GCSE
Sciences

Marking and improving student outcomes in maths-related questions

Support booklet and further information

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GCSE Science mark schemes

The 'Information to examiners' section

The following information is present at the front of every GCSE Science mark scheme. It gives clear and explicit information to examiners on what the various parts of a mark scheme mean, and how to apply them to ensure consistency of marking.

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement
- the Assessment Objectives and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening and underlining

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of error / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

[1 mark]

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name two planets in the solar system.

[2 marks]

Student	Response	Marks awarded
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Marks should be awarded for each stage of the calculation completed correctly, as students are instructed to show their working. Full marks can, however, be given for a correct numerical answer, without any working shown.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward is kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ecf in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(.....) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Allow

In the mark scheme additional information, 'allow' is used to indicate creditworthy alternative answers.

3.9 Ignore

Ignore is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

3.10 Do <u>not</u> accept

Do **not** accept means that this is a wrong answer which, even if the correct answer is given as well, will still mean that the mark is not awarded.

4. Level of response marking instructions

Extended response questions are marked on level of response mark schemes.

- Level of response mark schemes are broken down into levels, each of which has a descriptor.
- The descriptor for the level shows the average performance for the level.
- There are two marks in each level.

Before you apply the mark scheme to a student's answer, read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1: Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer.

When assigning a level you should look at the overall quality of the answer. Do **not** look to penalise small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level.

Use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 2 with a small amount of level 3 material it would be placed in level 2 but be awarded a mark near the top of the level because of the level 3 content.

Step 2: Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this.

The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do **not** have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme.

You should ignore any irrelevant points made. However, full marks can be awarded only if there are no incorrect statements that contradict a correct response.

An answer which contains nothing of relevance to the question must be awarded no marks.

The points-based mark scheme: prose questions

Below is an example points-based mark scheme. It is taken from the summer 2018 GCSE Chemistry 2H Paper.

The 'Answers' column shows the correct answer(s).

- For longer prose questions, the individual marking points are shown.
- For calculations, this column will be set out in a series of steps showing the expected method.

The 'Extra information' column expands on what is required or indicates other credit-worthy alternative answers.

The final column lists the Assessment Objective(s) the question addresses and the areas of the specification that the question covers. Different marking points may cover different Assessment Objectives or specification references.

Brackets indicate information that does not need to be included to gain the mark.

'allow' is used to indicate alternative answers that are worthy of credit.

Question	Answers	Extra information	Mark	AO/Spec. Ref.
07.3	any one from: • (to reduce) health problems • (to reduce) global dimming	allow (to reduce) specified health problems eg breathing difficulties, asthma, lung cancer allow (to reduce) the effects of global dimming eg reduced light levels allow (to reduce) smog allow (to reduce) the formation of particulates ignore global warming do **not** accept to reduce soot	1	AO1 4.9.3.1 4.9.3.2

'ignore' indicates a statement that doesn't gain credit, but which doesn't cancel the marking point.

'do not accept' means a wrong answer, which cannot be credited.

The points-based mark scheme: calculation questions

Below is an example points-based mark scheme for a calculation question. It is taken from the summer 2018 GCSE Physics 1H Paper.

The same principles for brackets, allow, ignore, do not allow etc apply as for a prose question.

Question	Answers	Extra information	Mark	AO/Spec. Ref.
09.3		an answer of 0.12 (kg) **or** an answer that rounds to 0.12 (kg) scores **5** marks		AO2 4.2.4.2 4.1.1.3
	E = 2530 × 14	this mark may be awarded if P is incorrectly / not converted	1	
	E = 35 420 (J)	this answer only	1	
	35 420 = m × 4200 × 70	allow their calculated E = m × 4200 × 70	1	
	$m = \frac{35\,420}{4200 \times 70}$	allow $m = \frac{\text{their calculated E}}{4200 \times 70}$	1	
	m = 0.12 (kg)	allow an answer that is consistent with their calculated value of E	1	

The levels of response mark scheme

This example is taken from the summer 2018 GCSE Biology 2H paper. It is for a 6-mark 'Design/plan' question (see generic levels descriptors, below).

Each command word has a generic set of levels descriptors.

The number of marks for each Assessment Objective are shown, along with the specification references

Question	Answers	Mark	AO / Spec. Ref.
04.3	**Level 3:** The method would lead to the production of a valid outcome. All 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	AO2
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	AO1
	No relevant content	0	
	Indicative content • placing of quadrat • large number of quadrats used • how randomness achieved – eg table of random numbers **or** random number button on calculator **or** along transect • quadrats placed at coordinates **or** regular intervals along transect • in each of two areas of different light intensities **or** transect running through areas of different light intensity • for each quadrat count number of dandelions • for each quadrat measure light intensity • compare data from different light intensity to access **level 3** the key ideas of using a large number of quadrats randomly, or along a transect, and counting the number of dandelions in areas of differing light intensity need to be given to produce a valid outcome		4.7.2.1

The indicative content shows the scientific points a student could use in their response. The list is not exhaustive, and students could use other ideas. Students do not need to include all of the indicative points to gain full marks.

GCSE Science generic level descriptors

The mark scheme uses generic level descriptors, which are linked to the specific command word.

This approach improves the consistency of levels-marked questions. There is specific indicative content for the examiner to consider.

1. Calculate/Determine: Use numbers/data to work out the correct answer.

2. Compare: Note/estimate/measure the similarity or dissimilarity between things.

4 or 6 marks.

Level 2: Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.	3–4 or 4–6
Level 1: Relevant features are identified and differences noted.	1–2 or 1–3
No relevant content	0

3. Describe: Recall some facts, events or process in an accurate way.

4 or 6 marks.

Level 2: Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.	3–4 or 4–6
Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.	1–2 or 1–3
No relevant content	0

4. Design/Plan: Set out in a logical order how something can be done.

4 or 6 marks

If 4 marks

Level 2: The plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	3–4
Level 1: The plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2
No relevant content	0

If 6 marks

Level 3: The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6
Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3–4
Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2
No relevant content	0

5. Evaluate: Make a judgement about the value of something, with respect to a particular purpose. The response is based on analysis – so identification of relevant features is necessary and the use of relevant criteria. Response might need to look critically, from a number of angles.

6 (or 4) marks

If 4 marks

Level 2: A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	3–4
Level 1: Relevant points are made. These are not logically linked	1–2
No relevant content	0

If 6 marks

Level 3: A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	5–6
Level 2: Some logically linked reasons are given. There may also be a simple judgement	3–4
Level 1: Relevant points are made. They are not logically linked.	1–2
No relevant content	0

6. Explain: Clarify by stating reasons why or how something has happened. Gives causes or motivating factors of why something has happened.

If 4 marks

Level2: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	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

