AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.3.1.2

# Changes of state

## Mark schemes and examiner comments

| | |
|---|---|
| Tier | **Foundation** |
| Question groups | **6** |
| 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.

6.3.1.2 Changes of state

Answer 01 · Mark scheme

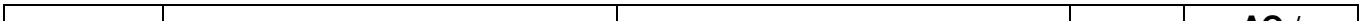
June 2018 | 8464/P/1F | Original Q4

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.1 | (casing is) not made of metal<br><br>little / no chance of electric shock | allow (casing is) made of plastic<br>allow they are double insulated | 1<br><br>1 | AO3<br>6.2.3.2 |
| 04.2 | charge flow = current × time | allow the equation given in symbols | 1 | AO1<br>6.2.1.2 |
| 04.3 | Q = 2.95 × 60<br><br>Q = 177 (C) | an answer of 177 scores **2** marks<br><br>allow 180 (C) | 1<br><br>1 | AO2<br>6.2.1.2 |
| 04.4 | straight line with a different positive gradient<br><br>straight line with positive gradient through the origin | must go through the first and third quadrant | 1<br><br>1 | AO1<br>6.2.1.4 |
| 04.5 |  | | 1 | AO1<br>6.2.1.1 |
| 04.6 | the particles vibrate about a fixed position regular arrangement<br><br>(the particles change) to being free to move around | allow the particles are in a regular arrangement<br><br>allow correct description of translational kinetic energy | 1<br><br>1 | AO1<br>6.3.1.1 |
| 04.7 | <br><br>L = 200 000 (J/kg)<br><br>E = 500 × 200 000<br><br>E = 100 000 000 (J) | an answer of 100 000 000 scores **3** marks<br><br><br>allow $1 \times 10^8$ (J)<br><br>allow correct calculation for incorrect conversion or no conversion of L for **2** marks | <br><br>1<br><br>1<br><br>1 | AO2<br>6.3.2.3 |
| **Total** | | | **13** | |

### 6.3.1.2 Changes of state

**Answer 01 · Mark scheme**

June 2018 | 8464/P/1F | Original Q4



### 6.3.1.2 Changes of state

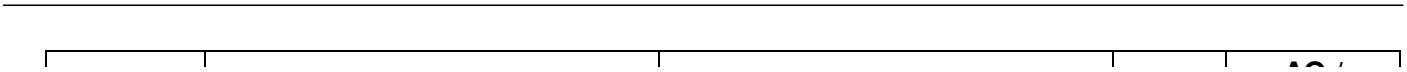
**Answer 02 · Mark scheme** June 2018 | 8464/P/1F | Original Q5

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / Spec. Ref.</th></tr>
<tr><td>05.1</td><td>gamma</td><td></td><td>1</td><td>AO1<br>6.4.2.1</td></tr>
<tr><td>05.2</td><td>alpha</td><td></td><td>1</td><td>AO1<br>6.4.2.1</td></tr>
<tr><td>05.3</td><td>gamma</td><td></td><td>1</td><td>AO1<br>6.4.2.1</td></tr>
<tr><td>05.4</td><td><table><tr><th>isotope</th><th>number of neutrons</th><th>number of protons</th></tr><tr><td>uranium-238</td><td>146</td><td>92</td></tr><tr><td>thorium-234</td><td>144</td><td>90</td></tr></table></td><td></td><td>1<br>1</td><td>AO2<br>6.4.1.2</td></tr>
<tr><td>05.5</td><td>$\Delta\theta = 80\ ^\circ C$<br>$E = 150 \times 4200 \times 80$<br>$E = 50\ 400\ 000$ (J)</td><td>an answer of 50 400 000 scores 3 marks<br><br><br>allow 50 000 000 (J)<br><br>allow max 2 marks for correct calculation using incorrect value of $\Delta\theta$<br><br>allow 1 mark for correct calculation using $\theta = 20$ or $\theta = 100$</td><td><br>1<br>1<br>1</td><td>AO2<br>6.3.2.2</td></tr>
<tr><td>Total</td><td></td><td></td><td>8</td><td></td></tr>
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### 6.3.1.2 Changes of state

