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OCR
Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

GATEWAY SCIENCE COMBINED SCIENCE A

J250

For first teaching in 2016

J250/09 Summer 2024 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 is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

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

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

Paper 9 series overview

Candidates generally performed well on this paper. A wide range of skills was demonstrated with a good range shown across the paper. Candidates used the space provided well and answered all the questions in the time provided.

Misconceptions around entities such as atoms, ions, particles, molecules etc. still cause concern when candidates are discussing bonding or the particle model. Centres could look to clarify this with candidates to enable them to respond appropriately to such questions.

The Level of Response question gave a range of responses, where some candidates found describing practical aspects more challenging. They gave responses based on theory rather than how to actually carry out the tests using simple laboratory equipment. Simple observations to look out for, such as fizzing and dissolving, were often missing from responses.

The expression of values to a set number of significant figures and decimal places was effectively done.

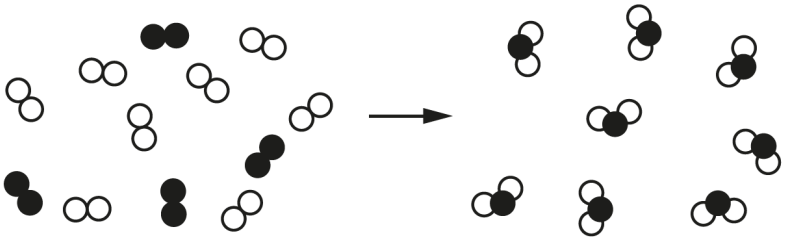
Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• showed good understanding of the Periodic Table including the position of metals and non-metals, the significance of groups and the number of electrons on the outer shells and isotopes showed an understanding of the loss and gain of electrons to form ions • could successfully draw, write, and balance formulae • could write an electronic configuration • could name compounds • could carry out moles calculations • could perform reacting mass calculations • could describe observations of Rutherford's gold foil experiment.	• did not demonstrate an understanding of the process of electrolysis • could not identify a neutralisation reaction • could not interpret the conclusions of Rutherford's experiment • struggled to construct half equations with electrons on the correct side of the arrow or give entities with the correct charges • did not understand the structure of alloys • could not the use of different terms for entities, such as atom, ions, particle, molecules etc. • could not convert units from cm^3 to dm^3 • did not demonstrate an understanding of limiting factors as determining the amount of product formed.

Section A overview

The multiple choice section was well answered with very few omissions.

Question 1

1 The diagram represents the particle model for a change in the arrangement of some particles.



Which row describes this change?

	Type of change	Explanation
A	chemical	The particles break up and then join together in a different way.
B	chemical	The particles stay the same but are arranged in a different way.
C	physical	The particles break up and then join together in a different way.
D	physical	The particles stay the same but are arranged in a different way.

Your answer ☐ **[1]**

The common misconception here was the type of change that was taking place. Incorrect responses generally chose C rather than the correct response of A, showing they lacked the understanding of physical and chemical changes.

Question 2

2 Which element in the table is a **non-metal**?

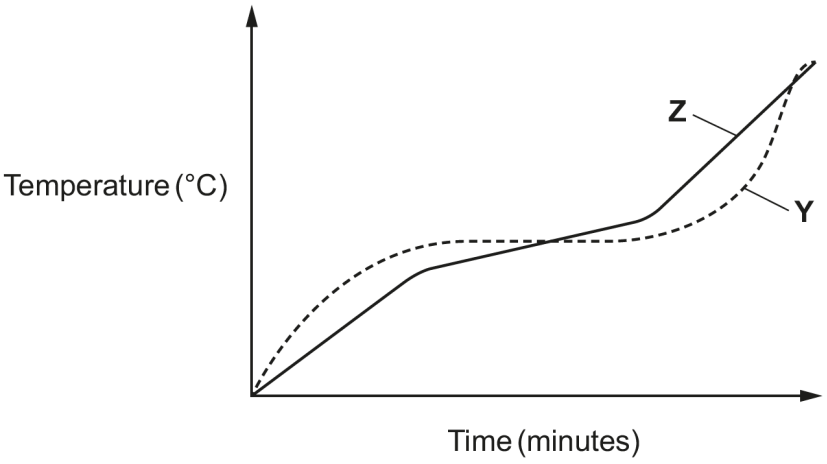
	Appearance at room temperature	Melting point (°C)	Electrical conductivity
A	silver liquid	–39	high
B	orange-red solid	1083	high
C	yellow solid	113	low
D	silvery-white	3422	high

Your answer ☐ **[1]**

This question was very well answered.