If 6 marks

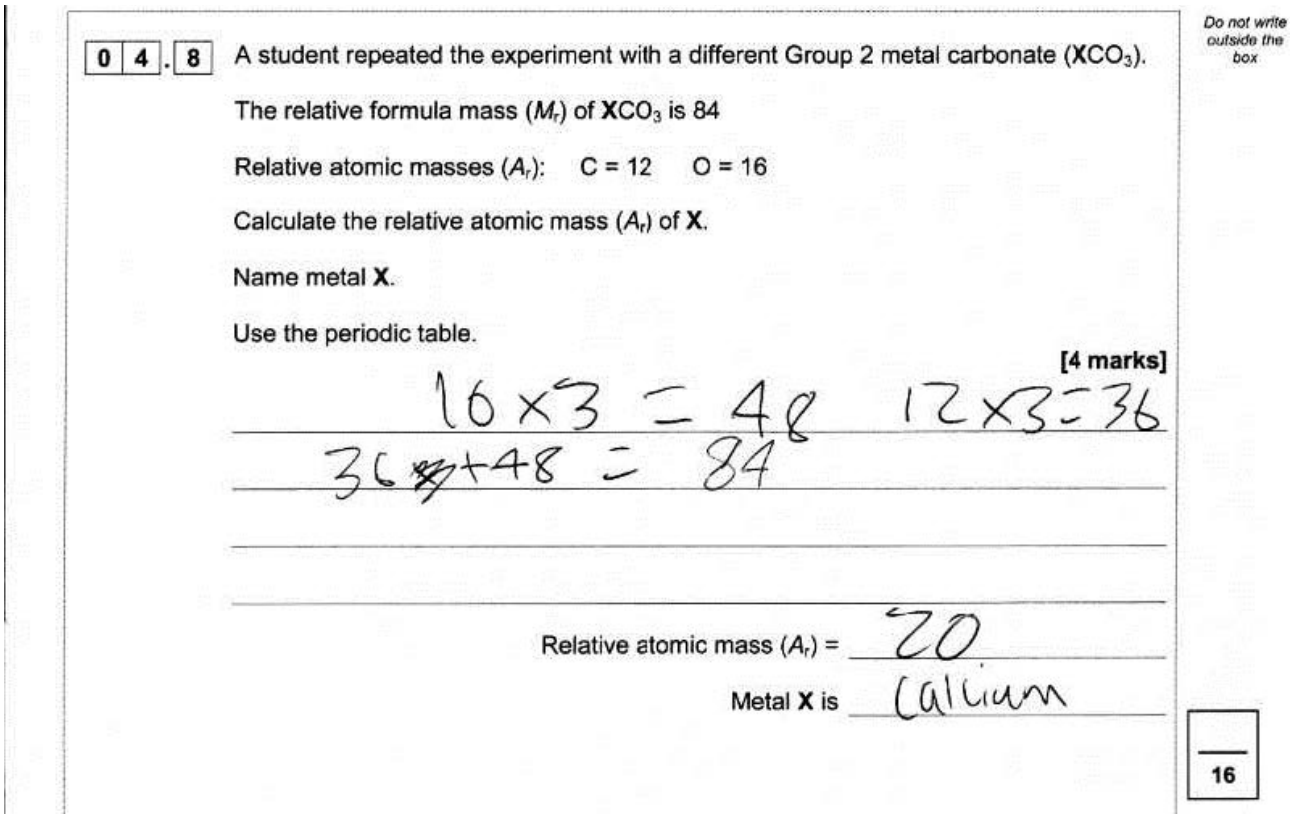
Level 3: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5–6
Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear.	3–4
Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2
No relevant content	0

Example student responses from 2018 papers

a) Calculations

Example 1: 8464/C/1F Question 4.8

This question required students to calculate the relative atomic mass of metal X, before naming the metal using the Periodic Table – it is aimed at standard demand (grades 4-5).



0 4 . 8 A student repeated the experiment with a different Group 2 metal carbonate (XCO_3).

The relative formula mass (M_r) of XCO_3 is 84

Relative atomic masses (A_r): C = 12 O = 16

Calculate the relative atomic mass (A_r) of **X**.

Name metal **X**.

Use the periodic table.

[4 marks]

16×3 = 48 12×3=36

36+48 = 84

Relative atomic mass (A_r) = 20

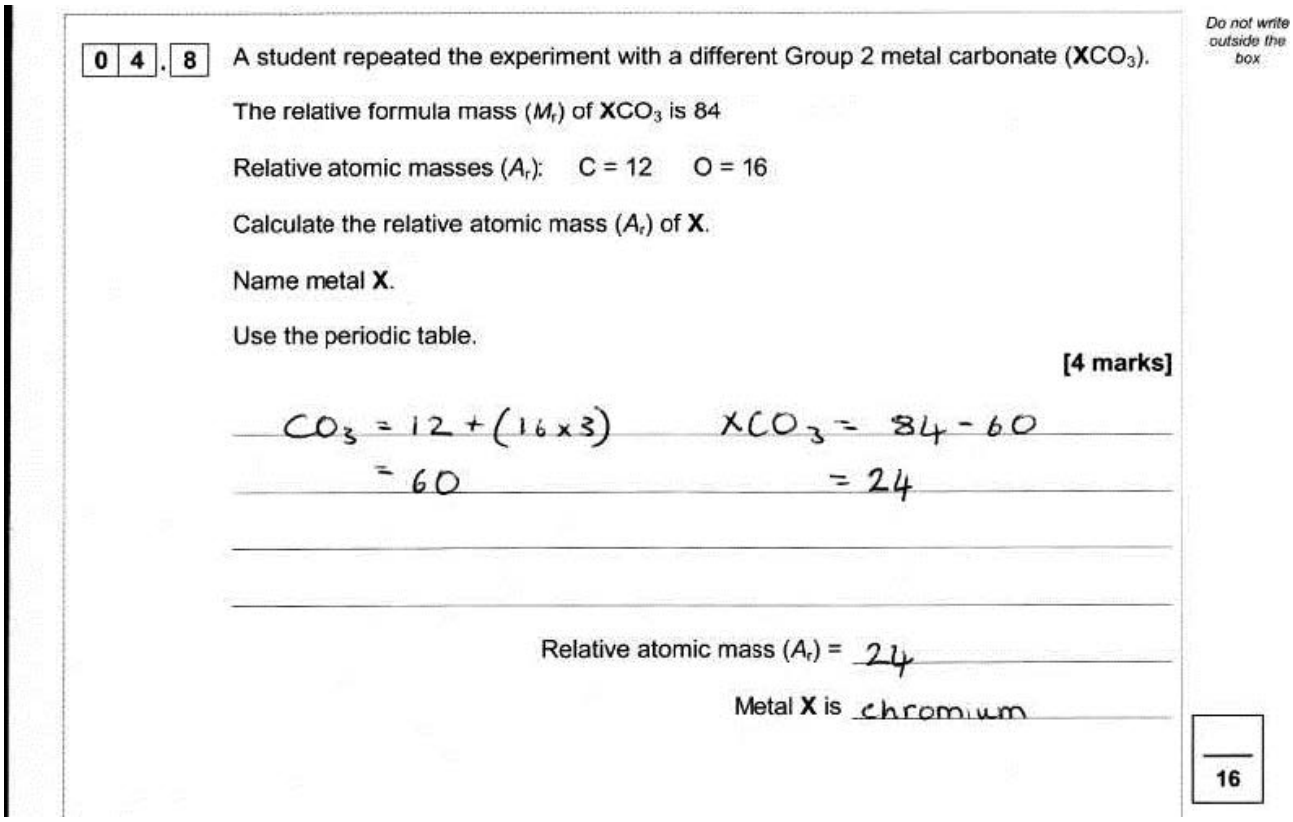
Metal **X** is Calcium

16

Do not write outside the box

04.8		an answer of 24 gains the **3** calculation marks		AO2/1 5.3.1.2 & 5.3.1.3 & 5.1.1.5
	3×16 or 48		1	
	(48) + 12 or 60	allow their mass of oxygen + 12	1	
	84 – (60) **or** 24	allow 84 – their mass of carbonate	1	
	magnesium **or** Mg	magnesium **or** Mg without working scores this mark	1	

Example 2: 8464/C/1F Question 4.8
This is a second response for this question.



0 4 . 8 A student repeated the experiment with a different Group 2 metal carbonate (XCO_3).

Do not write outside the box

The relative formula mass (M_r) of XCO_3 is 84

Relative atomic masses (A_r): C = 12 O = 16

Calculate the relative atomic mass (A_r) of **X**.

Name metal **X**.

Use the periodic table.