**Answer 02 · Mark scheme**

June 2018 | 8464/P/1F | Original Q5



### 6.3.1.2 Changes of state

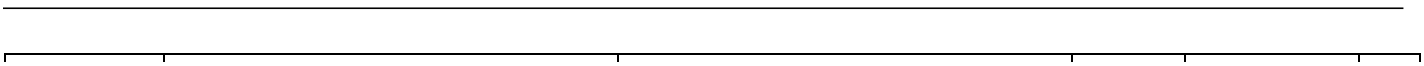
**Answer 03 · Mark scheme** June 2019 | 8464/P/1F | Original Q3

| Question | Answers | Extra information | Mark | AO / Spec. Ref. | ID |
|---|---|---|---|---|---|
| **03.1** | they changed direction | allow deflected/reflected/repelled | 1 | AO 1/1<br>6.4.1.3 | E |
| **03.2** | diameter = $\frac{0.18}{6000}$<br>= 0.000 030 (nm) | an answer of 0.000 03 (nm) or $3.0 \times 10^{-5}$ (nm) scores **2** marks<br>allow $3.0 \times 10^{-5}$ (nm) | 1<br>1 | AO2/2<br>6.4.1.1 | E |
| **03.3** | A | | 1 | AO 1/1<br>6.4.1.1 | A |
| **03.4** | 1100 (°C) | | 1 | AO3/2b<br>6.3.2.3 | G |
| **03.5** | 8 (minutes) | allow 12 (minutes) | 1 | AO3/2b<br>6.3.2.3 | G |
| **03.6** | the rate of change of temperature of the gold | | 1 | AO3/1a<br>6.1.1.3, 6.3.2.2 | A |
| **Total** | | | **7** | | |

### 6.3.1.2 Changes of state

**Answer 03 · Mark scheme**

June 2019 | 8464/P/1F | Original Q3



### 6.3.1.2 Changes of state

**Answer 04 · Mark scheme** June 2019 | 8464/P/1F | Original Q7

| Question | Answers | Extra information | Mark | AO / Spec. Ref. | ID |
|---|---|---|---|---|---|
| **07.1** | pressure decreased | | 1 | AO2.1 | E |
| | because molecules have less (kinetic) energy | allow less speed/velocity | 1 | 6.3.3.1 | |
| | so fewer collisions (with the wall/container each second) | allow collide with less force<br>allow less force on the walls | 1 | | |
| **07.2** | | an answer of 0.0021(212121…) scores **3** marks | | AO2.1<br>6.3.2.2 | E |
| | $0.70 = m \times 330$<br>**or**<br>$700 = m \times 330\,000$ | | 1 | 6.1.1.3 | |
| | $m = \frac{0.70}{330}$<br>**or**<br>$m = \frac{700}{330\,000}$ | allow correct rearrangement using converted value(s) of E to J and/or L to J/kg | 1 | | |
| | $m = 0.0021$ (kg) | allow 0.0021(212121…)<br>allow correct calculation using converted value(s) of E and/or L<br>**3** marks can only be awarded for m = 0.0021(212121…) (kg) | 1 | | |
| **07.3** | | | 2 | AO3/2b<br>6.3.1.1 | E |

| Substance | Solid | Liquid | Gas |
|---|---|---|---|
| Oxygen | | ✓ | |
| Nitrogen | | | ✓ |
| Carbon dioxide | ✓ | | |

2 correct answers scores **1** mark.
if more than one tick in a row, neither can score a mark

| | | | | |
|---|---|---|---|---|
| **07.4** | **Level 3:** Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account. | 5–6 | AO1.1<br>6.3.1.2 | E |
| | **Level 2:** Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear. | 3–4 | | |
| | **Level 1:** Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking. | 1–2 | | |
| | **No relevant content** | 0 | | |
| | **Indicative content**<br><br>cooling<br>• as the argon cools the particles slow down<br>• particles in a liquid move slower than particles in a gas<br>• particles in a solid move slower than particles in a liquid<br>• as the liquid/solid cools the particles get closer together<br>• as the liquid/solid cools the density increases<br><br>gas to liquid<br>• particles change from being spread apart to touching each other<br>• particles will (collide with other particles more often and) change direction more often<br><br>liquid to solid<br>• particles change from a random arrangement to a regular pattern<br>• particles change from moving freely to fixed positions<br>• particles change from moving freely/randomly to vibrating<br><br>explanation<br>• (internal) energy (of the argon) decreases<br>• (kinetic) energy (of the particles) decreases with temperature<br>• (potential) energy (of the particles) changes with change of state (of the argon)<br>• forces between particles in a gas are negligible/zero<br>• attractive forces act between atoms when they are close to each other<br>• attractive forces between particles are stronger in a solid than in a liquid<br><br>to access level 3 there must be an explanation of changes to arrangement and movement of particles during either cooling or a change of state | | | |