Question 3

3 The graph shows how the temperature of two samples of a substance, **Y** and **Z**, changes as they melt from solids to liquids.



Which row describes **Y** and **Z**?

	Y	Z
A	impure	impure
B	impure	pure
C	pure	impure
D	pure	pure

Your answer ☐ **[1]**

Only the highest achieving candidates scored here, with candidates mostly choosing B as their incorrect response. This showed they understood that one substance was pure and one was impure but could not identify which was which on the graph.

Question 4

4 This is the equation for the reaction between copper carbonate and dilute hydrochloric acid:

$CuCO_3(s) + 2HCl(aq) \longrightarrow CuCl_2(\ldots) + CO_2(g) + H_2O(l)$

What is the state symbol for $CuCl_2$?

A aq

B g

C l

D s

Your answer ☐ **[1]**

This question was well answered.

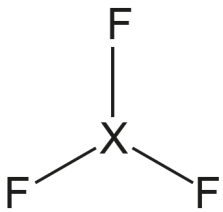
Question 5

5 In which molecule is **X** an atom of carbon?

A X—F

B

C



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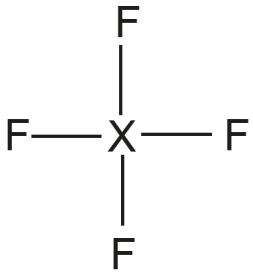


Your answer ☐ **[1]**

This question was generally well answered, with incorrect responses generally choosing option B.

Question 6

6 Boron, B, is in Group 3 of the Periodic Table and chlorine, C*l*, is in Group 7 of the Periodic Table.

What is the formula of the compound formed when boron reacts with chlorine?

A BC*l*

B BCl_3

C B_3Cl

D B_3Cl_7

Your answer ☐ **[1]**

This question was well answered.

Question 7

7 The equation shows the reaction of zinc carbonate when it is heated.

$ZnCO_3(s) \longrightarrow ZnO(s) + CO_2(g)$

- 5.0 g of zinc carbonate is heated in a test tube for 10 minutes.
- The mass of the test tube decreases by 0.6 g.

How does the law of conservation of mass explain this decrease in mass?

A 0.6 g of carbon dioxide is produced.

B 0.6 g of zinc oxide is produced.

C 4.4 g of carbon dioxide is produced.

D 5.6 g of zinc oxide is produced.

Your answer ☐ **[1]**

This question was well answered.

Question 8

8 Which statement describes the **mole**?

A The mole is defined relative to carbon-14.

B The mole is the unit for the amount of a substance.

C The number of particles in one mole of a substance depends on the substance.

D One mole contains 1.67×10^{-27} particles.

Your answer ☐ **[1]**

This question was generally answered well, but those who made an incorrect choice generally prompted for option C, realising that there was a link between the number of particles and the mole.

Question 9

9 Magnesium reacts very slowly with oxygen at room temperature.

When magnesium is heated in a Bunsen burner flame it burns very brightly after only a few seconds.

Which statement is correct?

A The activation energy for the reaction is high.

B The reaction is endothermic.

C Magnesium is an unreactive metal.

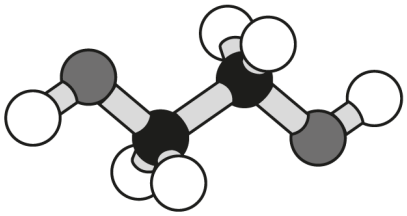
D Magnesium only reacts at very high temperatures.

Your answer ☐ **[1]**

This was more challenging than other multiple choice questions, with all options chosen by candidates.

Question 10

10 What is the empirical formula of this compound?



Key:
● = Carbon
○ = Hydrogen
● = Oxygen

A CHO

B CH_3O

C $C_2H_6O_2$

D $HOCH_2CH_2OH$

Your answer ☐ **[1]**

This question was generally well answered, with candidates able to understand the model and relate that to the molecular formula.

Section B overview

In this section candidates should be reminded to use the additional pages at the back of the exam paper if they need extra space to answer questions. There were a small number of examples where candidates wrote under the lines or into the space provided for the next question. In these cases the writing was often squashed or difficult to determine. The additional pages are offered as an extra space when candidates have more to say. This space is generally well used for the Level of Response questions. These additional pages simply need to be used for all incidents where candidates feel more space is needed to allow them to fully develop their answers.

