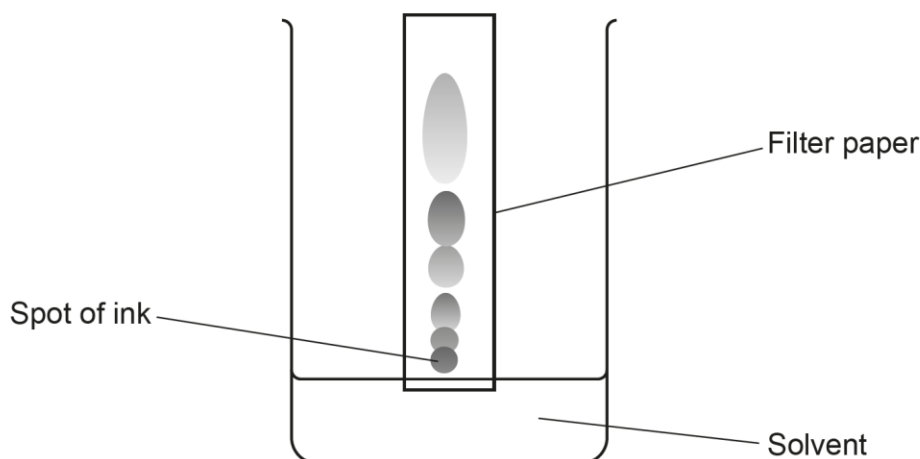
[1]

Many candidates knew that carbon was correct, but others gave a range of different answers.



## Question 6

6 The diagram shows how paper chromatography can be used to separate the colours in an ink.



What is the **solvent** called?

- A The baseline
- B The mobile phase
- C The reference phase
- D The stationary phase

Your answer

[1]

Only a minority of candidates could name the mobile phase, with many selecting A or D instead.

## Question 7

7 The **law of conservation of mass** states that the total mass stays the same during a chemical reaction.

Which is an explanation for the law of conservation of mass?

- A All the atoms in a chemical reaction are the same size.
- B All the atoms in a chemical reaction have the same mass.
- C No atoms are created or destroyed during a chemical reaction.
- D The atoms of each reactant and product have the same mass.

Your answer

[1]

Many candidates could define the law of conservation of mass, with the most popular incorrect choices being B followed by D.

### Question 8

8 Sodium sulfite contains  $\text{Na}^+$  ions and  $\text{SO}_3^{2-}$  ions.

What is the **formula** of sodium sulfite?

- A  $\text{NaSO}_3$
- B  $\text{Na}(\text{SO}_3)_2$
- C  $\text{Na}_2\text{SO}_3$
- D  $\text{Na}_2(\text{SO}_3)_2$

Your answer

[1]

A minority of candidates were able to work out the correct formula, with a range of incorrect answers seen.

### Question 9

9 Which substance is described as **pure** by a scientist?

- A A solution of sodium chloride
- B An alloy
- C Dilute sulfuric acid
- D Distilled water

Your answer

[1]

Many candidates chose D, with B as a common incorrect choice.

## Question 10

**10** A metal oxide has the formula  $X_2O$ , where **X** is a Group 1 metal.

The relative formula mass of the metal oxide is 94.2.

Relative atomic mass ( $A_r$ ): O = 16.0

What is the name of **X**?

- A** Lithium
- B** Potassium
- C** Rubidium
- D** Sodium

Your answer

[1]

Those candidates who showed their working mostly identified potassium. However, a range of incorrect choices were seen.

