AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.4.1.1

# Metal oxides

## Mark schemes and examiner comments

| | |
|---|---|
| Tier | **Foundation** |
| Question groups | **12** |
| Available paper years | **2018–2025** |

## Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

**Name:** _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

5.4.1.1 Metal oxides

Answer 01 · Mark scheme

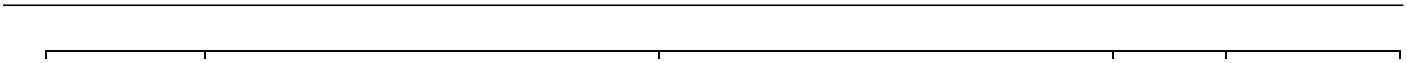
June 2018 | 8464/C/1F | Original Q3

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 03.1 | $H^+$ | | 1 | AO1 5.4.2.4 |
| 03.2 | nitric (acid) **or** $HNO_3$<br>zinc (oxide) **or** ZnO | this order only | 1<br>1 | AO2 5.4.2.3 |
| 03.3 | dissolved in water | | 1 | AO1 5.1.1.1 |
| 03.4 | any value from 0 to less than 8 | | 1 | AO2 5.4.2.4 |
| 03.5 | **Level 2:** The method would lead to the production of a valid outcome. Key steps are identified and logically sequenced. | | 3–4 | AO3 |
| | **Level 1:** The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear. | | 1–2 | AO2 |
| | **No relevant content** | | 0 | |
| | **Indicative content**<br>• add universal indicator **or** wide range indicator<br>indicator turns blue / purple / violet (because pH = 14)<br>**or** has highest pH **or** is an alkali<br>so A is sodium hydroxide<br>indicator turns red (because pH = 2)<br>**or** has lowest pH **or** is an acid<br>so B is phosphorus oxide<br>indicator turns green (because pH = 7)<br>**or** neutral<br>so C is silicon dioxide<br>• add solid to water<br>A and B dissolve; C does not<br>so C is silicon dioxide | | | 5.1.2.3<br>5.4.2.4 |
| **Total** | | | **9** | |

### 5.4.1.1 Metal oxides

**Answer 01 · Mark scheme**

June 2018 | 8464/C/1F | Original Q3



### 5.4.1.1 Metal oxides

**Answer 02 · Mark scheme** June 2019 | 8464/C/1F | Original Q2

| | | | | |
|---|---|---|---|---|
| **02.1** | hydrochloric acid | | 1 | AO1<br>5.4.2.3 |

| | | | | |
|---|---|---|---|---|
| **02.2** | (black) solid remains (after stirring) | allow copper oxide remains<br>allow no more copper oxide reacts | 1 | AO1<br>5.4.2.3 |

| | | | | |
|---|---|---|---|---|
| **02.3** | first stage **B**<br>second stage **A**<br>third stage **C**<br>fourth stage **D** | all 4 correct for **2** marks<br>allow **1** mark if either first stage or fourth stage is correct | 2 | AO1<br>5.4.2.3 |

| | | | | |
|---|---|---|---|---|
| **02.4** | (negative electrode) copper<br>(positive electrode) chlorine | allow Cu<br>allow $Cl_2$ / Cl<br>do **not** accept chloride or $Cl^-$<br>if no other mark awarded allow **1** mark if elements are reversed | 1<br>1 | AO2<br>5.4.3.2 |

### 5.4.1.1 Metal oxides

**Answer 02 · Mark scheme**



| | | | | |
|---|---|---|---|---|
| **02.5** | a reading of an increase in mass<br><br>correct linked reading of the increase in time<br><br>correct evaluation of gradient | e.g. 4 (mg) in 10 (mins) scores 2 marks<br><br>e.g. ($\frac{4}{10}$ =) 0.4 (mg per min)<br><br>allow correct calculation of gradient from incorrectly determined values for mass and/or time | 1<br><br>1<br><br>1 | AO2<br>5.4.3.4 |

| | | | | |
|---|---|---|---|---|
| **02.6** | cryolite<br><br>oxide | this order only | 1<br><br>1 | AO1<br>5.4.3.3 |

| | | | |
|---|---|---|---|
| **Total** | | | **11** |

### 5.4.1.1 Metal oxides

**Answer 02 · Mark scheme**

June 2019 | 8464/C/1F | Original Q2

| Question | Answers | Extra information | Mark | AO / Spec. |
|---|---|---|---|---|

### 5.4.1.1 Metal oxides

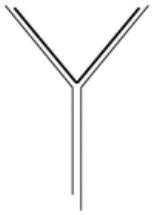
**Answer 03 · Mark scheme** November 2020 | 8464/C/1F | Original Q1

| | | | | |
|---|---|---|---|---|
| **01.1** | 1 | | 1 | AO1<br>5.4.2.4 |
| **01.2** | hydrochloric acid | | 1 | AO1<br>5.4.2.1<br>5.4.2.2 |
| **01.3** | salt | | 1 | AO1<br>5.4.2.1<br>5.4.2.2 |
| **01.4** | sodium hydroxide | | 1 | AO2<br>5.4.2.2 |
| **01.5** | CuO | | 1 | AO2<br>5.1.1.1 |
| **01.6** | any **one** from:<br>• increase the concentration of the acid<br>• increase the surface area of the copper oxide<br>• warm / heat the mixture | allow use powdered copper oxide<br>ignore increase room temperature<br><br>allow add catalyst<br><br>ignore stir | 1 | AO1<br>5.4.2.2<br>5.4.2.3<br>RPA8 |
| **01.7** | in excess | | 1 | AO1<br>5.1.1.2<br>5.4.2.3<br>RPA8 |