| | | | |
|---|---|---|---|
| **Total** | | | **14** |

6.3.1.2 Changes of state

Answer 05 · Mark scheme

June 2023 | 8464/P/1F | Original Q3

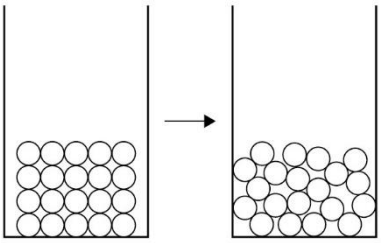
## Question 3

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 03.1 | $\Delta E = 4.0 \times 420 \times 50$<br><br>$\Delta E = 84\,000$ (J) | | 1<br><br>1 | AO2<br>6.1.1.3<br>6.3.2.2 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 03.2 | the total kinetic energy and potential energy of the steel particles | | 1 | AO1<br>6.3.2.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 03.3 | the particles are in fixed positions | | 1 | AO1<br>6.3.1.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 03.4 | stays the same | | 1 | AO1<br>6.3.1.2 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 03.5 |  | | 1 | AO1<br>6.3.1.1 |

Answer 05 · Mark scheme

June 2023 | 8464/P/1F | Original Q3

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **03.6** | (the space between the particles) increases | allow the particles move further apart | 1 | AO1<br>6.3.1.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **03.7** | physical | | 1 | AO1<br>6.3.1.2 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **03.8** | mass per kg = $\frac{18}{4.0}$<br><br>mass per kg = 4.5 g<br><br>medium carbon<br><br>**OR**<br><br>mass in 4.0 kg of medium carbon steel = 4.5 × 4.0 (1)<br><br>mass in 4.0 kg of medium carbon steel = 18 g (1)<br><br>medium carbon (1) | <br><br><br><br>dependent on MP2<br><br><br><br>allow mass in 4.0 kg of low carbon steel = 8 (g)<br>allow mass in 4.0 kg of high carbon steel = 28 (g)<br><br>dependent on MP1<br><br><br>dependent on MP2 | 1<br><br>1<br><br>1 | AO3<br>6.3.1.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **03.9** | 280 000 = 4.0 × *L*<br><br>$L = \frac{280\,000}{4.0}$<br><br>*L* = 70 000 (J/kg) | | 1<br><br>1<br><br>1 | AO2<br>6.3.2.3 |

| | |
|---|---|
| **Total Question 3** | **14** |

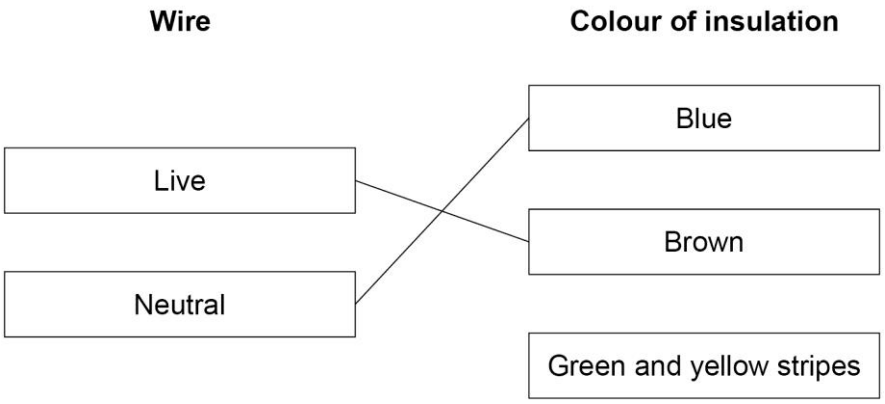
6.3.1.2 Changes of state

Answer 06 · Mark scheme

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

## Question 4

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **04.1** | 50 Hz | | 1 | AO1 6.2.3.1 |

| Question | Answers | Mark | AO / Spec. Ref. |
|---|---|---|---|
| **04.2** | <br>do **not** accept more than one line from a box on the left | 1<br>1 | AO1 6.2.3.2 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **04.3** | power = potential difference × current<br>**or**<br>$P = VI$ | | 1 | AO1 6.2.4.1 |