## Section B overview

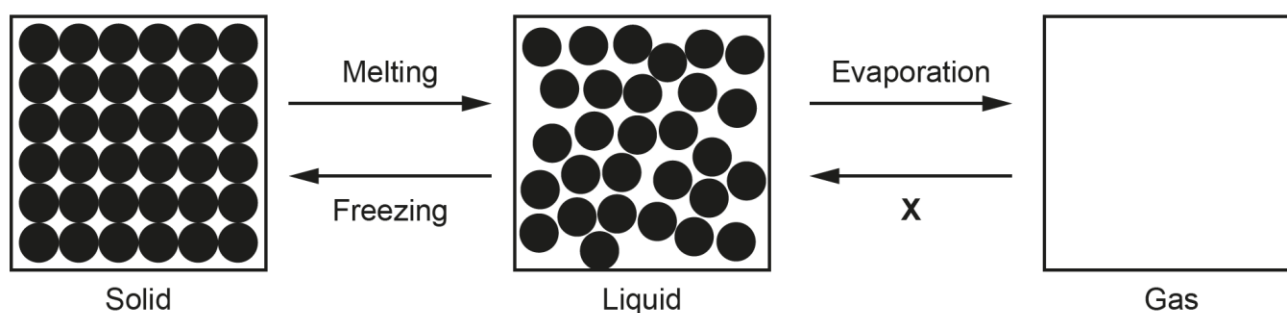
Many candidates attempted all the questions, but some candidates omitted a number of questions, particularly Question 13 and the questions that required them to complete dot and cross diagrams. Some handwriting was very difficult to read and may benefit from assistance. It is notable that a number of candidates chose not to use their assigned scribe, and this often resulted in a loss of marks when their answers could not be read.

Candidates who use the additional answer space at the back of the booklet must make sure that they clearly label their additional answers with the correct question number.

### Question 11 (a) (i)

11 (a) Fig. 11.1 shows the particle model for an element.

Fig. 11.1



(i) Complete Fig. 11.1 by drawing in the particles of the element when it is a gas. [1]

A significant number of candidates omitted to answer this question. The majority of those who answered it were given the mark. Those who drew particles that were touching were not credited the mark.

### Question 11 (a) (ii)

(ii) Describe how the particles of the element move in a solid.

..... [1]

Many candidates knew that particles only vibrate.

#### Misconception



A common misconception was that particles in a solid do not move in any way.

## Question 11 (a) (iii)

(iii) Name the change of state labelled **X** on **Fig. 11.1**.

..... [1]

The majority of responses correctly identified condensation. Common incorrect responses were melting, boiling, freezing or sublimation.

## Question 11 (b)

(b) The table shows the state of the element chlorine at three different temperatures.

State of chlorine	Temperature (°C)
solid	-165
liquid	-90
gas	-20

Use the information in the table to estimate the melting point of chlorine.

Tick (✓) **one** box.

-170 °C

-101 °C

-43 °C

-2 °C

[1]

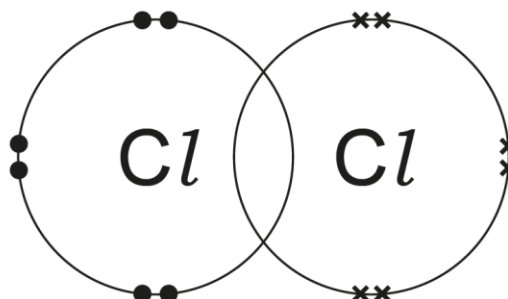
The majority correctly chose -101°C; common incorrect responses were -170°C and -43°C.

## Question 11 (c) (i)

(c) A particle of chlorine has the formula  $Cl_2$ .

Fig. 11.2 shows some of the outer electrons in a particle of chlorine.

Fig. 11.2



(i) Complete Fig. 11.2 by drawing in the missing outer electrons.

[1]

A significant number of candidates omitted this question. A minority drew a pair of shared electrons, but the most common error was to draw four electrons in the overlap area.

## Question 11 (c) (ii)

(ii) Complete the sentences about the bonding in a particle of chlorine.

Put a ring around each correct option.

The particles of chlorine are called **isotopes / molecules / polymers**.

The atoms of chlorine are joined together by a **covalent / ionic / metallic** bond.

[2]

The majority of responses selected covalent and were given at least 1 mark, with many scoring 2 marks. Common incorrect choices were isotopes and ionic.

## Question 11 (d)

(d) Which test is used to identify chlorine?

Tick (✓) **one** box.

It goes 'pop' when lit.

It relights a glowing splint.

It turns limewater cloudy white.

It turns damp litmus paper white.