### 5.4.1.1 Metal oxides

**Answer 03 · Mark scheme**



| | | | | |
|---|---|---|---|---|
| **01.8** |  | | 1 | AO1<br>5.1.1.2<br>5.4.2.3<br>RPA8 |

| | | | | |
|---|---|---|---|---|
| **01.9** | crystallisation | allow evaporation | 1 | AO1<br>5.4.2.2<br>5.4.2.3<br>RPA8 |

| | | | |
|---|---|---|---|
| **Total** | | | **9** |

### 5.4.1.1 Metal oxides

**Answer 03 · Mark scheme**

November 2020 | 8464/C/1F | Original Q1

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|

### 5.4.1.1 Metal oxides

**Answer 04 · Mark scheme** November 2020 | 8464/C/1F | Original Q6

| | | | | |
|---|---|---|---|---|
| **06.1** | 13<br><br>14 | this order only | 1<br><br>1 | AO2<br>5.1.1.4<br>5.1.1.5 |
| **06.2** | loss of oxygen | allow ($Al^{3+}$) gain of electrons<br><br>allow aluminium oxide loses oxygen | 1 | AO1<br>5.4.1.1<br>5.4.1.3 |
| **06.3** | <br><br>(at high temperature) oxygen reacts with carbon / electrode<br><br>(so the positive) electrode burns / wears away<br><br>to produce carbon dioxide | allow anode for (positive) electrode<br><br><br><br><br><br>$C + O_2 \rightarrow CO_2$ scores MP1 and MP3 | <br><br>1<br><br><br><br>1<br><br>1 | <br><br>AO1<br>5.4.3.1<br>5.4.3.2<br>5.4.3.3 |
| **06.4** | (delocalised) electron(s)<br><br>ion(s)<br><br>(delocalised) electron(s) | | 1<br><br>1<br><br>1 | AO1<br><br>AO2<br><br>AO1<br><br>5.2.2.3<br>5.2.2.8<br>5.2.3.2 |
| **Total** | | | **9** | |

### 5.4.1.1 Metal oxides

**Answer 04 · Mark scheme**

November 2020 | 8464/C/1F | Original Q6

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|

5.4.1.1 Metal oxides

Answer 05 · Mark scheme

November 2020 | 8464/C/1F | Original Q8

| | | | |
|---|---|---|---|
| 08 | **Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced. | 5–6 | AO3 |
| | **Level 2:** The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced. | 3–4 | 5.3.1.3<br>5.4.2.2 |
| | **Level 1**: The method would not lead to a valid outcome.<br>Some relevant steps are identified, but links are not made clear. | 1–2 | |
| | **No relevant content** | 0 | |
| | **Indicative content:**<br><br>• weigh test tube<br>• add metal carbonate<br>• weigh test tube and metal carbonate<br><br>• heat<br>• allow to cool<br>• weigh test tube and metal oxide<br>• repeat (heat, cool and weigh) until no change in mass<br><br>• determine mass of metal carbonate used<br>• determine mass of carbon dioxide produced<br><br>• repeat with different metal carbonate(s)<br><br>an alternative method can be based on any mass of metal carbonates and at end divide by this mass to find mass carbon dioxide per gram metal carbonate<br><br>level 3 change in mass is determined for at least one other carbonate | | |

| | | | |
|---|---|---|---|
| **Total** | | | **6** |

5.4.1.1 Metal oxides

Answer 06 · Mark scheme

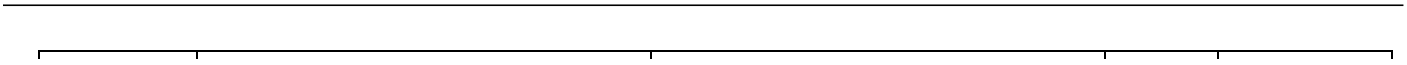
November 2021 | 8464/C/1F | Original Q1

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **01.1** | a metal and a non-metal | | 1 | AO1<br>5.1.2.1<br>5.1.2.3<br>5.3.1.1 |
| **01.2** | magnesium + chlorine → magnesium chloride | allow Mg for magnesium<br>allow $Cl_2$ for chlorine<br>allow $MgCl_2$ for magnesium chloride | 1 | AO2<br>5.1.1.1<br>5.1.2.6 |
| **01.3** | balance | | 1 | AO1<br>5.3.1.3 |
| **01.4** | more than 1.0 g | | 1 | AO3<br>5.3.1.3<br>5.4.1.1 |
| **01.5** | (% =) $\frac{24}{40} \times 100$<br>= 60 (%) | | 1<br>1 | AO2<br>5.3.1.2 |
| **01.6** | the student heated the magnesium carbonate for less than ten minutes | | 1 | AO3<br>5.3.1.3 |
| **01.7** | $\frac{0.97 + 0.91 + 0.95}{3}$ **or** $\frac{2.83}{3}$<br>= 0.943333 (g)<br>= 0.94 (g) | allow for **1** mark<br>$\frac{0.97 + 0.91 + 0.50 + 0.95}{4}$ **or** $\frac{3.33}{4}$<br>= 0.8325 (g)<br>allow an answer correctly rounded to 2 significant figures using values from the table | 1<br>1<br>1 | AO3<br>AO2<br>AO2<br>5.3.1.3 |
| **Total** | | | **10** | |

### 5.4.1.1 Metal oxides

**Answer 06 · Mark scheme**

November 2021 | 8464/C/1F | Original Q1



### 5.4.1.1 Metal oxides

**Answer 07 · Mark scheme** November 2021 | 8464/C/1F | Original Q7

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **07.1** | green to red | | 1 | AO1<br>5.4.2.4 |
| **07.2** | decreases | | 1 | AO1<br>5.4.2.4 |
| **07.3** | (aq) | allow aq<br><br>ignore aqueous<br><br>ignore $HNO_3$ | 1 | AO1<br>5.2.2.2 |
| **07.4** | any **two** from:<br>• (white) solid disappears<br>• fizzing **or** bubbles (of gas) **or** effervescence<br>• (then) stops fizzing<br>• (white) solid left at the end / bottom | <br><br><br>allow a gas is produced<br><br><br><br>ignore colourless solution | 2 | AO3<br>5.4.2.2<br>5.4.2.3 |
| **07.5** | $Zn(NO_3)_2$ | | 1 | AO2<br>5.1.1.1<br>5.4.2.2 |