[4 marks]

$CO_3 = 12 + (16 \times 3)$
$= 60$

$XCO_3 = 84 - 60$
$= 24$

Relative atomic mass (A_r) = 24

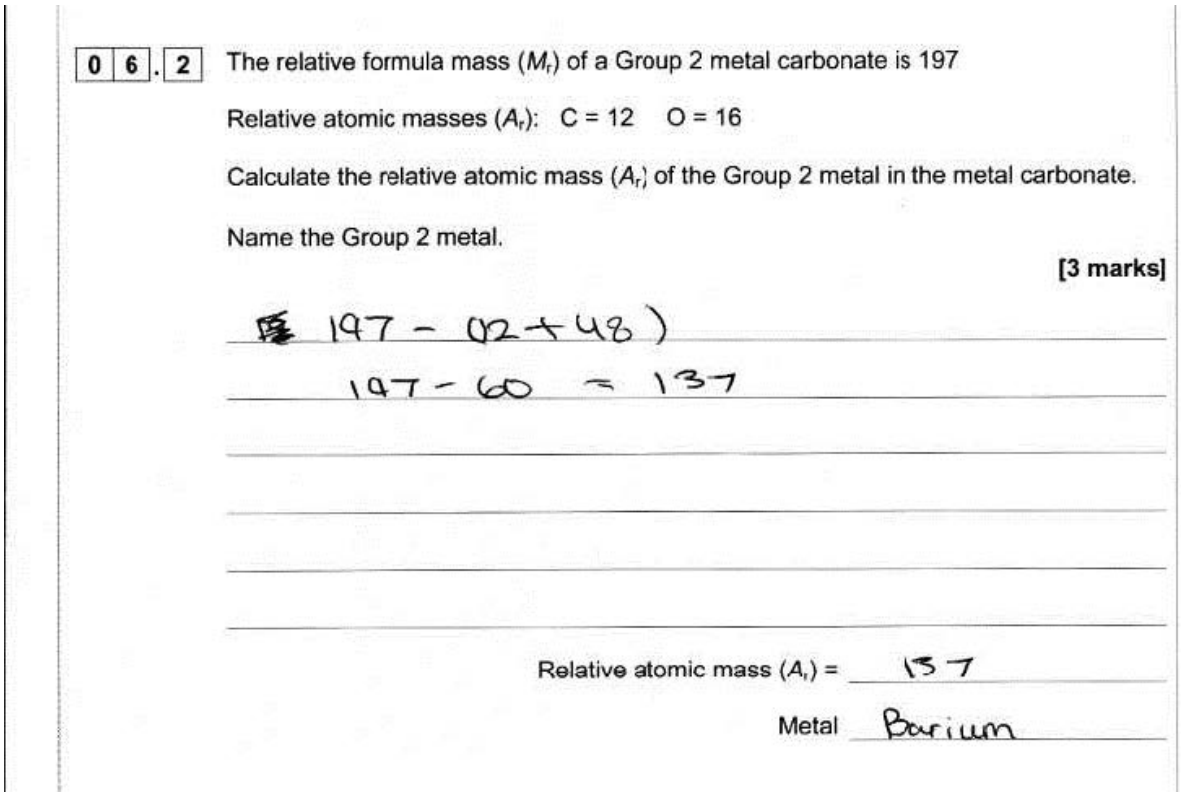
Metal **X** is chromium

16

04.8		an answer of 24 gains the **3** calculation marks		AO2/1 5.3.1.2 & 5.3.1.3 & 5.1.1.5
	3×16 or 48		1	
	(48) + 12 or 60	allow their mass of oxygen + 12	1	
	84 – (60) **or** 24	allow 84 – their mass of carbonate	1	
	magnesium **or** Mg	magnesium **or** Mg without working scores this mark	1	

Example 3: 8464/C/1H question 6.2

This is a high-demand question requiring students to use the relative atomic masses of magnesium and iron to calculate the mass of iron produced in the reaction between magnesium and iron chloride solution.



0 6 . 2 The relative formula mass (M_r) of a Group 2 metal carbonate is 197

Relative atomic masses (A_r): C = 12 O = 16

Calculate the relative atomic mass (A_r) of the Group 2 metal in the metal carbonate.

Name the Group 2 metal.

[3 marks]

197 - (12+48)

197 - 60 = 137

Relative atomic mass (A_r) = 137

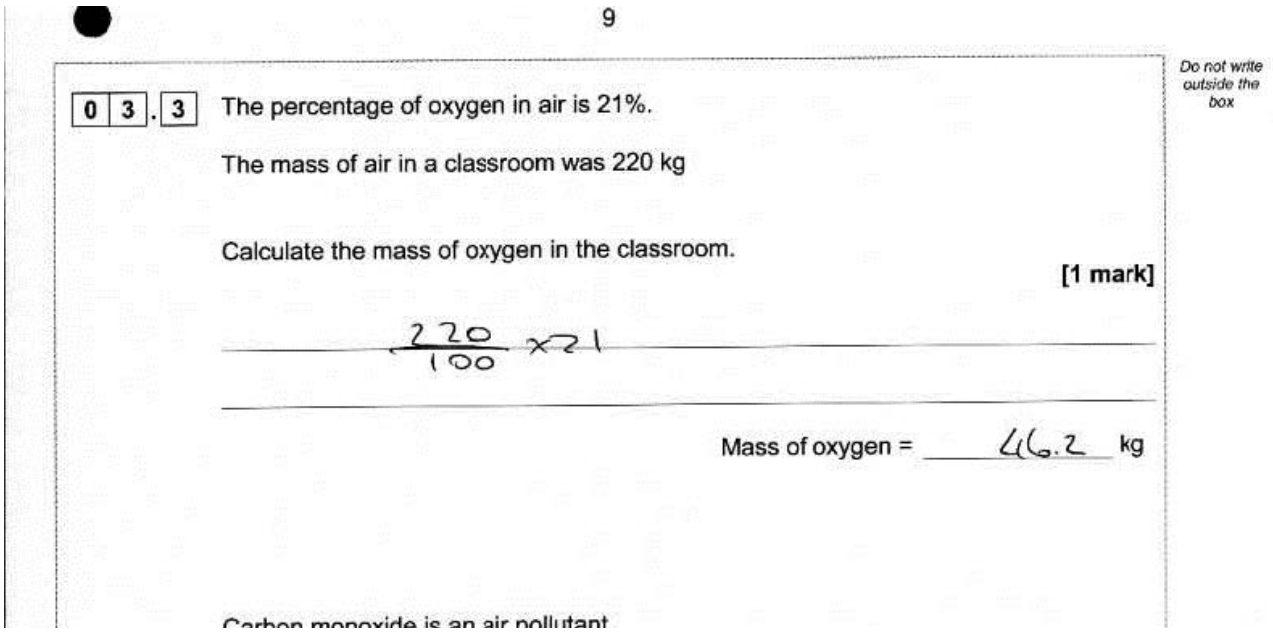
Metal Barium

06.2	[12 + (3x16)] or 60 (197-60=) 137 barium **or** Ba	an answer of 137 gains the **2** calculation marks barium **or** Ba without working scores this mark	1 1 1	AO2/1 5.3.1.2 & 5.3.1.3 & 5.1.1.5

b) More calculations

Example 4: 8465/1F question 3.3

This question required students to calculate the mass of a gas given the percentage of that gas in the air. It is a low demand question aimed at grades 1-3.



9

Do not write outside the box

0 3 . 3 The percentage of oxygen in air is 21%.

The mass of air in a classroom was 220 kg

Calculate the mass of oxygen in the classroom.

[1 mark]

$\frac{220}{100} \times 21$

Mass of oxygen = 46.2 kg

Carbon monoxide is an air pollutant

03.3	46.2 (kg)	allow 46 (kg)	1	AO2 4.4.1.1

Example 5: 8464/B/2F question 3.5

This low demand question asks students to calculate the difference between two values which they need to extract from a table of data provided.

0 3 . 5 Doctors tested people of different ages to time how long it took between touching a sharp pin and the arm muscle contracting.

At each age they tested five men and calculated a mean value for the time.

Table 1 shows the results.

Table 1

Age in years	Mean time for muscle to contract in milliseconds
20	18
40	20
60	23
80	30

How much longer does it take for the muscle to contract at 80 years of age compared to at 20 years of age?

Give your answer in seconds.