Question 11 (a)

11 Lithium reacts with oxygen to form lithium oxide.

The symbols for lithium and oxygen on the Periodic Table are:

3
Li
6.9

8
O
16.0

(a) Explain how the positions of lithium and oxygen in the Periodic Table are used to decide that lithium is a metal and oxygen is a non-metal.

Use the Periodic Table on the Data Sheet.

.....

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

This question was well answered. Where candidates didn't score, it was usually because they hadn't made a comparison between the position of lithium and oxygen, only quoting the position of one element.

Question 11 (b)

(b) Lithium reacts with oxygen to make lithium oxide.

Complete the **balanced symbol** equation for the reaction.

$$.....Li + O_2 \rightarrow .....Li_2O$$

[2]

Almost all candidates could correctly give the number of lithium oxide molecules. Where candidates didn't score both marks, it was the inability to identify the correct number of atoms of lithium in the oxide. 2 was the most common incorrect response in front of Li.

Question 11 (c)

(c) Write the electron arrangement for an atom of lithium.

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

This question was very well answered.

Question 11 (d)

(d) When an atom of lithium reacts with oxygen it forms a lithium ion, Li^+.

Describe how an atom of lithium forms a lithium ion.

.....

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

The correct convention of 2,1 was seen in most responses. A few candidates wrote out the position of the electrons in a sentence. This was also acceptable.

Question 11 (e)

(e) A student thinks that sodium reacts in a similar way to lithium.

Explain why they are **correct**.

Use the Periodic Table on the Data Sheet.

.....

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

The majority of candidates could correctly identify the same group as the important factor for similar reactions. Occasionally candidates discussed columns, rows, and periods rather than groups.

Question 11 (f)

(f) Lithium can exist as two isotopes.

3 **Li** 6	3 **Li** 7

Explain what **isotope** means.

.....

.....

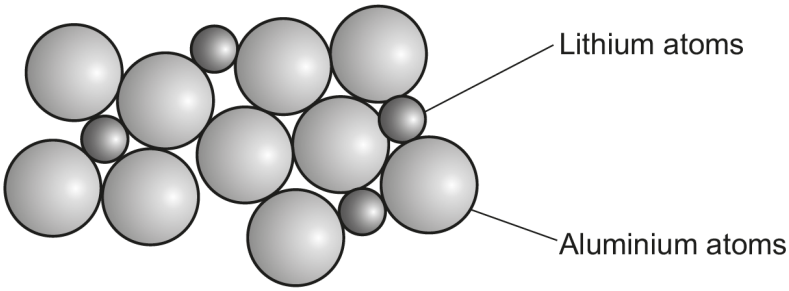
..... **[2]**

Candidates should simply refer to the number of protons and neutrons when discussing isotopes as the misconception of electrons having an impact was evident in some responses. Where responses were incorrect, candidates mixed up electron and neutron numbers, or atomic number with mass number.

Question 11 (g) (i)

(g) Lithium can be added to aluminium to make an alloy. One alloy contains 2% lithium.

A student draws a diagram of the alloy.



(i) Calculate the percentage of lithium atoms in the alloy drawn by the student.

Percentage of lithium atoms in the alloy = ... % **[2]**

A significant number of candidates scored 2 marks here. Candidates struggled most with dividing by the total number of atoms present rather than just the number of aluminium atoms. For example 4/10 to give 40% rather than 4/14 to give the correct answer. There were also a number of rounding errors. Candidates occasionally rounded to 28 rather than 29 or 28.5 rather than 28.6. Where rounding does take place, it must be correct.

Question 11 (g) (ii)

(ii) Suggest a reason why the student's diagram is **incorrect**.

.....

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

This question was not answered well, with candidates often quoting the percentage of each atom drawn in the diagram rather than realising that either too many lithium atoms or too few aluminium atoms were drawn to give the correct percentages. Answers needed to reference the number of atoms drawn.

Question 12 (a)

12 Potassium bromide is an ionic compound. It contains potassium ions, K^+, and bromide ions, Br^-.

For electrolysis to happen, an electric current must be passed through **molten** potassium bromide.

(a) Describe what happens when solid potassium bromide is heated up until it melts into a liquid.

Use ideas about the particle model.