5.4.1.1 Metal oxides

Answer 07 · Mark scheme

November 2021 | 8464/C/1F | Original Q7

| Question | Answers | Mark | AO / Spec. Ref. |
|---|---|---|---|
| 07.6 | **Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced. | 5–6 | AO1<br>5.4.2.2<br>5.4.2.3<br>RPA8 |
| | **Level 2:** The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced. | 3–4 | |
| | **Level 1:** The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear. | 1–2 | |
| | **No relevant content** | 0 | |
| | **Indicative Content:**<br>• react hydrochloric acid<br>• (with) copper oxide<br>• in a suitable container<br>• warm (hydrochloric) acid<br>• add copper oxide<br>• until is in excess<br>**or**<br>until solid remains<br>• stir<br>• filter excess copper oxide<br>• pour solution / filtrate into evaporating basin<br>• use of water bath<br>**or**<br>use of electric heater<br>• to heat gently<br>**or**<br>partially evaporate<br>• leave to cool / crystallise<br>For level 3 the correct chemicals must have been selected. | | |
| **Total** | | **12** | |

5.4.1.1 Metal oxides

Answer 08 · Mark scheme

June 2022 | 8464/C/1F | Original Q4

## Question 4

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **04.1** | **2** Mg + $O_2$ → 2 MgO | allow multiples | 1 | AO2<br>5.1.2.5<br>5.4.1.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **04.2** | any **one** from:<br>• wear safety glasses / goggles<br>• do not look directly at burning magnesium<br>• wear heat proof glove | allow look through blue glass<br><br>allow use tongs<br>allow tie hair back | 1 | AO3<br>5.4.1.1<br>5.4.1.2<br>5.5.1.1 |

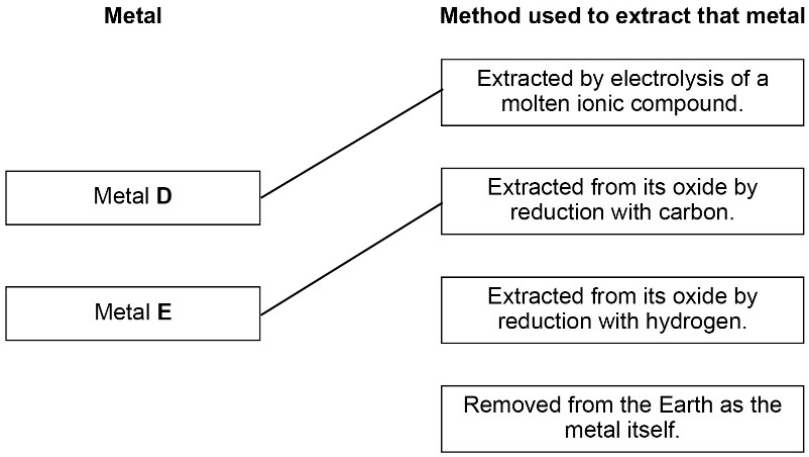
| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **04.3** | ($M_r$ = ) 24 + (2 × 19)<br><br>= 62 | | 1<br><br>1 | AO2<br>5.1.2.5<br>5.3.1.2 |

5.4.1.1 Metal oxides

Answer 08 · Mark scheme

June 2022 | 8464/C/1F | Original Q4

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.4 | any **one** from:<br>• argon has a full outer shell<br>• argon has 8 electrons in the outer shell<br>• argon has a stable arrangement of electrons. | allow energy level for shell<br><br>allow does not need to lose and / or gain electrons | 1 | AO2 |
| | (so) argon is unreactive | ignore argon is a noble gas | 1 | AO1<br>5.1.2.4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.5 | <br>do **no**t accept more than one line from a box on the left | | 1<br><br>1 | AO3<br>5.4.1.2<br>5.4.1.3<br>5.4.3.1<br>5.4.3.2<br>5.4.3.3 |

5.4.1.1 Metal oxides

Answer 08 · Mark scheme



| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.6 | (because) ions<br><br>(which are) free to move when molten<br><br>(but are) fixed in solid | <br><br><br><br><br>allow reference to charged particles for MP2 and MP3 | 1<br><br>1<br><br>1 | AO1 5.2.2.3 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.7 | (sodium contains) delocalised electrons<br><br>(which) carry (electrical) charge (through the metal / sodium) | allow free electrons<br><br>ignore throughout for through<br><br>ignore current / electricity | 1<br><br>1 | AO1 5.2.2.8 |

| Total Question 4 | | 13 |
|---|---|---|

5.4.1.1 Metal oxides

Answer 09 · Mark scheme

June 2023 | 8464/C/1F | Original Q5

## Question 5

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.1** | energy / electricity | | 1 | AO1<br>5.4.3.1<br>5.4.3.3 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.2** | carbon dioxide | | 1 | AO1<br>5.4.3.1<br>5.4.3.3 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.3** | sodium reacts with air / oxygen<br>**or**<br>sodium is highly reactive | allow titanium (chloride) reacts with air / oxygen | 1 | AO3<br>5.1.2.5<br>5.4.1.2 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.4** | argon | | 1 | AO3<br>5.1.2.4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.5** | $TiCl_4 + 4\,Na \longrightarrow Ti + \mathbf{4}\,NaCl$ | allow multiples | 1 | AO2<br>5.1.1.1<br>5.4.1.2 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.6** | 4.4 (g) | | 1 | AO2<br>5.3.1.1<br>5.3.1.3 |