[2 marks]

80years. 20years

30ms. 18ms

30 - 18 = 12ms

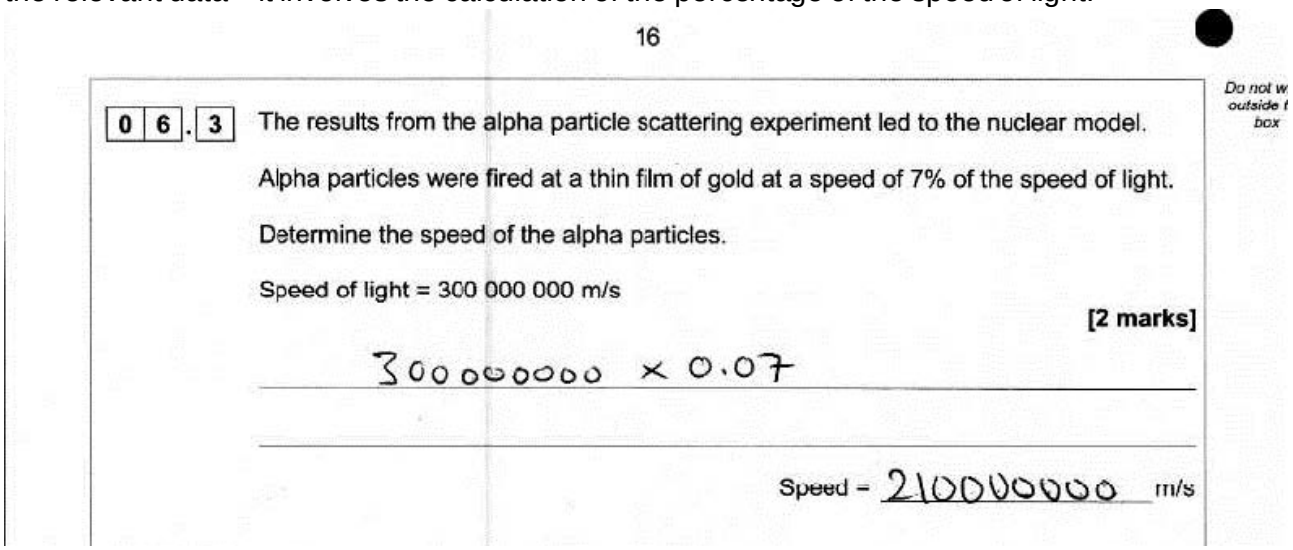
Time = 12m. s

Turn over ▶

03.5	12 (ms) 0.012 (s)	an answer of 0.012 (s) scores **2** marks	1 1	AO2 4.5.2

Example 6: 8464/P/1F question 6.3

This standard-demand question requires students to calculate the speed of alpha particles, given the relevant data – it involves the calculation of the percentage of the speed of light.



16

0 6 . 3 The results from the alpha particle scattering experiment led to the nuclear model.

Alpha particles were fired at a thin film of gold at a speed of 7% of the speed of light.

Determine the speed of the alpha particles.

Speed of light = 300 000 000 m/s

[2 marks]

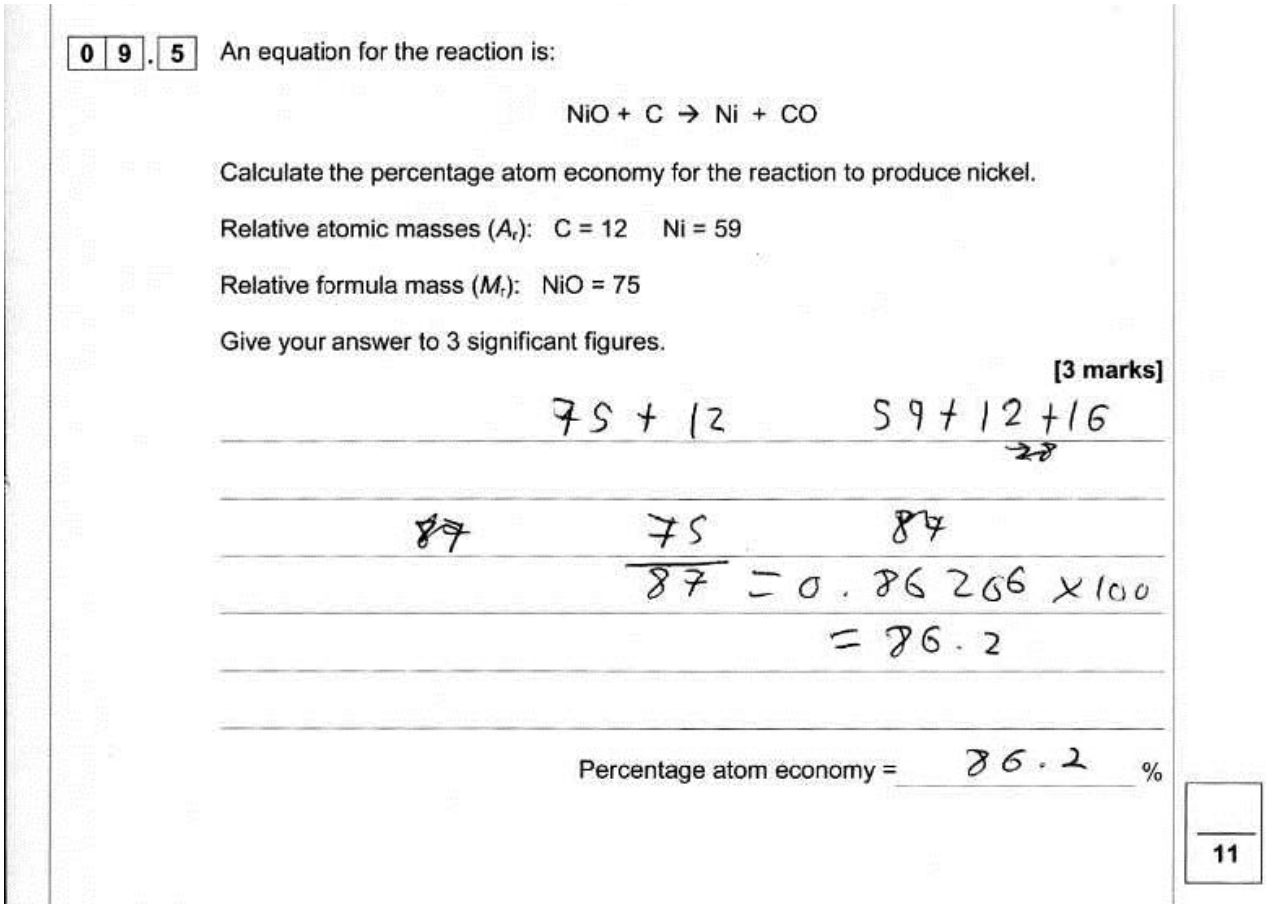
300000000 × 0.07

Speed = 21000000000 m/s

Do not w outside t box

06.3	v = 300 000 000 × (7/100) v = 21 000 000 (m/s)	an answer of 21 000 000 scores **2** marks allow any correct method of determining 7% of 300 000 000 allow 2.1×10^7 (m/s)	1 1	AO2 6.4.1.3	E

Example 7: 8462/1F question 9.5
A standard-demand question requiring students to calculate the percentage atom economy for the production of nickel by a given reaction. Students are required to give their answer to 3 sig figs.



0 9 . 5 An equation for the reaction is:

$$NiO + C \rightarrow Ni + CO$$

Calculate the percentage atom economy for the reaction to produce nickel.

Relative atomic masses (A_r): C = 12 Ni = 59

Relative formula mass (M_r): NiO = 75

Give your answer to 3 significant figures.

[3 marks]

75 + 12 59 + 12 + 16

87 75 87

87 = 0.86206 × 100

= 86.2

Percentage atom economy = 86.2 %

11

09.5	(total M_r of reactants =) 87	an answer of 67.8 (%) scores **3** marks an answer of 67.8160919 (%) or correctly rounded answer to 2, 4 or more sig figs scores **2** marks an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps	1	AO2 4.3.3.2
	(percentage atom economy) $= \frac{59}{87} \times 100$	allow (percentage atom economy) $= \frac{59}{\text{incorrectly calculated } M_r} \times 100$	1	
	= 67.8 (%)	allow an answer from an incorrect calculation to 3 sig figs	1	

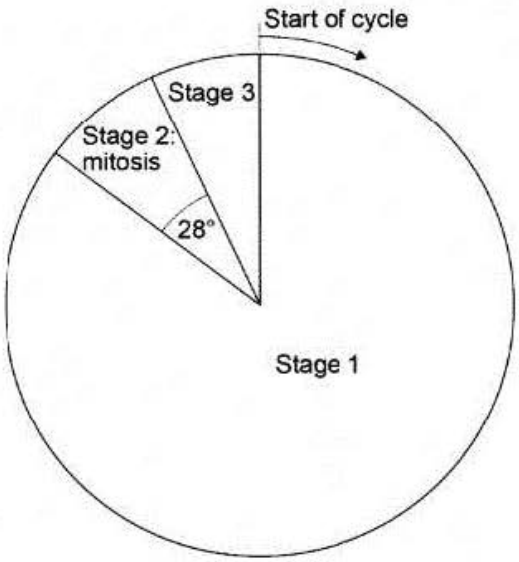
Example 8: 8464/B/1H question 6.3

This high-demand question requires students to demonstrate their ability to convert the units of a measurement and to give their answer using standard form.