[1]

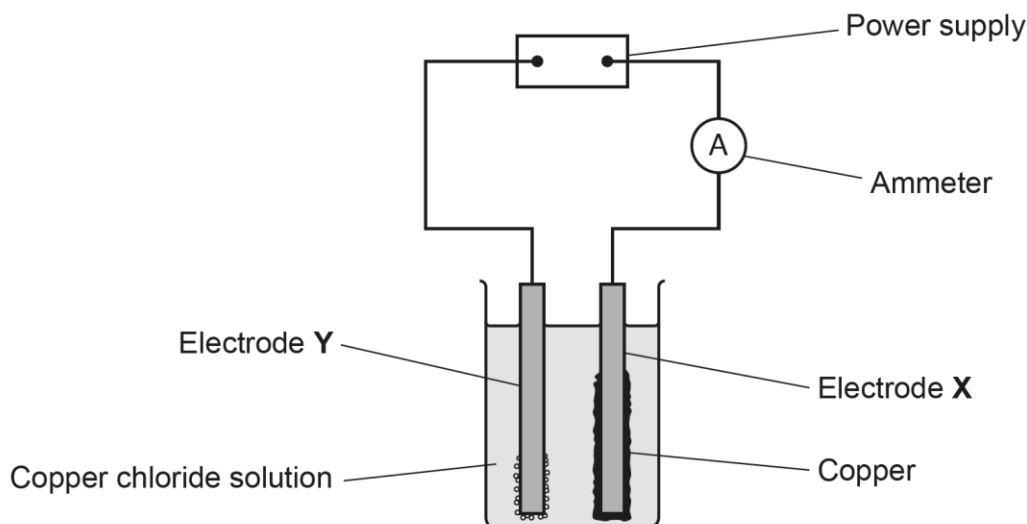
A minority of responses identified the correct test, many confusing it with the limewater test.

## Question 12 (a)

12 Copper can be produced from copper chloride solution by electrolysis.

A student investigates how changing the current used changes the mass of copper produced.

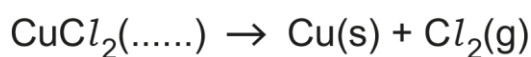
The diagram shows the apparatus the student uses.



The table shows the student's results.

Current (A)	Mass of copper produced (g)
1	0.03
2	0.06
3	0.19
4	0.12
5	0.15

(a) The equation for the reaction is



Complete the balanced symbol equation for the reaction by writing in the missing **state symbol** for copper chloride solution.

[1]

The majority of responses could not say what state symbols are, with a significant number omitting this question. The majority answered 'sg', having seen (s) and (g) on the right hand side. 'l' and 'ag' were commonly seen with many numbers or chemical symbols being used instead of state symbols.



### Question 12 (b)

(b) The student thinks that the experiment shows that electrode **X** is the cathode.

Explain why the student is **correct**. Use the diagram.

.....  
 .....  
 ..... [2]

Electrolysis presented a challenge. A minority of responses were given marks and those that did were mostly only given 1 mark for the idea that copper or the metal was attracted to the cathode or electrode X. Some responses said that copper was negative or said that copper was positive but did not mention ions. With no mention of ions, the majority of responses were unable to access 2 out of the 3 marks. A few thought that the cathode was always drawn on the right in the diagram.

#### Exemplar 1

Electrode X is the cathode as it attracts the positive metal in this case ~~iron~~ copper.  
 ..... [2]

Many candidates knew that the cathode was negative so attracted copper. If they had mentioned that the copper formed positive ions, they would have gained a second mark.

### Question 12 (c)

(c) Use the data in the table to show that the mass of copper produced doubles as the current doubles.

.....  
 .....  
 ..... [2]

Many responses were given both marks for selecting two appropriate current values where the mass of copper doubled, together with the correct masses. Many responses that were given 2 marks mentioned both the 1A/2A and 2A/4A relationships. Most incorrect responses mentioned incremental increases without selecting 1, 2 or 4A as the relevant currents.

## Question 12 (d) (i)

(d) (i) Plot a graph of the results on the grid.