5.4.1.1 Metal oxides

Answer 09 · Mark scheme

June 2023 | 8464/C/1F | Original Q5

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 05.7 | (the) mass decreased<br><br>(because) carbon dioxide escapes (into the atmosphere) | <br><br>allow (because) carbon dioxide is a gas<br><br>allow (because) a gas is produced | 1<br><br>1 | AO2<br>5.3.1.1<br>5.3.1.3 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 05.8 | the copper oxide is reduced<br><br>(reason)<br>(copper oxide) loses oxygen | | 1<br><br>1 | AO2<br>5.4.1.3 |

| Total Question 5 | 10 |
|---|---|

5.4.1.1 Metal oxides

Answer 10 · Mark scheme

June 2023 | 8464/C/2F | Original Q4

## Question 4

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **04.1** | hydrogen peroxide → water + oxygen | allow $H_2O_2$ for hydrogen peroxide<br>allow $H_2O$ for water<br>allow $O_2$ for oxygen | 1 | AO2<br>5.6.1.4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **04.2** | mass of catalyst<br><br>volume of hydrogen peroxide solution | | 1<br><br>1 | AO3<br>5.6.1.4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **04.3** | all points plotted correctly<br><br><br><br>line of best fit | allow a tolerance of ± ½ a small square<br>allow at least 3 points plotted correctly for **1** mark | 2<br><br><br><br>1 | AO2<br>5.6.1.4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **04.4** | manganese dioxide<br><br>any **one** from:<br>• steepest curve<br>• reaction finishes first<br>• greatest volume of oxygen (in given time) | allow ecf from question **04.3** | 1<br><br>1 | AO3<br>5.6.1.4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **04.5** | accurate | | 1 | AO1<br>5.6.1.4 |

### 5.4.1.1 Metal oxides

**Answer 10 · Mark scheme**



| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **04.6** | increase | | 1 | AO1<br>5.6.1.2<br>5.6.1.3<br>5.6.1.4 |

| | |
|---|---|
| **Total Question 4** | **10** |

5.4.1.1 Metal oxides

Answer 11 · Mark scheme

June 2024 | 8464/C/1F | Original Q5

## Question 5

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.1** | hydrogen | | 1 | AO1<br>5.4.1.2<br>5.4.2.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.2** | $MgCl_2(l)$ | | 1 | AO2<br>5.1.1.1<br>5.2.2.2 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.3** | (negative electrode) magnesium | allow Mg | 1 | AO2<br>5.4.3.1<br>5.4.3.2 |
| | (positive electrode) chlorine | allow $Cl_2$ | 1 | |
| | | allow **1** mark if both elements are reversed | | |

### 5.4.1.1 Metal oxides

**Answer 11 · Mark scheme**



| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.4** | (most reactive metal)<br>magnesium<br>(iron)<br>copper<br>(least reactive metal)<br><br>any **two** from:<br><br>• magnesium reacts with both copper chloride solution and iron chloride solution<br><br>• iron only reacts with copper chloride solution<br><br>• copper does not react with either magnesium chloride solution or iron chloride solution | <br>allow Mg<br>allow Fe<br>allow Cu<br><br><br><br>allow magnesium has two / most reactions<br><br>allow iron has one reaction<br><br>allow copper does not react | <br>1<br><br><br>2 | AO3<br>5.4.1.2 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.5** | 1.6 (g) | | 1 | AO2<br>5.4.3.1<br>5.4.3.2 |

5.4.1.1 Metal oxides

Answer 11 · Mark scheme

June 2024 | 8464/C/1F | Original Q5

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 05.6 | (conversion 30.0 $cm^3$ =) 0.030 $dm^3$ | | 1 | AO2 5.3.2.5 |
| | (mass =) 0.030 × 180 | allow correct use of incorrect / no conversion of volume | 1 | |
| | = 5.4 (g) | | 1 | |
| | **OR** | | | |
| | 1000 $cm^3$ contains 180 g $MgCl_2$ (1) | | | |
| | 30 $cm^3$ contains $\frac{180}{1000}$ × 30 (g) (1) | | | |
| | (30 $cm^3$ contains) 5.4 (g) (1) | | | |
| | **OR** | | | |
| | (ratio of volume $\frac{1000}{30}$ =) 33.3 (1) | | | |
| | (so ratio of mass) = $\frac{180}{33.3}$ (1) | | | |
| | = 5.4 (g) (1) | | | |

| Total Question 5 | 11 |
|---|---|

5.4.1.1 Metal oxides

Answer 12 · Mark scheme

June 2025 | 8464/C/1F | Original Q4

## Question 4

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.1 | compounds | | 1 | AO1 5.4.1.3 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.2 | iron is less reactive than carbon | | 1 | AO1 5.4.1.3 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.3 | to reduce the amount of energy used | | 1 | AO1 5.4.3.3 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.4 | the electrodes react with oxygen gas | | 1 | AO1 5.4.3.3 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.5 | the alloy is harder than the pure metal | | 1 | AO1 5.2.2.7 |

### 5.4.1.1 Metal oxides

Answer 12 · Mark scheme

June 2025 | 8464/C/1F | Original Q4

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **04.6** | (melting point of alloy) decreases | | 1 | AO2 5.2.2.7 |
| | until 70% (silver) | allow a value in the range 69% to 71% | 1 | |
| | **or** | | | |
| | until 530 °C | allow a value in the range 520 °C to 540 °C | | |
| | then (melting point) increases | | 1 | |
| | | if no other mark awarded, allow **1** mark for (melting point) increases from 660 °C to 960 °C **or** (melting point) increases by 300 °C | | |

| | |
|---|---|
| **Total Question 4** | **8** |

5.4.1.1 Metal oxides

Answer 01 · Examiner comments — June 2018 | 8464/C/1F | Original Q3

## Question 3 (low & standard demand)

No reportable questions.