.....

.....

.....

.....

.....

..... **[3]**

This question had varied responses. The majority of candidates scored the second marking point, which described a gain of energy or increased motion of ions. The use of an incorrect entity often limited the marks to 2. In such cases the candidates may have identified the changes to the arrangement and motion of the ions but described them as atoms, molecules, or particles.

Misconception

The entity is important when discussing an ionic compound. Often candidates discussed atoms or molecules rather than ions. This is important when describing the breakdown of an ionic lattice and the movement of ions.

Exemplar 1

Potassium bromide is an ionic compound so it has strong ionic co electrostatic forces of attraction so it will take alot of heat to break these bonds when it is heated the electrostatic forces weaken and now can move around more more than making it into liquid then if is heated heated up more so they ke can free to move and ions delocalised electrons [3]

Marking points 3 and 4 are given. Marking point 5 is not given as there is no mention of 'ions' being free to move, instead the candidate has discussed delocalised electrons being free to move. This is an incorrect entity. Ions move, not delocalised electrons.

Question 12 (b)

(b) Explain why potassium bromide must be **molten** for electrolysis to happen.

.....

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

A significant number of candidates discussed there being something 'free to move', but often this was delocalised electrons, atoms, particles, or molecules rather than ions. The entity must be correct to score this mark.

Question 12 (c)

(c) State the product made at the **cathode** and write the half equation for the reaction.

Product .....

Half equation .....

[2]

Potassium was usually identified by candidates, but they occasionally referred to potassium ions being the product rather than atoms - this is a contradiction, as atoms are the product not ions. K^+ was a common incorrect response.

Question 12 (d)

(d) The electrolysis is repeated with a **solution** of potassium bromide.

A student thinks that the **same** product will be formed at the cathode.

Explain why the student is **incorrect**.

Name of the different product formed .....

Reason .....

.....

[2]

Some candidates did not respond to this question. It was usually only the high achieving candidates that could identify hydrogen as the correct product and the reason for the hydrogen to be released rather than potassium. Several candidates misidentified bromine as the product and then found they struggled for a sensible reason.

Question 13*

13* A student has samples of three solids labelled **A**, **B** and **C**.

They think:
- **A** is calcium carbonate
- **B** is sodium carbonate
- **C** is sodium chloride.

They know the following information.

Solid	Solubility in water	Reaction with dilute hydrochloric acid
Calcium carbonate	insoluble	reacts to produce carbon dioxide
Sodium carbonate	soluble	reacts to produce carbon dioxide
Sodium chloride	soluble	no reaction

Describe simple test tube experiments the student could do using water **and** dilute hydrochloric acid to show the solids have been labelled correctly.

Describe any observations that the student would see in these experiments **and** how they help show the labels are correct.

.....

.....

.....

.....

.....

..... **[6]**

Candidates often misinterpreted the command word on this question. Candidates were asked to describe the simple 'test tube experiments' that could be carried out and the 'observations' they would make. A significant number of candidates did not realise or mention that fizzing would take place when an acid was added to a carbonate. Instead, many took the information from the table that carbon dioxide would be produced and either tried to attach a delivery tube to bubble the gas produced through limewater to prove this was carbon dioxide or attaching a gas syringe to measure the volume of the carbon dioxide produced. Both these comments missed the point of simple test tube experiment. There was no expectation to do anything other than add the solids to water to look for dissolving or to add to the acid and look for fizzing. The conclusions that followed were often convoluted rather than concise. The additional pages at the back were frequently used as candidates struggled to articulate their ideas in the given space, especially when describing unnecessary additional gas tests.

Exemplar 2

The student can put Calcium carbonate in a test tube with water and mix it up to see if it gets disolved in water. I the water ~~tarns~~ doesn't change colour and you can still see the Calcium carbonate then it means it's labelled correctly as it hasn't disolved (because calcium carbonate is insoluble) in the water (insoluble means can't be disolved in the liquid). If the student places by placing sodium chloride in a test ~~tube~~ tube of water and mixes it and sees that the colour of the water is changing it means that it is soluble. ~~and then~~ If then the student takes sodium chloride and puts in a test tube of dilute hydrochloric acid and nothing happen (no bubble, no fizzing, no change in colour) then it doesn't react with the acid meaning sodium chloride is [6]
labled correctly. If the student takes sodium carbonate and places it in a test tube with water and gets results like sodium chloride then it means its soluable. If the student takes sodium carbonate and places it hydrochloric acid and theres fizzing, bubbling and a change in colour. That means sodium carbonate is labelled correctly as it disolved in the water and reacted with dilute ~~a~~ hydrochloric acid.