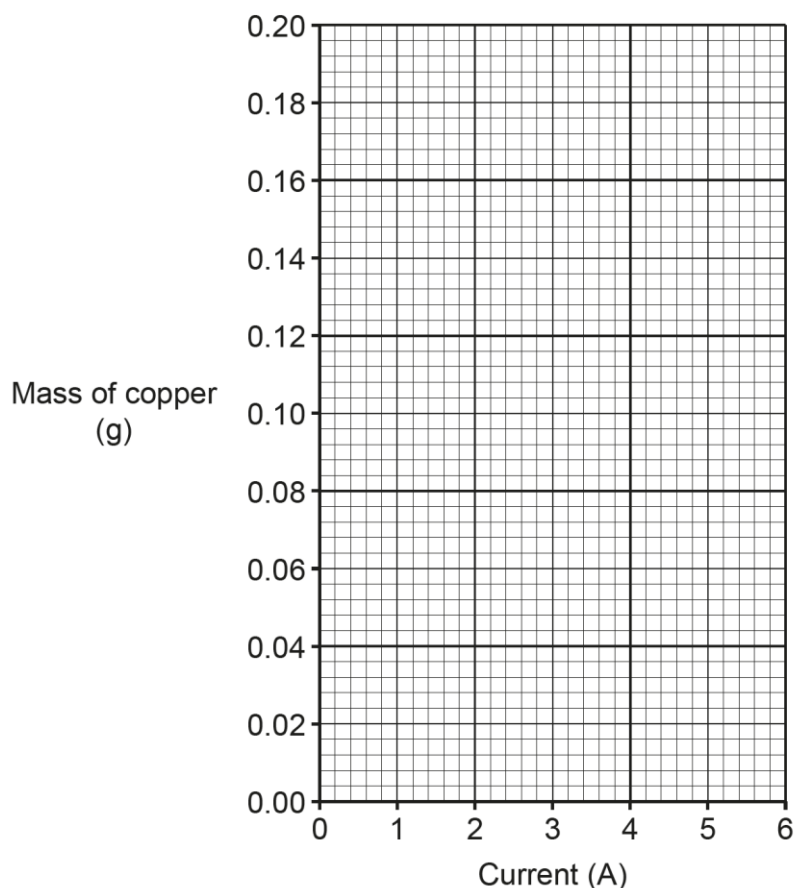
[2]

The majority of responses were given 2 marks for correctly plotting all the points. Candidates who drew large crosses with blunt pencils often lost a mark as there was only half a square tolerance. Most candidates read the scale correctly. Only a very few drew bar charts instead of line graphs. Those who used a pen instead of pencil often lost marks as they were unable to make clear enough changes when they tried to correct any errors.

## Question 12 (d) (ii)

(ii) Draw a line of best fit.

[1]



Many candidates drew a correct straight line of best fit which excluded the anomalous point, although not all lines appeared to have been drawn using a ruler. Many others drew a line from point-to-point through all points, although in later answers it was clear they knew the 3A point was an anomaly. A few tried to draw a straight line between all 5 points, but which did not actually go through any of them.

Question 12 (d) (iii)

(iii) The student thinks that the result for the mass of copper produced at 3A is **incorrect**.

Explain how the student knows this result is **incorrect**.

.....  
 ..... [1]

Many responses were given this mark for anomaly, outlier, or the idea that it did not fit the pattern. Others did not articulate their answers well enough to be credited the mark, often just stating that the 3A result was higher than 4A or just quoting data.

Question 12 (d) (iv)

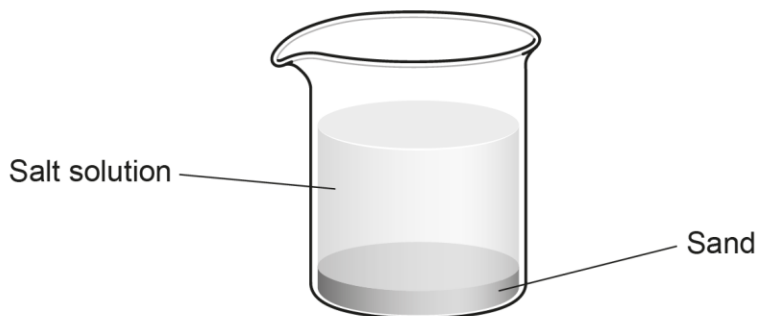
(iv) Use your graph to predict the mass of copper that should have been produced at 3A.

Mass of copper produced = ..... g [1]

Many candidates did not read this value from their graph. Many of those that did this gained the mark, but some read the value incorrectly often giving 9 or 0.9 as their answer instead of 0.09. Most candidates realised from the table that the answer should be 0.09 but if this did not agree with the graph they had drawn, usually because their line of best fit was incorrect, they were unable to gain the mark.

### Question 13\*

13\* A student has a mixture of sand and a salt solution.



They do a **two stage** experiment to obtain a sample of pure salt from the mixture.

Describe the two stages of the student's experiment.  
 Include labelled diagrams of how the equipment is set up in each stage.

.....

.....

.....

.....

.....

.....