Answer 06 · Examiner comments — November 2021 | 8464/C/1F | Original Q1

### Question 1 (low and standard demand)

**01.1** Most students knew that magnesium reacting with chlorine is an example of a metal reacting with a non-metal.

**01.2** Approximately two thirds of students were able to construct a word equation from the information supplied in the question.

**01.3** Approximately two thirds of students knew that a balance is used to measure 1.0 g of magnesium.

**01.4** Nearly half of students deduced that more than 1.0 g of magnesium chloride is formed when 1.0 g of magnesium reacts with chlorine.

**01.5** Just under one third of students gained two marks for correctly calculating the percentage of magnesium in magnesium oxide.

**01.6** More than half of students deduced that the anomalous result is explained when the student heated the magnesium carbonate for less than ten minutes. ‘The student used a higher temperature’ was a strong distractor.

**01.7** Approximately one quarter of students gained three marks for correctly calculating the mean and just under one third of students incorrectly included the anomalous result in their mean. A few did not give their answer to two significant figures.

5.4.1.1 Metal oxides

Answer 07 · Examiner comments

November 2021 | 8464/C/1F | Original Q7

**Question 7 (standard demand)**

**07.1** Approximately one quarter of students were able to give the colour change, 'green to red', as the observed change when nitric acid is added to a mixture of universal indicator and water.

**07.2** Many students appeared to confuse the increase in acidity when nitric acid is added to water with an increase in pH, which proved to be a strong distractor.

**07.3** Very few students were able to give (aq) as the state for a substance dissolved in water.

**07.4** The required practical activity of making a soluble salt starts by reacting either an insoluble metal oxide or metal carbonate with an acid. The word equation was provided to help students with this question although many students found difficulty in making links between this and the resulting observations. Since carbon dioxide is produced, initial observations would be fizzing and white solid disappearing. Excess zinc carbonate would result in all the nitric acid reacting; fizzing would stop and excess solid would collect at the bottom. Just under one fifth of students gained a mark.

**07.5** $Zn_2NO_3$ proved a more commonly seen response than $Zn(NO_3)_2$, the correct answer. Just under one quarter of students answered this correctly.

**07.6** Students had difficulty in describing the essential steps of the method of making a soluble salt from an insoluble metal oxide and an acid. Most failed to select the correct chemicals, copper oxide and hydrochloric acid, without these the method would not lead to a valid outcome. Just under one third of students gave a level one answer and very few got into level two.

5.4.1.1 Metal oxides

Answer 07 · Examiner comments

November 2021 | 8464/C/1F | Original Q7

**Concluding Remarks**

The demand of this paper was similar to those previously set for this specification. Students should note that two-mark questions require two answer points and so on.

15% of marks are based upon the required practical activities; students should question 'what and why' is happening in each step of these procedures. Answers should be chemically accurate, e.g. crystals are produced from salt solutions when the solution is heated (partially evaporated to produce a more concentrated solution) and then left to crystallise, rather than implying that 'all the water was evaporated'.

In chemistry 20% are marks are for questions assessing mathematical skills. In these questions, students should show their working for each step. If an error is made, such as an incorrect evaluation of values in the question, credit can be awarded for each correct step shown. Students should be encouraged to think about their answers; in **01.5** a small number gave percentages in excess of 100. In **01.7** students did not always disregard the anomalous result but were able to get a mark for the correct division of all four values. A few were unable to give the answer to two significant figures. In **02.6** students needed to use all the data provided and to use the ratio of volumes to evaluate the mass. In **04.4** a minority of students multiplied, rather than adding, the relative atomic masses. In **06.5** not all students used all the data provided to evaluate the relative atomic mass, a weighted mean of the mass numbers.

5.4.1.1 Metal oxides

Answer 07 · Examiner comments



**Mark Ranges and Award of Grades**

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

5.4.1.1 Metal oxides

Answer 08 · Examiner comments — June 2022 | 8464/C/1F | Original Q4

**Question 4 (Low and standard demand)**

04.1 More than 70% of students correctly balanced the equation. Some students changed the formula, usually from MgO to $MgO_2$

04.2 Almost three-quarters of students stated a safety precaution that should be taken when heating magnesium and oxygen. The most common correct responses were to wear eye protection and to use tongs.

04.3 Almost one-quarter of students gave the correct answer for the relative formula mass of magnesium fluoride. These students recognised that the subscript 2 means the relative atomic mass of fluorine needed to be doubled before being added to the relative atomic

Answer 08 · Examiner comments — June 2022 | 8464/C/1F | Original Q4

mass of magnesium. Many showed clear steps in their calculation. The most common errors were to either add or multiply 24 and 19.

04.4 Magnesium does not react when heated with argon - argon is unreactive because argon atoms have eight electrons in the outer shell. Common responses referred to magnesium (and argon) both being unreactive, that metals (or solids) do not react with gases or that both elements had full outer shells. This question discriminated well.

04.5 Almost 60% of students gained at least one of the two marks for correctly deducing the method used to extract a metal. The students were given a reactivity series showing the position of these two metals compared to other known metals, carbon and hydrogen.

04.6 Students found difficulty in explaning why sodium chloride conducts electricity when molten but not when a solid. Many indicated that this was due to something being able to move but failed to link this to ions or charged particles. Most referred to moving particles, atoms or electrons.

04.7 Students also found difficulty in explaning why sodium conducts electricity when solid. Delocalised electrons were rarely seen as was the concept of these delocalised electrons carrying charge through the sodium.