6.3.1.2 Changes of state

Answer 06 · Mark scheme



| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **04.4** | $2100 = 230 \times I$ | | 1 | AO2 6.2.4.1 |
| | $I = \frac{2100}{230}$ | | 1 | |
| | $I = 9.13\ldots$ | | 1 | |
| | $I = 9.1$ (A) | allow an answer calculated using the numbers from the question given to two significant figures | 1 | |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **04.5** | $18\,000 = 0.0080 \times L$ | | 1 | AO2 6.3.2.3 |
| | $L = \frac{18\,000}{0.0080}$ | | 1 | |
| | $L = 2\,250\,000$ (J/kg) | allow 2 300 000 | 1 | |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **04.6** | efficiency $= \frac{75\,600}{84\,000}$ | | 1 | AO2 6.1.2.2 |
| | efficiency = 0.9 | | 1 | |
| | **OR** | | | |
| | efficiency $= \frac{75\,600}{84\,000} \times 100$ (1) | | | |
| | efficiency = 90% (1) | | | |

### 6.3.1.2 Changes of state

**Answer 06 · Mark scheme**



| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.7 | less energy is wasted | allow power for energy throughout | 1 | AO1 |
| | (so) costs less to run<br>**or**<br>(so) uses less electricity / energy | allow so the appliance is used for less time | 1 | AO2<br><br>6.1.2.1<br>6.1.2.2<br>6.2.4.2 |

| Total Question 4 | 15 |
|---|---|

6.3.1.2 Changes of state

Answer 03 · Examiner comments — June 2019 | 8464/P/1F | Original Q3

## Question 3

**03.1** Only about 30% of students could describe alpha particles as deflecting or rebounding from the gold atom. Many described the alpha particles as not going through, which was insufficient as it was given in the question. Some students thought alpha particles would be absorbed or destroyed.

**03.2** A good attempt at this question to calculate the size of a nucleus using the ratio to the size of the atom was made by around 40% of students, with approximately 30% gaining both marks. A common mistake was to divide instead of multiplying. Some students tried to do the correct sum, but instead calculated 0.18 ÷ (1/6000) instead of calculating 0.18/6000. Nearly 10% of students made no attempt at this question. Using ratios is a mathematical skill in the specification.

**03.3** This question testing knowledge of electron energy levels was correctly answered by just over 30% of students.

**03.4** This question required students to identify that the temperature remains constant while a substance melts, and then read this temperature from the graph. 45% of students were able to do this correctly. Some student did not associate the constant temperature with the change of state, but more commonly they failed to correctly determine the scale on the temperature axis.

Answer 03 · Examiner comments — June 2019 | 8464/P/1F | Original Q3

**03.5** About 35% of students could determine the time for the change of state from the graph. Reading values from graphs and using those values are required mathematical skills.

**03.6** Nearly 60% of students correctly identified the gradient of the graph as the rate of change of temperature.

Answer 04 · Examiner comments — June 2019 | 8464/P/1F | Original Q7

## Question 7

**07.1** This question tested students' understanding of the links between temperature and pressure via the motion of the particles in a gas. Over 30% of students scored at least one mark but fewer than 5% scored all three marks. Roughly 20% made no attempt. Many

students wrote about successful collisions, which was condoned here. However, writing about particles moving less was not seen as equivalent to writing about particles moving more slowly. The most common reason for gaining 2 marks rather than three was the omission of any mention of collisions. One common misconception is that, as the particles cool down, the number of particles increases. There were also a number of students who did not mention pressure in their answer, instead discussing how the movement of particles changed as they cooled and how this linked with temperature.

**07.2** Just over 25% of students scored at least one mark while around 1 in 5 students scored all three marks; approximately 10% made no attempt at all. Some students did not show an equation and just divided one number by the other – sometimes achieving the correct result. Others multiplied the two numbers and therefore did not score. Some chose the wrong equation, while others multiplied or divided by zero, because it was in the question. Those students who scored 2 marks had usually made an erroneous conversion of either kJ to J or kg to g. Many students tried to answer the question using the equation $E = mc\Delta\theta$, with 20 °C as their change in temperature, gaining 0 marks.