[6]

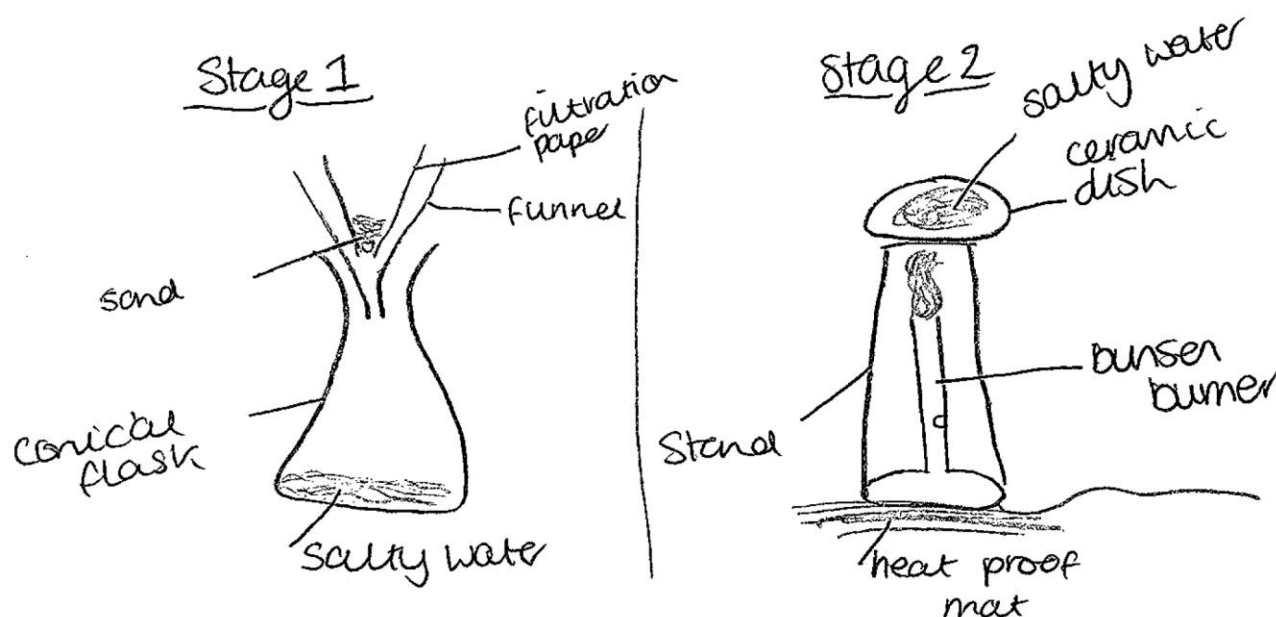
Many responses were given 1 or 2 marks mostly for naming or describing filtration. A significant number of candidates did not attempt this question, including a few of those who were more successful elsewhere. Some candidates misunderstood the question so explained how to prepare a mixture of sand and salt water. A few described chromatography.

Level 1 responses generally attempted to describe filtration but often suggested distillation or fractional distillation as the second stage. However, credit could be given for heating to remove the water and leave the salt behind in the distillation flask. Many achieved 2 marks for an attempt at a labelled diagram. A significant number evaporated the water then tried to separate the two solids by filtration.

Few responses named suitable apparatus or drew appropriate scientific diagrams, with some using kitchen equipment e.g. sieves, saucepans, or buckets. Filter paper without a filter funnel was frequently used. Some candidates seemed unfamiliar with the idea of heating to evaporate off the water and crystallise the salt, so just left the salty water on a windowsill for the water to evaporate.

A small number of more successful responses provided clear descriptions with correct use of scientific terminology including the names for the processes and equipment. However, candidates must make sure they draw diagrams when the questions instruct them to. Some who clearly knew the science were limited in the marks awarded because they did not include labelled diagrams.

## Exemplar 2



In Stage 1, the mixture gets separated apart by using filtration paper to separate the sand + salt solution, you are then left with your salt solution. Next in Stage 2 you put the salt solution into a ceramic dish and heat over a bunsen burner on a stand until the liquid solution gradually turns into a solid, which is then your sample of pure salt.

[6]

This response was given Level 3, 5 marks. Filtration is clearly described with the diagram showing that sand is retained as residue with the salty water as filtrate. There is a description of evaporation but neither of the terms evaporation nor crystallisation are used. Use of correct scientific terminology was needed to gain the full 6 marks. The diagrams show all the required equipment and are adequately labelled.