This response has given details on how the experiments can be carried out to identify the solids. They have also described observations that could be seen and conclusions that can be drawn to determine the correct labelling of the solids. This is a clear Level 3 response. The additional information given about colour changes is irrelevant and can be ignored as it does not detract from the answer. This response scored 6 marks.

Exemplar 3

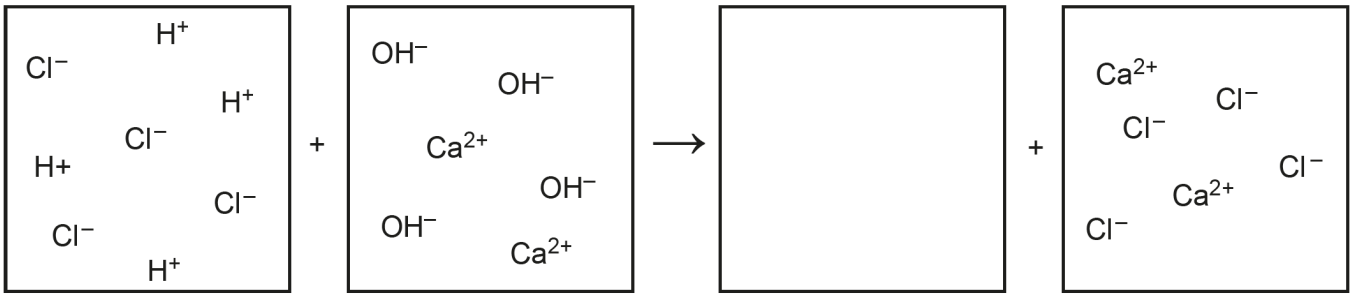
If the students believe that the calcium carbonate is insoluble, then they should use filtration as filtration separates an insoluble solute from a solvent. After the ~~filt~~ solution has been filtered using funnel paper, there should be residue left which proves that it is ~~not~~ insoluble. If the experiment is said to produce carbon dioxide, then limewater can be used to detect the gas. The limewater would turn a cloudy white solution to indicate the presence of carbon dioxide. If the solid B, ~~is~~ and C are said to be soluble, then the student should use distillation to attempt to separate the water from the solid (or evaporation) After the solution has heated and the water has evaporated there should remain the solid, either B or C which shows that. **[6]**

13 they are soluble. If the sodium carbonate is said to be unreactive, the student can use a gas syringe to check if any gas has been produced. If the syringe moves from its original position then ~~CO_2~~ gas has been produced otherwise it is not reactive and could therefore be Sodium carbonate.

This response has misunderstood the question and has quoted many additional experiments to test for gases that would require additional equipment. The candidate has not actually added either solid to water of hydrochloric acid. The science of the extra tests may well be correct but it does not answer the question. Unfortunately, this response scored zero marks.

Question 14 (a)

14 The diagram shows a reaction between two solutions **P** and **Q**.



P **Q** **R** **S**

(a) Write the formula of the molecules in the box for **R** to show a **balanced** reaction. **[2]**

The nature of the ions in the other boxes led many candidates to draw waters constituent 'ions' of H^+ and OH^- rather than water molecules. Where ions rather than molecules were drawn, the correct number of entities were drawn to balance the equations.

Question 14 (b)

(b) Write the name and the formula of the compound in solution **S**.

Name .....

Formula .....

[2]

Most candidates could name the product but fewer could successfully identify the formula of the compound. Where incorrect information was quoted it was often the formula of the ions rather than the formula of the compound.

Question 14 (c)

(c) Name the type of reaction which happens between solutions **P** and **Q**.

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

Very few candidates could correctly identify the type of reaction. A wide variety of reaction types were quoted including redox, oxidation, reduction, displacement, chemical, exothermic, endothermic and combustion.

Question 14 (d)

(d) Which of the solutions in the diagram shows a strong acid?

Tick (✓) **one** box.

P ☐

Q ☐

S ☐

Give **two** reasons for your answer.

1 .....

.....

2 .....

.....

[3]

A large number of candidates could identify P as the box showing the strong acid, but the reasons they chose this box were often incorrect. The H^+ ions were often correctly identified but the acid being fully ionised was very rarely seen.