**07.3** Slightly over a quarter of students scored on this question, and half of those scored both marks. Many students drew a temperature line, which then enabled them to come to the correct conclusions and gain both marking points. A small number of students chose to fill the boxes with numbers representing temperatures, rather than ticking one box for each row of the table.

**07.4** Many students who gained 0 marks on this question failed to talk about particles, instead naming and describing changes of state. Many students were able to get into Level 1 (1 or 2 marks) because they knew something about the arrangement and movement of particles in one state. A common misconception was that particles cease to move at all in the solid state. A large number of students gave a basic description of the change of arrangement such as the particles getting closer together as the change of states occurs or the movement of the particles slowing down, but then gave very little additional detail. Fewer students managed to link the changes to energy changes or forces between particles. Very few students achieved Level 3. Some students referred to the energy decreasing at each change of state and some talked about 'bonding' occurring. However, often the relevant points regarding the changes to arrangement or movement were not effective and prevented them from acquiring Level 3. Around 15% made no attempt at the question, about 20% scored 0 marks, around 30% scored in Level 1, approximately 30% in Level 2, with the remainder reaching Level 3.

6.3.1.2 Changes of state

Answer 04 · Examiner comments

June 2019 | 8464/P/1F | Original Q7

**Use of statistics**

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

**Mark Ranges and Award of Grades**

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

### 6.3.1.2 Changes of state

**Answer 05 · Examiner comments** June 2023 | 8464/P/1F | Original Q3

**Question 03 (Low demand and standard demand)**

**03.1** Nearly 90% of students gained both marks for this calculation. A fairly common incorrect method was to subtract 50°C from 420 J/Kg°C, and give a value for the temperature change of 370°C, which gained no credit.

**03.2** Slightly less than 40% of students selected the correct meaning for internal energy. It was (very) slightly more common for students to think that internal energy is the energy added to the steel particles as they are heated than to select the correct answer.

**03.3** About 70% of students chose the correct statement describing the particles in a solid.

**03.4** Approximately 45% of students knew the mass of steel stays the same.

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**Answer 05 · Examiner comments** June 2023 | 8464/P/1F | Original Q3

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**03.5** The correct diagram to show the change in arrangement of the particles was chosen by over 95% of students.

**03.6** Roughly two fifths of students answered this correctly. Many students wrote about the motion of particles, which was ignored, rather than the arrangement of particles. Students who stated that the particles spread out but remained in contact with each other scored this mark.

**03.7** Just over three quarters of students recognised that melting is a physical change.

**03.8** Over half of the students gained full marks on this question. Almost no students gained 1 or 2 marks, but about 10% did not attempt it at all. Evidence of a relevant calculation had to be shown before any credit could be awarded. So, for example, students who calculated the average of 2, 4.5 and 7 and came up with an answer of 4.5 g, and then selected medium carbon did not score any marks.

**03.9** Nearly 60% of students gained full marks on this standard demand calculation. A small proportion of students attempted to convert 4.0 kg to g, which limited them to a maximum mark of 2.