### 5.4.1.1 Metal oxides

**Answer 09 · Examiner comments** June 2023 | 8464/C/1F | Original Q5

**Question 5 (low/standard demand)**

05.1 More than a third of students knew that the extraction of aluminium is expensive because the process uses large amounts of energy. Heat was a very common response that was insufficient to gain credit.

05.2 More than 50% of students knew that carbon dioxide is produced when oxygen reacts with the positive carbon electrodes when aluminium is extracted by electrolysis from a molten mixture of aluminium oxide and cryolite.

05.3 Only a very small number of students were able to suggest that when titanium was extracted from a mixture of titanium chloride and sodium an inert atmosphere was essential to prevent the sodium reacting with air.

05.4 A third of students knew that argon is used for the inert atmosphere when titanium is extracted from a mixture of titanium chloride and sodium.

05.5 Just over half of the students correctly balanced the equation for the reaction of sodium with titanium chloride. Students should be aware that they should not change the formula of the compounds in the equation.

05.6 Students should know that the law of conservation of mass states that the mass of reactants equals to the mass of products. In this experiment the mass of carbon dioxide produced equals the difference between the sum of the mass of copper oxide and carbon (reactants) minus the mass of copper produced (other product). Only 20% of students calculated this correctly.

05.7 Students were asked to explain why the mass of a mixture of copper oxide and carbon in a crucible changed when the mixture was heated. Few students recognised that the mass would decrease because the carbon dioxide produced is a gas that escapes into the atmosphere. The term evaporation was incorrectly used by a large number of students. Only a small number of students gained two marks.

05.8 This question asked what happens to copper oxide in the reaction between copper oxide and carbon. Students should be careful with their use of technical terms as many incorrectly stated that ‘copper’ loses oxygen. Approximately 30% of students knew that copper oxide was reduced but very few students were then able to give a reason why.

**Answer 10 · Examiner comments** June 2023 | 8464/C/2F | Original Q4

**Question 4**

04.1 Around two thirds of students were able to extract the necessary information to write a word equation. Where they found difficulty was when they attempted to write a formula instead of the word.

5.4.1.1 Metal oxides

**Answer 10 · Examiner comments**

June 2023 | 8464/C/2F | Original Q4

04.2 Only a quarter of students successfully identified two control variables. Over half of the students identified one of the control variables. Once again, it is worth noting that several students ticked only one box. Students must be encouraged to read the question carefully.

04.3 A quarter of students gained all three marks for plotting the graph and drawing a curve of best fit. A further two fifths plotted all the points correctly but, drew a straight line of best fit. Fewer than one in ten students gained one mark for plotting at least three points correctly. Students need to be exposed to as many examples as possible of lines of best fit that are not straight lines.

04.4 Just over a third of students either used their graphs or the lines given to choose the best catalyst and explain why for two marks. It should be noted that the mark scheme was looking for the steepest, greatest etc. A simple comparative was insufficient to get the mark as there were three lines being compared. A similar number gained one mark for identifying manganese dioxide as the best catalyst.

04.5 Just over a third of students knew the definition of accurate, with the most common incorrect response being approximate.

04.6 Over four in five students were able to identify that the rate increased with an increase in temperature.

Answer 11 · Examiner comments

June 2024 | 8464/C/1F | Original Q5

# Question 5 (low demand)

**05.1** Just over two thirds of students knew that hydrogen gas is produced when a metal reacts with an acid. A quarter of students selected the distractor nitrogen.

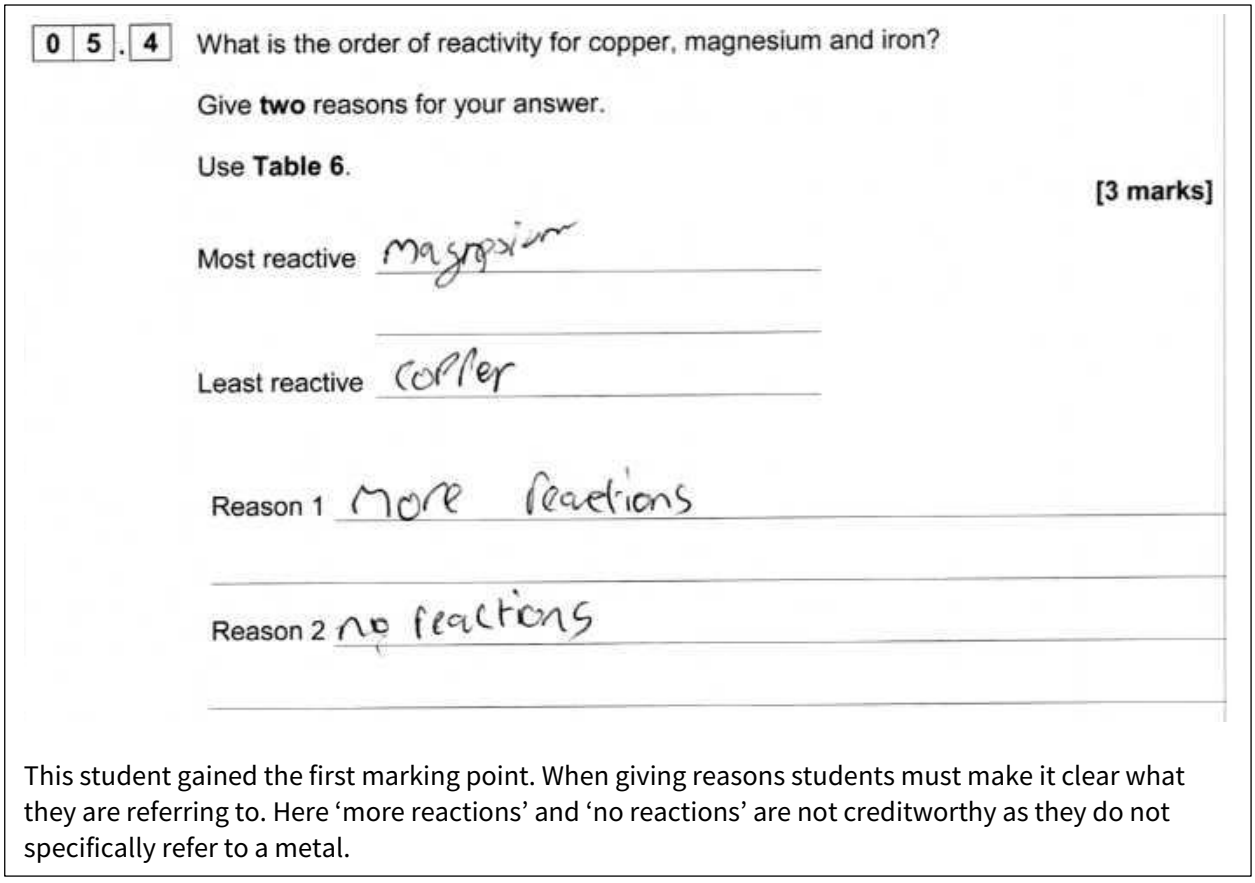
**05.2** Nearly two-thirds of students knew molten magnesium chloride is a liquid, which is represented by the state symbol (l). A quarter of students incorrectly selected (g) as the state symbol.