### Question 14 (a)

14 Zinc, Zn, reacts with sulfuric acid,  $\text{H}_2\text{SO}_4$ , to form the salt,  $\text{ZnSO}_4$ , and hydrogen.

(a) Write the **balanced symbol** equation for the reaction of zinc with sulfuric acid.

..... [1]

Few responses constructed a balanced symbol equation, and many did not attempt to answer this question. The most common error was to write 2H instead of  $\text{H}_2$ . Others did not include hydrogen as a product or wrote just H or  $\text{H}_2\text{O}$ . A few candidates tried to balance the equation, which was not actually necessary, by including the number 2 before (some) formulae.

### Question 14 (b)

(b) Name the salt,  $\text{ZnSO}_4$ , made from zinc and sulfuric acid.

..... [1]

Some more successful responses named the salt, but many did not realise that a chemical name was required. Common incorrect answers included sulphate, zinc sulphur oxygen, zinc oxide, and zinc sulphide. Many less successful responses mentioned types of salt that could be purchased e.g. table salt, sea salt, rock salt. A significant number of candidates did not try to answer.

### Question 14 (c)

(c) To make sure **all** the sulfuric acid reacts, an excess of zinc is used.

Describe how universal indicator could be used to show that **all** the sulfuric acid has reacted.

.....  
.....  
..... [2]

A minority of candidates scored any marks, with many not answering the question. Mostly, 1 mark was awarded for saying that the indicator changed colour. Many candidates referred to pH but few mentioned any colours with even fewer giving correct colours. Some thought that the final colour would be blue or purple.

## Question 14 (d) (i)

(d) (i) Calculate the relative formula mass of  $\text{ZnSO}_4$ .

Relative atomic mass ( $A_r$ ): O = 16.0 S = 32.1 Zn = 65.4

Relative formula mass of  $\text{ZnSO}_4$  = ..... [1]

The majority of candidates attempted this question with some calculating the correct answer of 161.5. The most common incorrect answer was 113.5, obtained by just adding the three numbers that were supplied, but some attempted to multiply instead of adding.

## Question 14 (d) (ii)

(ii) The percentage mass of an element in a compound can be calculated using the formula

$$\text{percentage mass of an element} = \frac{\text{total relative atomic mass of the element}}{\text{relative formula mass of the compound}} \times 100$$

Calculate the percentage mass of zinc in  $\text{ZnSO}_4$ .

Give your answer to 1 decimal place.

Percentage mass of zinc = ..... % [3]

Some candidates who had obtained 161.5 in Question 14 (d)(i) gained 3 marks. A number of those who obtained 113.5 in Question 14 (d)(i) also scored 3 marks here, benefitting from “error carried forward” (ECF). A few gained 1 mark for using their answer to Question 14 (d) (i) in a percentage calculation and giving their answer to 1 decimal place, although not all were able to round their answer correctly. A significant number did not attempt this question at all.

### Assessment for learning



Candidates should be reminded to use the formula supplied in the question. Many candidates did not use their answer to Question 14 (d)(i) as the denominator or forgot to multiply by 100.

## Question 14 (e) (i)

(e) The reaction between zinc and sulfuric acid is **exothermic**.

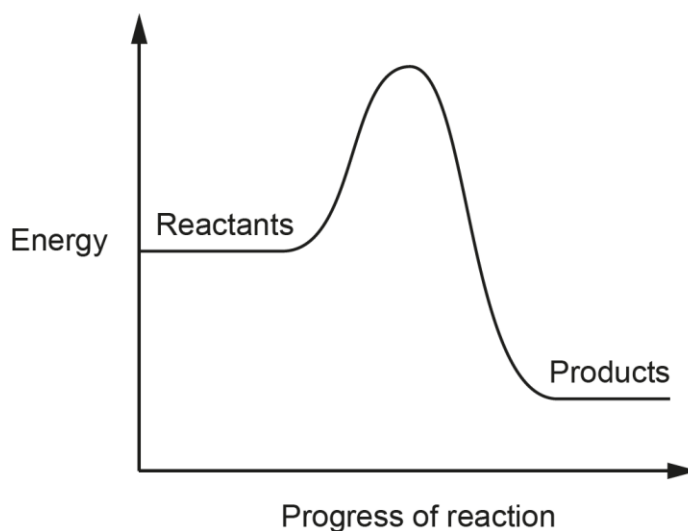
(i) Explain what is meant by an **exothermic** reaction.