Answer 06 · Examiner comments

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

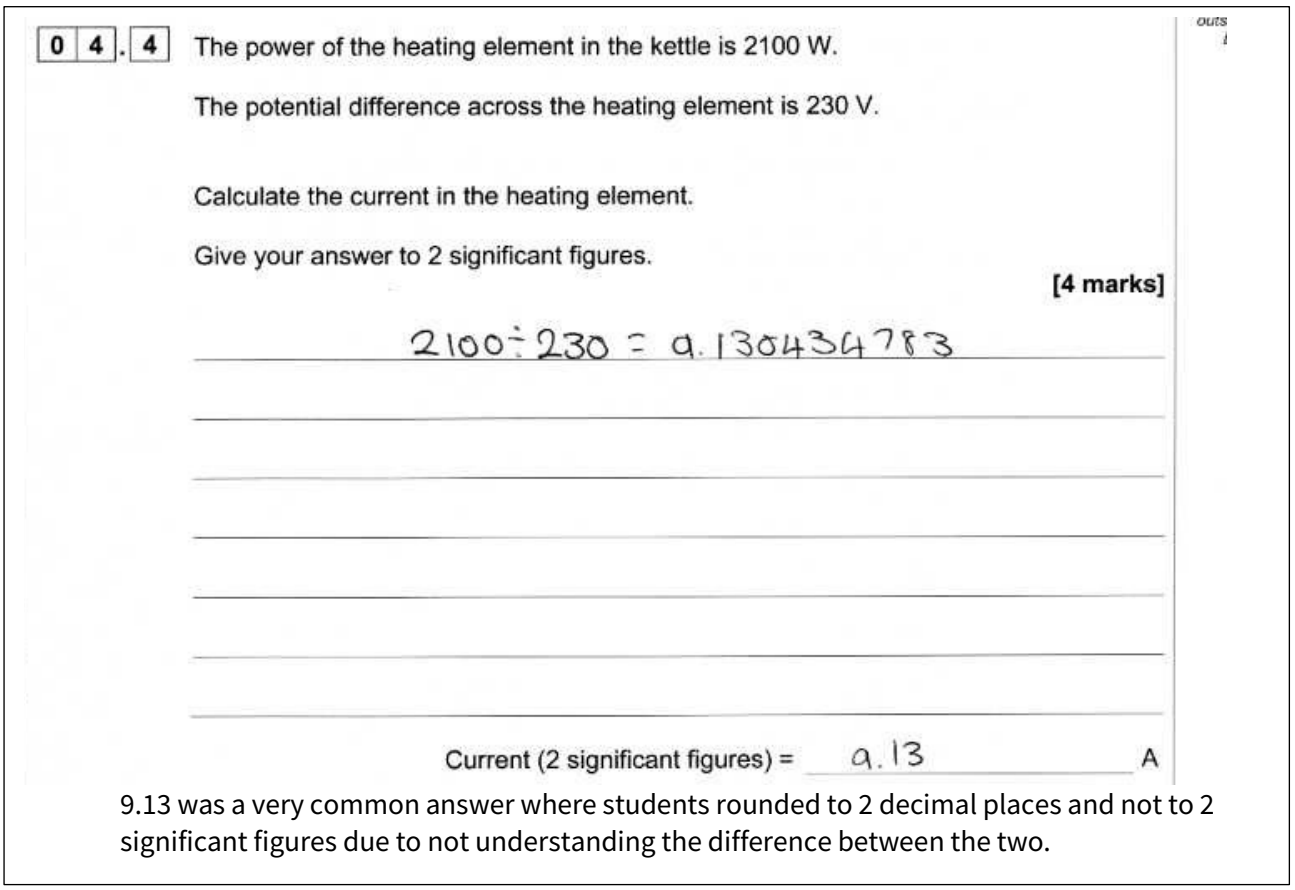
# Question 4 (Low and standard demand)

**04.1** 45% of students selected the correct answer for the frequency of the UK mains electricity supply.

**04.2** Just over 20% of students gained 1 mark for correctly identifying the colour of the insulation on one of the wires. 35% of students were able to identify both the colours of the insulation.

**04.3** Students now have the equation sheet to select the equation from, so 90% of students gained the mark on this question. Approximately 5% of students selected the incorrect equation.

**04.4** The vast majority of students who correctly substituted into the equation scored the 3 calculation marks. Approximately 75% of students gained 3 marks, but only 35% of students gained the mark for the significant figures. Many students gave their answer to 2 decimal places and not to two significant figures.



0 4 . 4 The power of the heating element in the kettle is 2100 W.

The potential difference across the heating element is 230 V.

Calculate the current in the heating element.

Give your answer to 2 significant figures.

[4 marks]