**05.3** 10% of students gained both marks and students were awarded 1 mark if both elements were correct but reversed. Chlor*ide* is not creditworthy although was a common response.

Many students wrote the formula of the ions that were attracted to the electrodes rather than the element that is discharged. Nearly 20% of students did not attempt this question.

**05.4** More than half of students gained 2 or 3 marks for correctly deducing the order of reactivity, with magnesium being the most reactive and copper the least reactive and giving one or two reasons. Students were able to give a reason associated with each metal eg iron only reacts with copper chloride solution or copper does not react.

Common incorrect responses included magnesium reacts with both metals (rather than both metal chloride solutions) or reasons which were not clearly linked to a metal (see example below).



0 5 . 4 What is the order of reactivity for copper, magnesium and iron?

Give **two** reasons for your answer.

Use **Table 6**.

**[3 marks]**

Most reactive magnesium

Least reactive copper

Reason 1 More reactions

Reason 2 no reactions

This student gained the first marking point. When giving reasons students must make it clear what they are referring to. Here 'more reactions' and 'no reactions' are not creditworthy as they do not specifically refer to a metal.

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### 5.4.1.1 Metal oxides

**Answer 11 · Examiner comments** June 2024 | 8464/C/1F | Original Q5

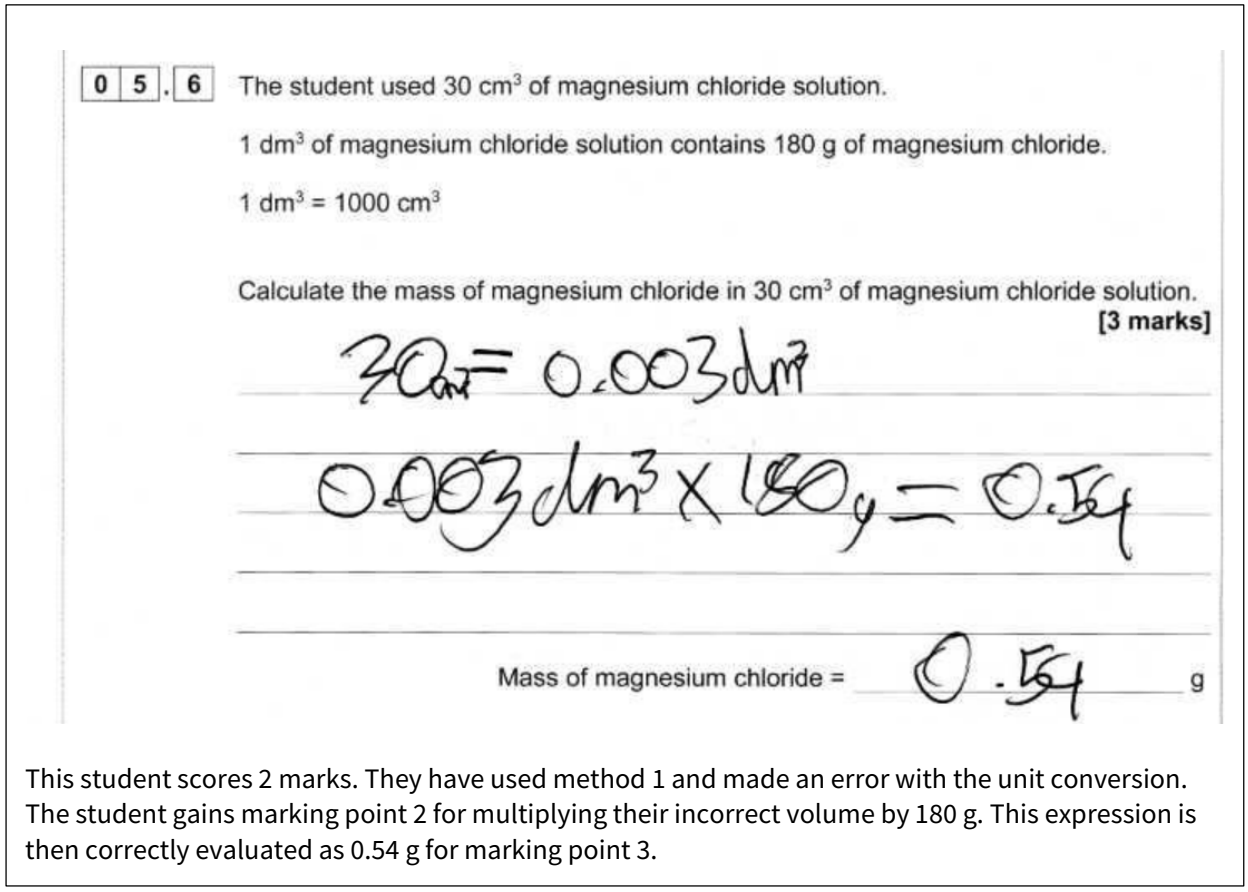
**05.5** The law of conservation of mass states that the mass of reactants equals the mass of products. In this question a third of students correctly evaluated that the mass of iron oxide that reacts with 0.72 g of magnesium.