Embryonic stem cells divide by mitosis.

Figure 9 represents a cell cycle for a human embryonic stem cell.

Figure 9



0 6 . 3 The mass of DNA in the cell at the start of the cycle is 6 picograms.

A picogram is 10^{-3} nanograms.

Convert 6 picograms to grams.

Give your answer in standard form.

[1 mark]

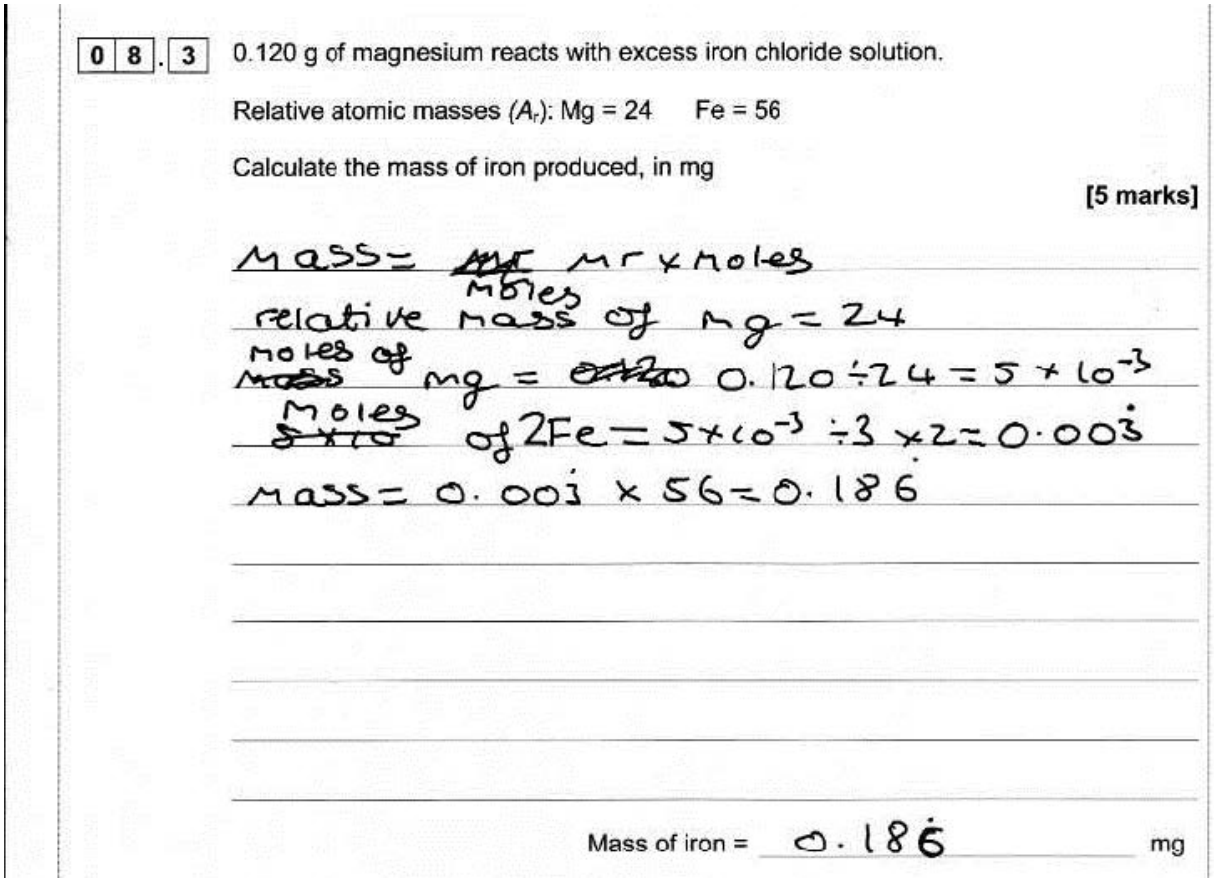
6pg = 6×10^{-12} g

Mass = 6×10^{-12} g

06.3	6 x 10^{-12} (grams)		1	AO2 4.1.2.1 4.1.2.2

Example 9: 8464/C/1H question 8.3

This high-demand question requires students to calculate the mass of iron produced in a reaction.



0 8 . 3 0.120 g of magnesium reacts with excess iron chloride solution.

Relative atomic masses (A_r): Mg = 24 Fe = 56

Calculate the mass of iron produced, in mg

[5 marks]

Mass = ~~MF~~ Moles Mr × Moles

relative mass of Mg = 24

~~Moles of Mass~~ moles of Mg = ~~0.120~~ 0.120 ÷ 24 = 5×10^{-3}

~~Moles 5 x 10~~ moles of 2Fe = $5 \times 10^{-3} \div 3 \times 2 = 0.00\dot{3}$

Mass = $0.00\dot{3} \times 56 = 0.186$

Mass of iron = 0.186 mg

08.3		an answer of 185-190 (mg) gains **5** marks an answer of 0.185-0.19 gains **4** marks		5xAO2/2 5.3.2.2
	(Mg) $\frac{0.12}{24}$ or 0.005 (moles)	mark is for ÷ by 24	1	
	(Fe) $\frac{2}{3}$ × 0.005 = 0.00333(moles)	mark is for × $\frac{2}{3}$	1	
	(mass Fe) = 0.00333 × 56	mark is for × 56	1	
	= 0.1866 (g)		1	
	= 187 (mg)		1	
		an answer of 280 (mg) gains **4** marks an answer of 0.280 gains **3** marks (no ratio from equation) 184 scores 0 [=(3×24)+(2×56)]		
	OR (Mg) = $\frac{0.12}{(3\times24=)\ 72}$ (1) = 0.00166 **or** $\frac{1}{600}$ (moles) (1) (mass of Fe) = 0.00166 **or** $\frac{1}{600}$ × 112 (2×56) (1) = 0.1866 (g) (1) 187 (mg) (1) **OR** 72g Mg → 112g Fe (1) 1g Mg → $\frac{112}{72}$ **or** 1.56g Fe (1) 0.12g Mg → $\frac{112}{72}$ × 0.12 (1) = 0.1866 (g) (1) = 187 (mg) (1)			

c) Mean and Range

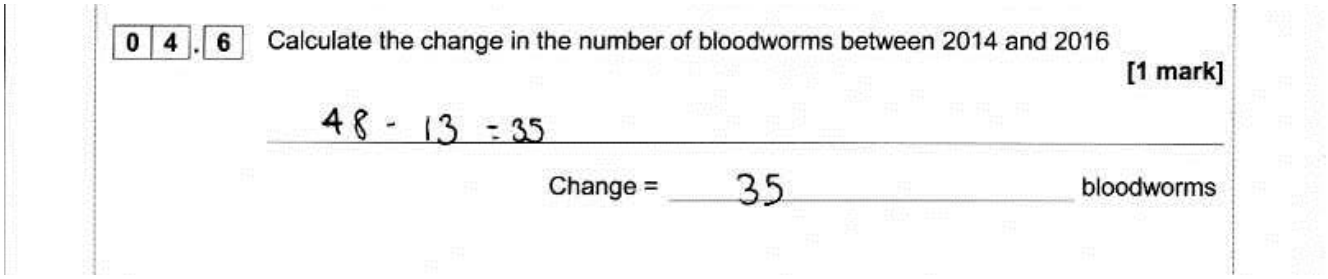
Example 10: 8464/B/2F question 4.6
This low-demand question requires students to extract and work on data from a table provided in the question. Calculating the change (difference) between two values requires a simple subtraction:

Scientists counted some different invertebrates living in a pond in 2014 and in 2016

Table 3 shows the results.