.....  
..... [1]

Many candidates understood this concept but used a wide variety of terms to gain the mark. Some thought exothermic reactions gave out oxygen. Some less successful responses confused energy leaving the reaction with a temperature drop (in the surroundings).

## Question 14 (e) (ii)

(ii) The diagram shows the reaction profile for the reaction.



Label the activation energy on the diagram.

[1]

Very few responses were given this mark, with a lot omitting the question. Most knew that it had something to do with the top of the curve, so just labelled that as the activation energy or put a cross by it. Incorrect answers included double-headed arrows, arrows that were much too long or short, and arrows outside the area of the curve just pointing to parts of the curve.



## Question 14 (e) (iii)

(iii) Explain the term activation energy.

.....  
 ..... [1]

A minority of responses were given this mark, often for the idea of the 'energy to start a reaction', but few would have been given the mark if the word 'minimum' had been required. Incorrect responses often referred to the diagram with the idea that the energy goes up then down or mentioned the 'optimum' perhaps confusing it with an enzyme activity curve in Biology.

## Question 14 (f)

(f) The table shows the temperature changes in four reactions.

The reaction between zinc and sulfuric acid is **slightly** exothermic.

Which shows the reaction between zinc and dilute sulfuric acid?

Give a reason for your answer.

Reaction	Start temperature (°C)	End temperature (°C)
A	20	19
B	20	64
C	20	22
D	20	20

Reaction .....

Reason .....

..... [3]

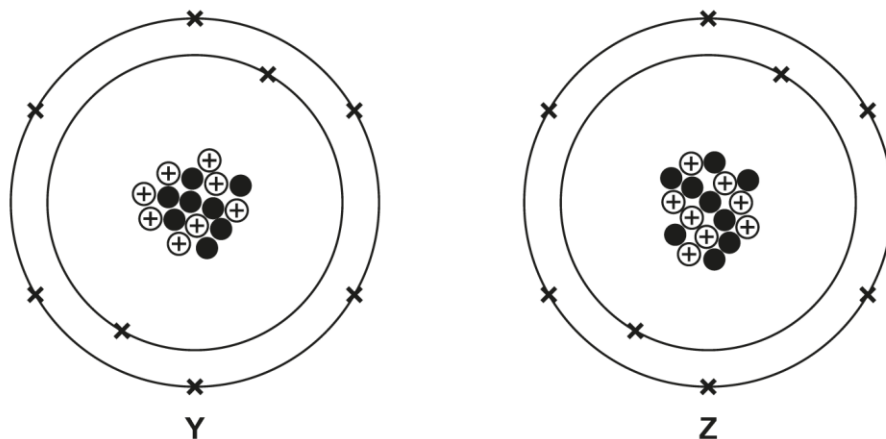
A minority of responses were given any marks. Even those who knew the definition struggled to identify the two exothermic reactions and then select the correct one, with the most common answer being A. Those who correctly identified C mostly did not gain all 3 marks due to their explanation, often talking about energy instead of a rising temperature.

### Question 15 (a)

15 Atoms of the same element can have different structures.

Fig. 15.1 shows the structure of two different atoms, Y and Z, of the same element.

Fig. 15.1



(a) What name is given to different atoms of the same element such as Y and Z?

..... [1]

The majority of candidates attempted this question, but only a minority knew they were isotopes. Incorrect answers included ions, allotropes, compounds, protons, and electrons.

### Question 15 (b)

(b) Write the number of protons, neutrons and electrons in an atom of Z.

Number of protons = .....

Number of neutrons = .....

Number of electrons = .....

[2]

Most responses were given at least 1 mark, with many candidates scoring both marks. It was common to see an incorrect number of neutrons.

### Question 15 (c)

(c) Write the **mass number** of an atom of Z.

Mass number of an atom of Z = ..... [1]

Few responses worked out the correct mass number, even when they had given the correct answer in Question 15(b). Some gained a mark for saying 17, despite giving the numbers of both protons and neutrons as 8. The most common incorrect responses were 16, 25 or 8, with many candidates having added their number of protons and electrons.