Question 14 (e)

(e) A student dissolves 2 g of a strong acid in 250 cm^3 of water.

Calculate the concentration of the solution formed in **g / dm^3**.

Concentration of the solution = ... g / dm^3 **[3]**

Candidates rarely scored all 3 marks due to incorrect conversions from cm^3 to dm^3. There were a variety of incorrect conversions and power of ten errors ranging from 2 to 6 powers of ten. This is a definite area that centres can work on for future examination series.

Question 15 (a)

15 Copper can be made by reacting copper oxide, CuO, with carbon, C.

$2CuO + C \longrightarrow 2Cu + CO_2$

When 2.00 g of copper oxide reacts with 1.00 g of carbon, copper oxide is the limiting reactant.

(a) Explain the effect of a limiting reactant on a reaction.

.....

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

Most candidates found this question challenging. Lots of responses centred around the reaction 'stopping' rather than the amount of product being limited by the limiting reagent being used up.

Question 15 (b)

(b) Calculate the number of moles in 2.00 g of copper oxide and 1.00 g of carbon.

Give your answers to **3** decimal places.

Relative atomic mass (A_r): C = 12.0 O = 16.0 Cu = 63.5

Number of moles in 2.00 g of copper oxide = ... mol

Number of moles in 1.00 g of carbon = ... mol

[3]

Candidates were frequently able to quote their answers to 3 decimal places but there were a variety of errors made in the calculations including power of ten errors, giving 0.83 rather than 0.083. The other common error was the value of 0.013 rather than 0.025 for the moles of copper oxide.

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Question 15 (c)

(c) Use your answers in part **(b)** to explain why copper oxide is the limiting reactant.

.....

.....

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

The majority of candidates struggled to express an understanding of the limiting factor in previous parts of the question and so found an explanation of the limiting reactant difficult to articulate.

Question 15 (d)

(d) The number of moles in a different mass of copper oxide is 0.045.

$2CuO + C \longrightarrow 2Cu + CO_2$

Calculate the maximum mass of copper, Cu, that can be made from 0.045 moles of copper oxide.

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

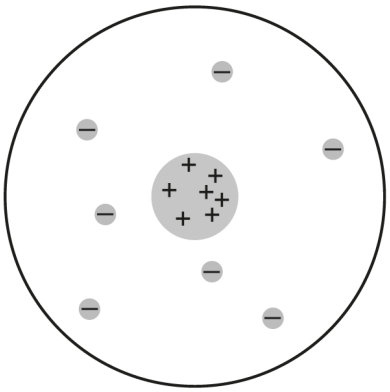
Relative atomic mass (A_r): Cu = 63.5

Maximum mass of copper = ... g **[3]**

The majority of candidates could correctly calculate the theoretical mass of copper and quote their answer to 2 significant figures. The common errors included calculating twice the mass, giving an answer of 5.7 rather than 2.9. This was one error and so scored 2 marks. Another common error was the use of the M_r of copper oxide rather than copper, giving an answer of 3.6 rather than 2.9 grams.

Question 16 (a)

16 The diagram shows the model of the atom developed by Rutherford.



(a) The model developed by Rutherford was based on the results of an experiment performed whilst working with Geiger and Marsden.

They fired positively charged alpha particles at very thin gold foil.

State **two** observations made in the experiment and the conclusion Rutherford reached.

Observation 1 .....

.....

Observation 2 .....

.....

Conclusion .....

.....

[3]

Candidates could identify the pathways taken by the alpha particles that were fired at the gold foil, however they struggled to quantify the number of particles with each pathway. For example 'some went straight through' rather than 'most went straight through' was a commonly seen error. Where conclusions were given the most correct response was that most of the atom was empty space. Some misconceptions were seen here, including discussions of neutrons, which of course had not yet been discovered at the time of Rutherford's experiment.

Question 16 (b)

(b) Describe how Bohr improved Rutherford's model of the atom.

.....

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

Most candidates could identify 'shells' as the improvement to the model made by Bohr.

Question 16 (c)

(c) What is the typical atomic radius size of an atom in metres?

Give your answer in **standard form**.

..... m **[1]**

The higher attaining candidates could give a suitable value for the typical radius of the atom. Common errors were either quoting a value of the size of a nucleus at $x10^{-15}$ m or numbers around Avogadro's constant.

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