Table 3

Invertebrate species	Number of invertebrates	
	2014	2016
Bloodworms	13	48
Freshwater shrimps	24	9
Mayfly nymphs	32	0
Water snails	19	24



0 4 . 6 Calculate the change in the number of bloodworms between 2014 and 2016 **[1 mark]**

48 - 13 = 35

Change = 35 bloodworms

04.6	35		1	AO2 4.7.2.1

Example 11: 8464/B/2F question 4.2

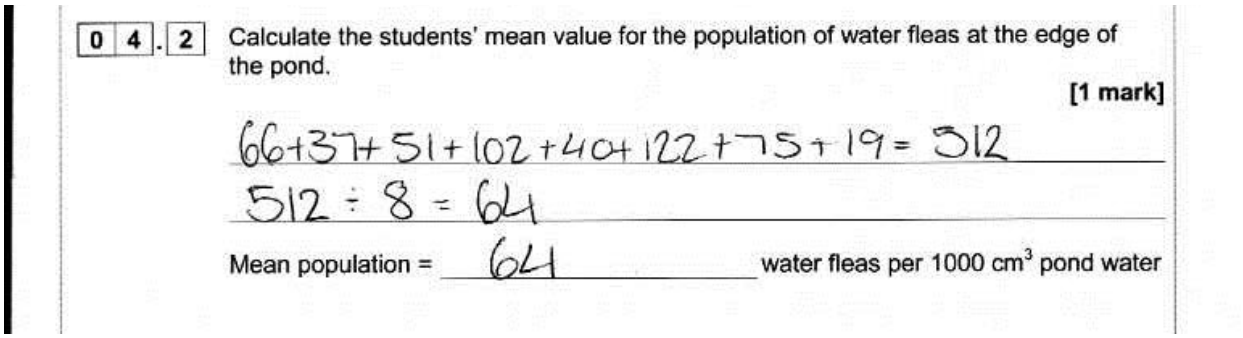
This is a low-demand question requiring students to extract and work on data from a table provided in the question:

The eight students then used a different method to obtain valid results.

Table 2 shows their results.

Table 2

Student	Number of water fleas per 1000 cm^3 pond water
A	66
B	37
C	51
D	102
E	40
F	122
G	75
H	19



0 4 . 2 Calculate the students' mean value for the population of water fleas at the edge of the pond.

[1 mark]

66+37+51+102+40+122+75+19 = 512

512 ÷ 8 = 64

Mean population = 64 water fleas per 1000 cm^3 pond water

04.2	64		1	AO2 4.7.2.1

Example 12a and 12b: 8464/B/2F question 4.3

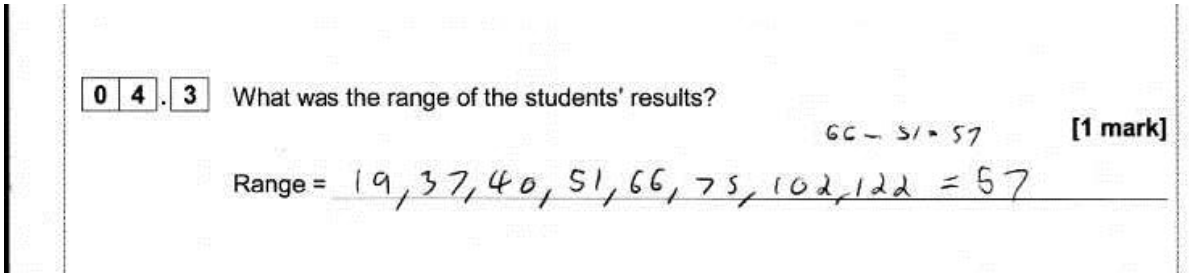
This low-demand question asks students to identify the range in the data in the table provided.

The eight students then used a different method to obtain valid results.

Table 2 shows their results.

Table 2

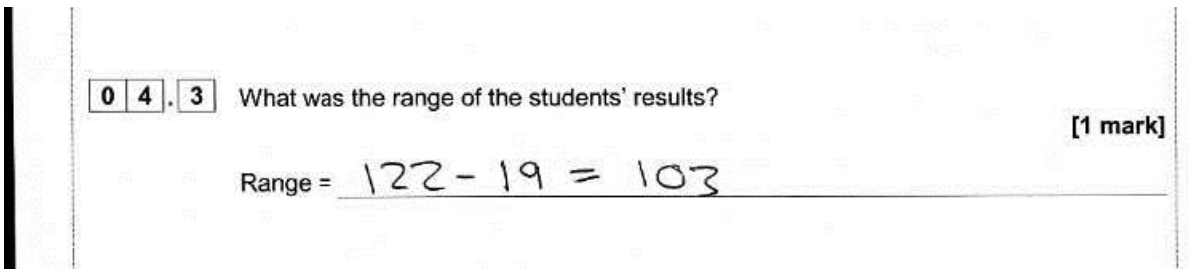
Student	Number of water fleas per 1000 cm^3 pond water
A	66
B	37
C	51
D	102
E	40
F	122
G	75
H	19



0 4 . 3 What was the range of the students' results?

GC – SI = 57 [1 mark]

Range = 19, 37, 40, 51, 66, 75, 102, 122 = 57



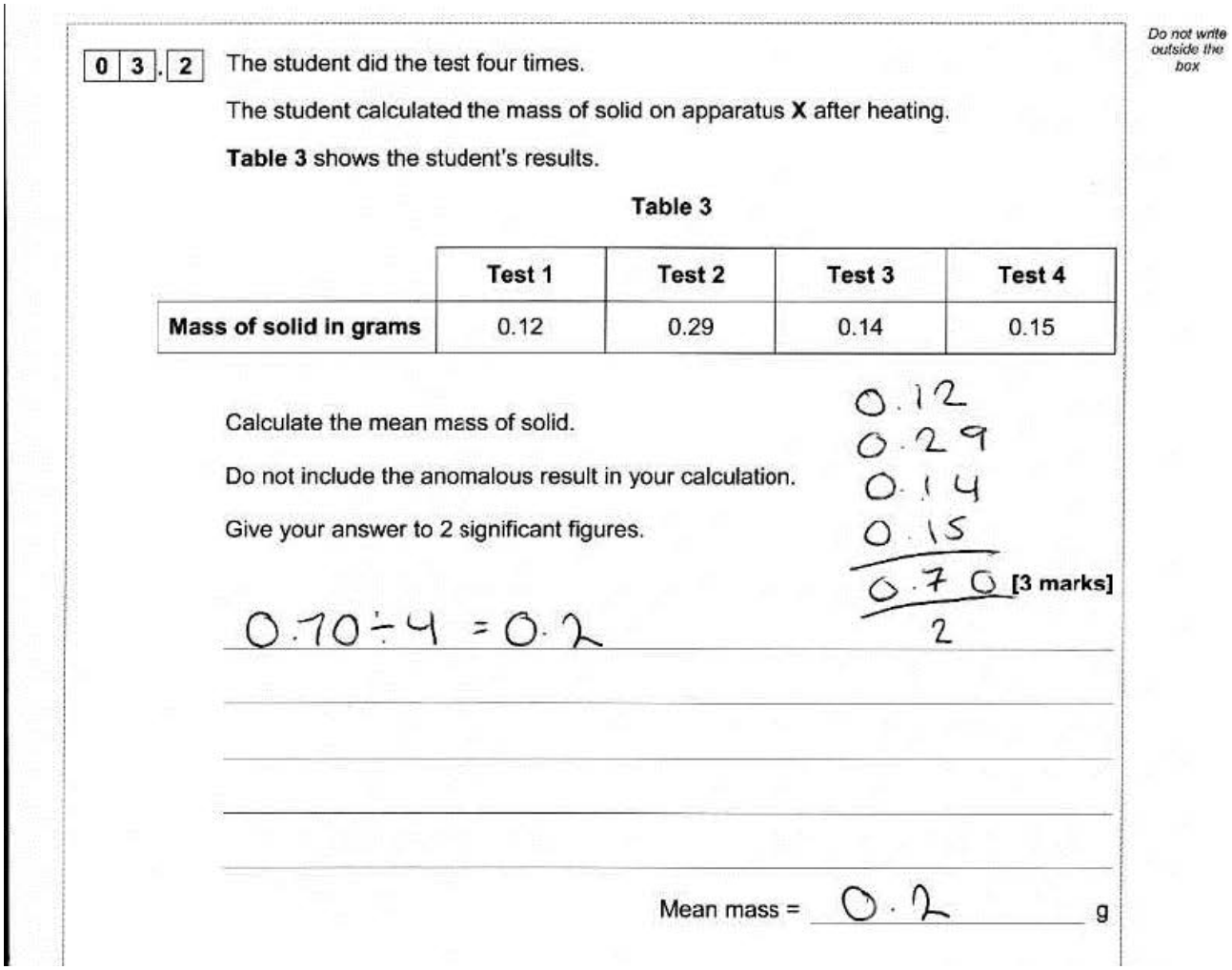
0 4 . 3 What was the range of the students' results? [1 mark]