### Question 15 (d)

(d) Write the name of the element that contains atoms of **Y** and **Z**.

Use the Periodic Table.

..... [1]

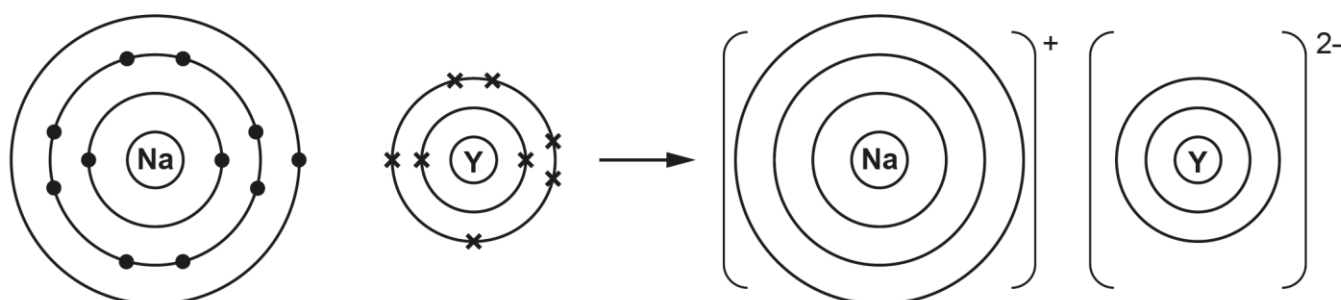
Many responses correctly identified oxygen, but a significant number omitted this question and seemed unclear as to what was being asked. A wide range of incorrect responses were seen, some not even names of elements. Common incorrect responses included magnesium, chloride (sic), titanium and yttrium.

### Question 15 (e) (i)

(e) Atoms of sodium react with atoms of **Y** to form an ionic compound.

**Fig. 15.2** shows the ions formed when an atom of sodium reacts with an atom of **Y**.

**Fig. 15.2**



(i) Complete **Fig. 15.2** to show the arrangement of electrons in the ions. [2]

Some more successful responses were given at least 1 mark, but many omitted this question. It was common to see a correct diagram for sodium, but with Y missing one electron as they didn't realise that it needed to gain two electrons. Candidates should be encouraged to use pencil or make any crossings out very clear on such questions.

## Question 15 (e) (ii)

- (ii) What is the formula of the ionic compound formed when atoms of sodium react with atoms of **Y**?

Tick (✓) **one** box.

NaY<sub>2</sub>

Na<sub>2</sub>Y

Na<sub>2</sub>Y<sub>2</sub>

[1]

Many responses correctly said Na<sub>2</sub>Y, but both other answers were seen. Many did not seem to be aware that they needed to use the information about ionic charges from the previous part of the question.

## Question 15 (e) (iii)

- (iii) Why does sodium react with **Y** and **Z** in a similar way?

Tick (✓) **one** box.

Atoms of **Y** and **Z** have the same number of electrons.

Atoms of **Y** and **Z** have the same number of neutrons.

Atoms of **Y** and **Z** have the same number of protons.

[1]

The first answer was most popular, but many also chose the other two options.

## Question 15 (e) (iv)

- (iv) The ionic compound formed in **Fig. 15.2** has a high melting point.

Explain why. Use ideas about structure and bonding.

.....

.....

.....

.....

.....

.....

..... [3]

The majority of candidates found this to be a challenging question with a large number omitting to answer it. Very few scored more than 1 mark, which was generally awarded for the idea that the bonds were strong or occasionally for the idea that they required a lot of energy to break. Those who wrote about stronger bonds or more energy could not be awarded that mark. However, many thought that the bonds were covalent, metallic, or intermolecular.

It was rare to see any mention of electrostatic forces, ions, or lattices. A few responses mentioned attractions but between the wrong particles, e.g., atoms, electrons, nuclei, or metal and non-metals. Most wrote about metals having high melting points, lots of electrons, electrons being able to escape easily and other non-creditworthy ideas.

## Exemplar 3

it has more electrons and  
 more shells meaning it takes  
 more energy ~~as~~ to break the  
 intermolecular structure. AS they have  
 strong bonds. [3]

This response illustrates some of the misconceptions that candidates have regarding bonding. However, they do gain credit for knowing that the bonds, even if they are not the correct type, are strong.

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