2100 ÷ 230 = 9.130434783

Current (2 significant figures) = 9.13 A

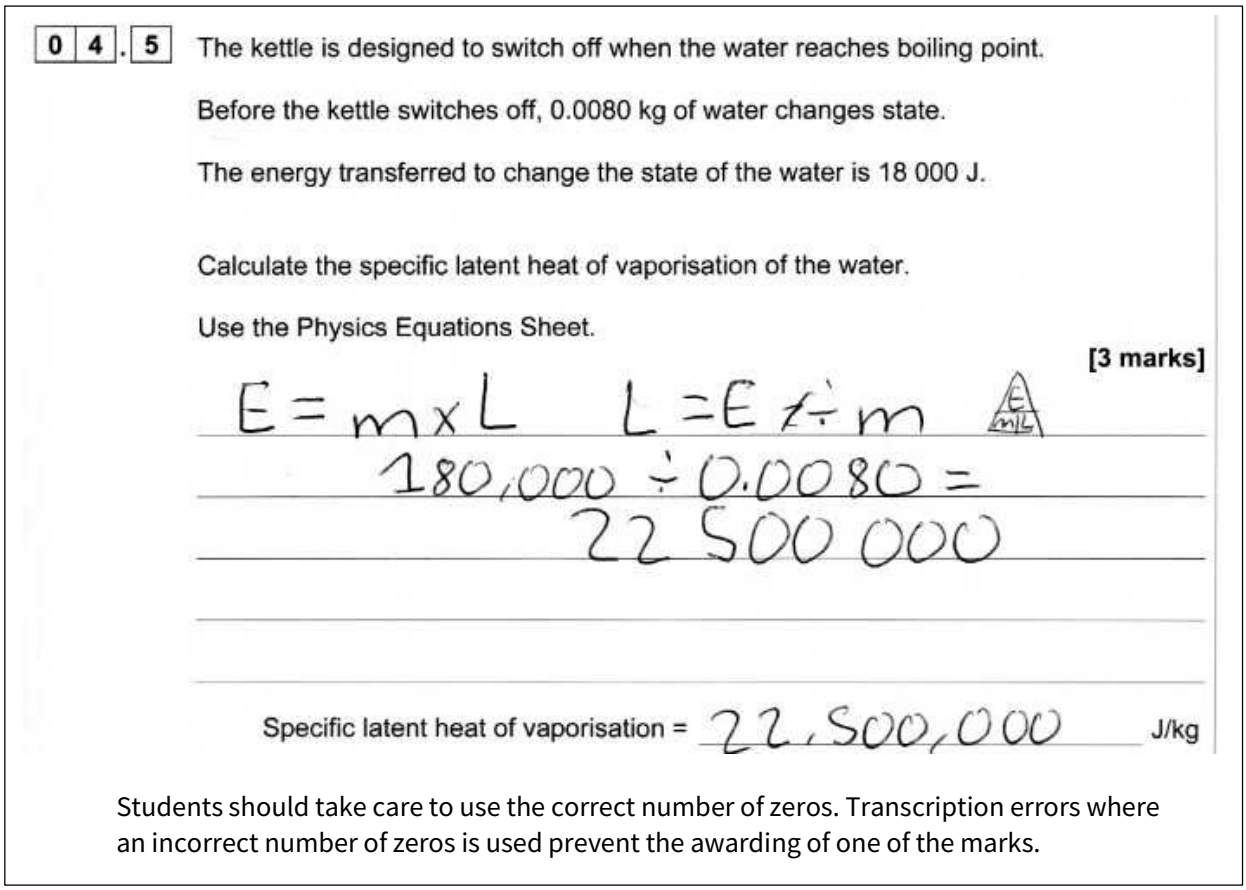
9.13 was a very common answer where students rounded to 2 decimal places and not to 2 significant figures due to not understanding the difference between the two.

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### 6.3.1.2 Changes of state

**Answer 06 · Examiner comments** June 2025 | 8464/P/1F | Original Q4

**04.5** This calculation proved to be more challenging with approximately 50% of students gaining 3 marks. The vast majority of students who substituted correctly were able to rearrange the equation correctly and then arrive at the correct answer. Most students who did not gain any marks either did not select the correct equation from the equation sheet or did an incorrect initial substitution.



0 4 . 5 The kettle is designed to switch off when the water reaches boiling point.

Before the kettle switches off, 0.0080 kg of water changes state.

The energy transferred to change the state of the water is 18 000 J.

Calculate the specific latent heat of vaporisation of the water.

Use the Physics Equations Sheet.

[3 marks]

$E = m \times L$ $L = E \div m$

$180,000 \div 0.0080 =$

$22\,500\,000$

Specific latent heat of vaporisation = 22,500,000 J/kg

Students should take care to use the correct number of zeros. Transcription errors where an incorrect number of zeros is used prevent the awarding of one of the marks.

**04.6** This calculation was well answered with approximately 90% of students gaining 2 marks.

**04.7** 40% of students gained a mark on this question, but only 3% gained both marks. Very few explained that higher efficiency means less energy is wasted. Many students answered in terms of a kettle due to the previous question and explained that the appliance would complete its task in less time. This was awarded a mark due to the context of the question.

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