Range = 122 - 19 = 103

04.3	19 to 122	allow 122 to19 **or** 103	1	AO2 4.7.2.1

Example 13a and 13b: 8464/C/2F question 3.2

This low-demand question requires students to identify the anomalous result from a table of data and then calculate the mean from the remaining values. They should then give the answer to 2 significant figures. The work of two students is provided for comparison.



Do not write outside the box

0 3 . 2 The student did the test four times.

The student calculated the mass of solid on apparatus **X** after heating.

Table 3 shows the student's results.

Table 3

	Test 1	Test 2	Test 3	Test 4
Mass of solid in grams	0.12	0.29	0.14	0.15

Calculate the mean mass of solid.

Do not include the anomalous result in your calculation.

Give your answer to 2 significant figures.

[3 marks]

0.12
0.29
0.14
0.15
0.70
2

0.70 ÷ 4 = 0.2

Mean mass = 0.2 g

Do not write outside the box

0 3 . 2 The student did the test four times.

The student calculated the mass of solid on apparatus **X** after heating.

Table 3 shows the student's results.

Table 3

	Test 1	Test 2	Test 3	Test 4
Mass of solid in grams	0.12	0.29	0.14	0.15

Calculate the mean mass of solid.

Do not include the anomalous result in your calculation.

Give your answer to 2 significant figures.

[3 marks]

① $0.12 + 0.14 + 0.15 = 0.41$

② $\frac{0.41}{3} = 0.136$

Mean mass = 0.136 g

03.2	identify 0.29 as anomaly	an answer of 0.14 (g) gains **3** marks	1	AO3
	$\frac{0.12 + 0.14 + 0.15}{3}$ **or** $\frac{0.41}{3}$	allow $\frac{0.12 + 0.29 + 0.14 + 0.15}{4}$ **or** $\frac{0.70}{4}$	1	AO2
	(=) 0.14 (g)	allow 0.18 (g) if first marking point not awarded	1	AO2 5.10.1.2 5.10.2.13

Example 14: 8465/3F question 6.2

In this low-demand question, students need to identify the anomalous result before calculating the mean – the data is provided in vertical columns and involves values for temperature rise.

0 6 . 2 The teacher did the experiment four times.

Table 1 shows the teacher's results.

Table 1

Experiment	Maximum temperature rise in °C
1	6.1
2	7.8
3	6.1
4	6.4

Calculate the mean maximum temperature rise.

Do **not** use the anomalous result in your calculation.

[2 marks]

6.1 + 6.1 + 6.4 = 18.6 ÷ 3 = 6.2

Mean maximum temperature rise = 6.2 °C

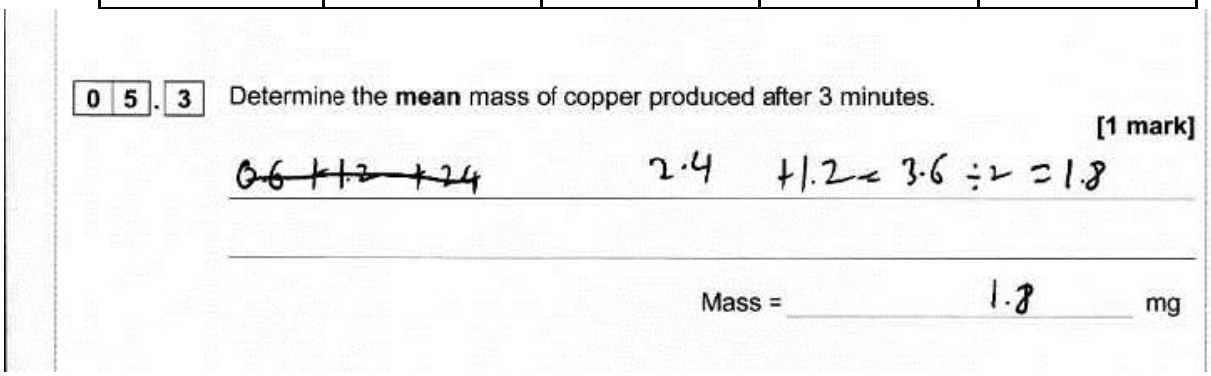
06.2	(mean =) $\frac{6.1 + 6.1 + 6.4}{3}$ = 6.2 (°C)	an answer of 6.2 (°C) scores **2** marks allow an answer of 6.6 (°C) for **1** mark	1 1	AO2 4.7.3.3

Example 15: 8464/C/1F question 5.3
This standard-demand question requires students to interrogate a table of results to calculate the mean value, representing a time period that was not measured.

Table 4 **shows the student's results.**

Table 4

	Total mass of copper produced in mg			
Time in mins	**Experiment 1**	**Experiment 2**	**Experiment 3**	**Mean**
1	0.60	0.58	0.62	0.60
2	1.17	1.22	1.21	1.20
4	2.40	2.41	2.39	2.40
5	3.02	**X**	3.01	3.06



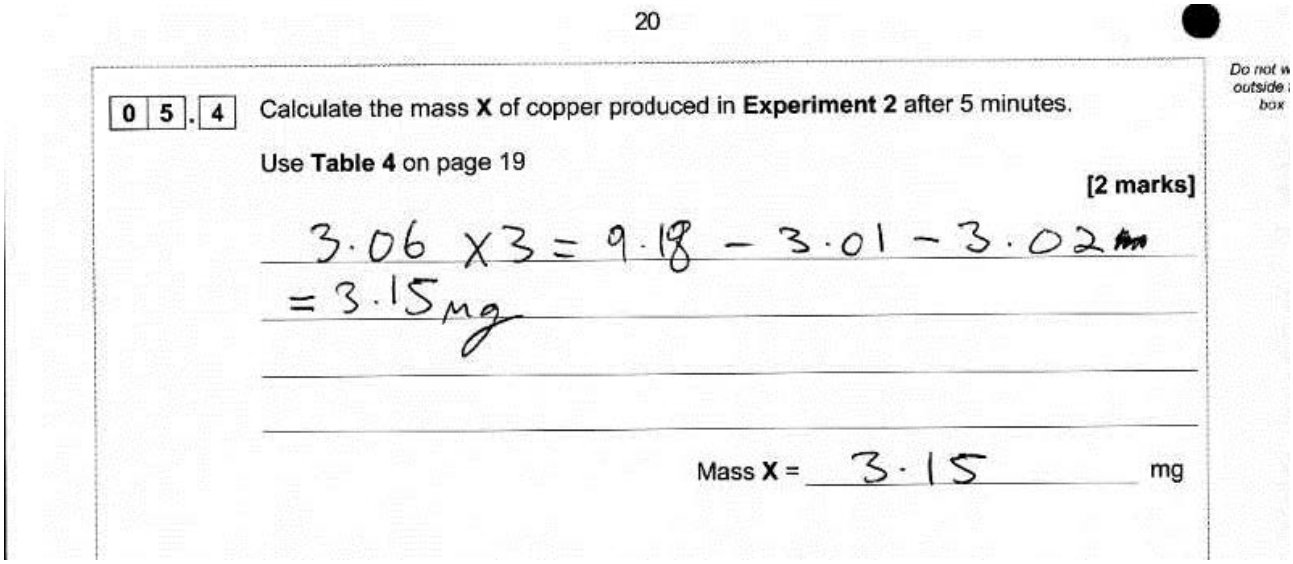
05.3	1.8 (mg)	allow answer in range 1.7-1.9	1	AO3/2a 5.4.3.4

Example 16: 8464/C/1F question 5.4
In this standard-demand question, students need to calculate the missing value from the mean and those values which were provided. This tests students understanding of a mean and how it is calculated.