Common incorrect responses were 1.67 (multiplying 0.72 by 2.32) together with 3.2 and 0.31 (evaluated by dividing 2.32 by 0.72 or 0.72 by 2.32 respectively).

**05.6** This question required a unit conversion as data is given in $dm^3$ and needed to be converted to $cm^3$. This conversion factor was given to lower the demand of the question.

Nearly 30% of students gained all 3 marks. Approximately 10% of students gained 2 marks usually for either not using the conversion factor, for multiplying rather than dividing by 1000 or for using an incorrect factor (eg dividing by 100 rather than 1000). A further 10% of students who gained 1 mark usually calculated the volume correctly in $dm^3$ but then did not multiply their answer by 180 g or used method 3 in the mark scheme and calculated the ratio of volume as 33.3 but then incorrectly multiplied this by 180 g.

17% of students did not attempt this question.



0 5 . 6 The student used 30 $cm^3$ of magnesium chloride solution.

1 $dm^3$ of magnesium chloride solution contains 180 g of magnesium chloride.

1 $dm^3$ = 1000 $cm^3$

Calculate the mass of magnesium chloride in 30 $cm^3$ of magnesium chloride solution.

**[3 marks]**

30 cm³ = 0.003 dm³

0.003 dm³ × 180 g = 0.54

Mass of magnesium chloride = 0.54 g

This student scores 2 marks. They have used method 1 and made an error with the unit conversion. The student gains marking point 2 for multiplying their incorrect volume by 180 g. This expression is then correctly evaluated as 0.54 g for marking point 3.

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Answer 12 · Examiner comments

June 2025 | 8464/C/1F | Original Q4

# Question 4 (Low demand)

**04.1** Half the students were able to select the word from the box to complete the sentence that most metals are found in the Earth as compounds. Elements was the common incorrect distractor. Credit was awarded if the student identified the correct answer in the box.

**04.2** Half the students knew that iron is extracted from iron oxide by reduction with carbon because iron is less reactive than carbon. A third of students selected the incorrect converse response that iron is more reactive than carbon.

**04.3** Less than half of students knew that cryolite is added to aluminium oxide to reduce the amount of energy used in the extraction of aluminium from aluminium oxide by electrolysis. The most popular incorrect distractor was to reduce the rate of reaction.

**04.4** In the extraction of aluminium from aluminium oxide by electrolysis the positive electrodes need to be replaced. Fewer than 20% of students knew that this is because the electrodes react with oxygen gas. The other three options were all more popular. The electrodes react with aluminium was the most common incorrect response.

**04.5** Just under half of students recalled that an alloy is harder than a pure metal. The converse statement an alloy is less hard than a pure metal was the most popular incorrect distractor.

**04.6** When describing trends in graphs examiners are looking for students to state how the change in the *x*-axis (an increase in the independent variable) affects the value plotted on the *y*-axis (the dependent variable). In figure 9 as the percentage of silver in the mixture (*x*-axis) increased the melting point (*y*-axis) decreased. However, there was a marked change in the trend at 70% silver (where the curve was a minimum) after which the melting point increased. Students may have realised how the 3 marks were allocated. Examiners were not looking for a description of the rate of changes e.g. a sharp increase after 70% silver. Some students were careless with their terminology referring to the percentage of aluminium not silver and the boiling point of the alloy. A third of students gained all 3 marks. Many were awarded 1 mark usually for the initial decrease in melting point.

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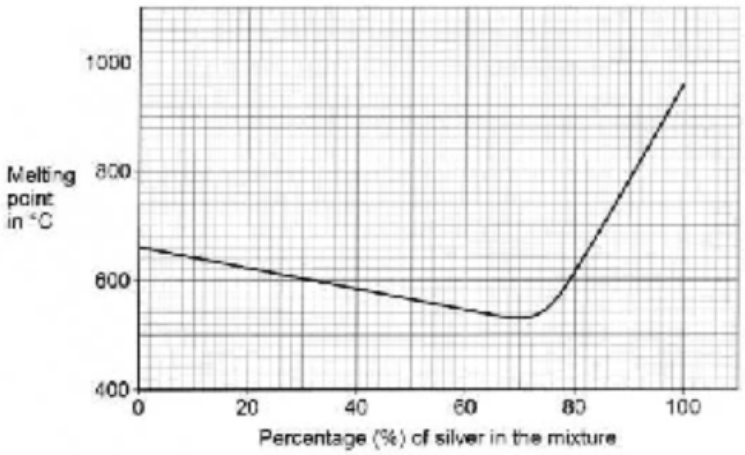
### 5.4.1.1 Metal oxides

**Answer 12 · Examiner comments** June 2025 | 8464/C/1F | Original Q4

0 4 . 6 Aluminium can form an alloy with silver.

**Figure 9** shows how the melting point of the alloy changes with the percentage (%) of silver in the mixture.

**Figure 9**




Describe how the melting point of the alloy changes as the percentage of silver in the mixture increases.

Use data from **Figure 9**.

**[3 marks]**

the melting point decreases as the percentage of silver increases, however once the mixture is over 70% the melting point significantly increases.

All 3 marking points were awarded. The student has described an initial decrease (in melting point), followed by an increase and has also indicated the point at which the change occurs.

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