Table 4 **shows the student's results.**

Table 4

	Total mass of copper produced in mg			
Time in mins	**Experiment 1**	**Experiment 2**	**Experiment 3**	**Mean**
1	0.60	0.58	0.62	0.60
2	1.17	1.22	1.21	1.20
4	2.40	2.41	2.39	2.40
5	3.02	**X**	3.01	3.06


20

0 5 . 4 Calculate the mass **X** of copper produced in **Experiment 2** after 5 minutes.

Use **Table 4** on page 19

[2 marks]

3.06 X3 = 9.18 − 3.01 − 3.02
= 3.15 mg

Mass **X** = 3.15 mg

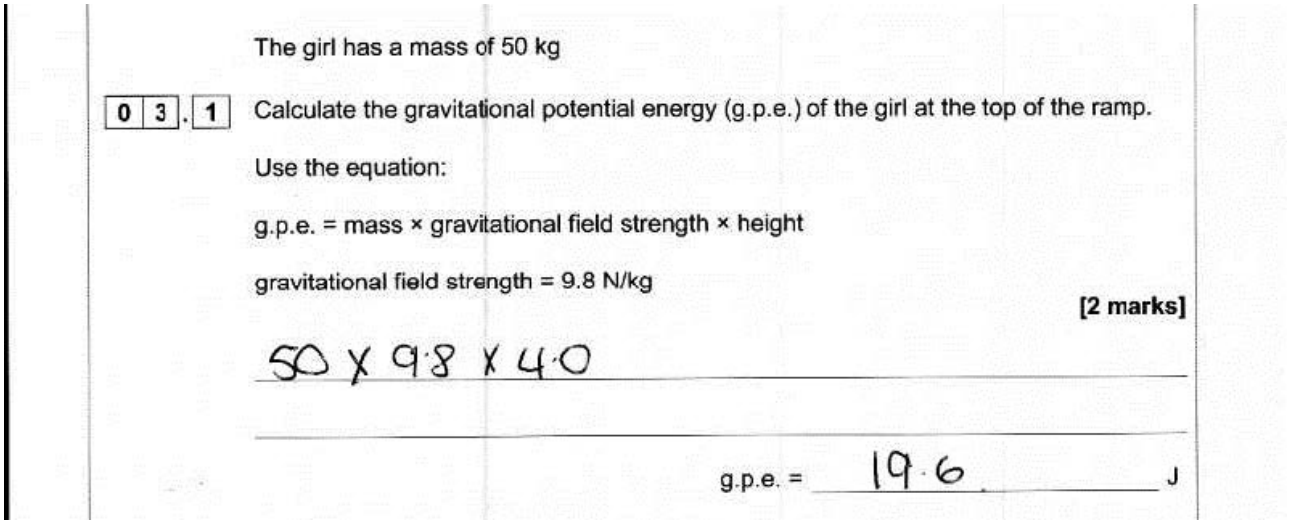
Do not w outside box

05.4	$\frac{3.02 + 3.01 + x}{3} = 3.06$ 3.15 (mg)	an answer of 3.15 (mg) gains **2** marks allow any other suitable method if no other mark awarded allow 9.18 for **1** mark	 1 1	AO2/2 5.4.3.4

d) Use of equations and formulae

Example 17: 8464/P/1F question 3.1

In this low-demand question, students are given an equation and the required values to substitute into that equation in order to calculate the g.p.e. of the girl at the top of the ramp.



The girl has a mass of 50 kg

0 3 . 1 Calculate the gravitational potential energy (g.p.e.) of the girl at the top of the ramp.

Use the equation:

g.p.e. = mass × gravitational field strength × height

gravitational field strength = 9.8 N/kg

[2 marks]

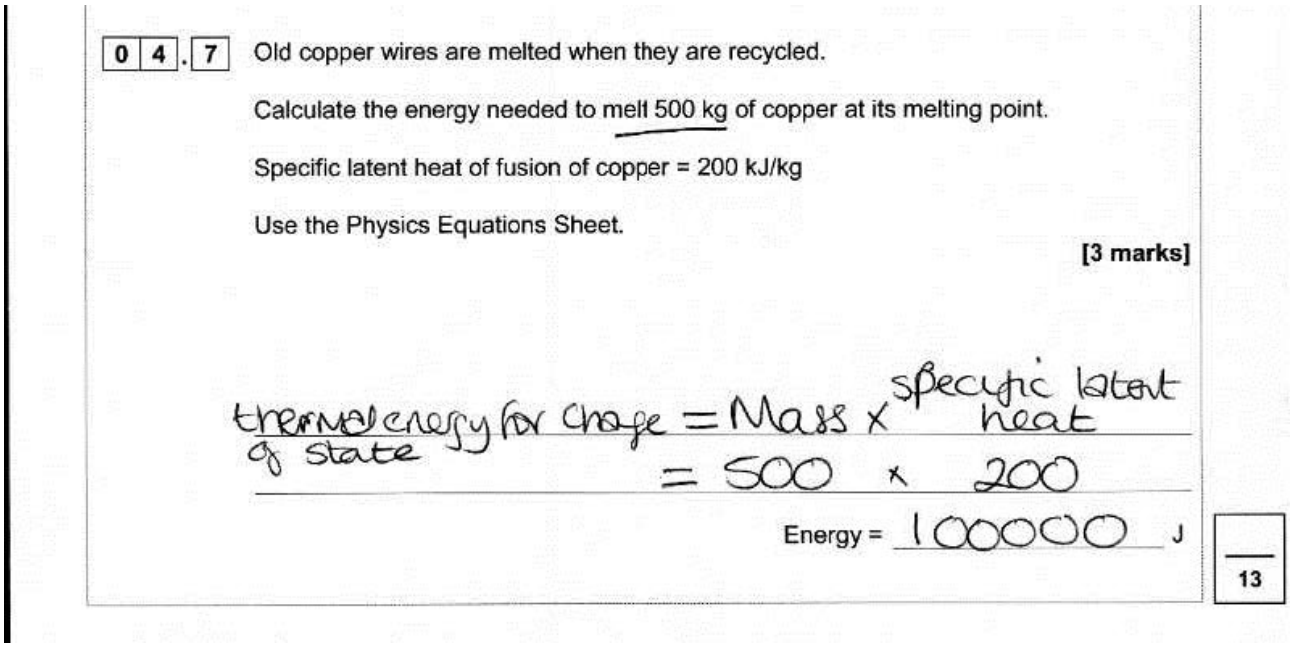
50 X 9·8 X 4·0

g.p.e. = 19·6 J

03.1	$E_p = 50 \times 9.8 \times 4.0$ $E_p = 1960$ (J)	an answer of 1960 scores 2 marks allow an answer rounded to 2000 (J) allow a maximum of **1** mark if g=10 N/kg is used	1 1	AO2 6.1.1.2	E

Example 18: 8464/P/1F question 4.7

To answer this low-demand question students need to select and use the correct equation from the Physics Equations Sheet. All data is provided in the question, but students must convert the values in order to provide the required answer.



0 4 . 7 Old copper wires are melted when they are recycled.

Calculate the energy needed to melt 500 kg of copper at its melting point.

Specific latent heat of fusion of copper = 200 kJ/kg

Use the Physics Equations Sheet.

[3 marks]

thermal energy for change of state = Mass × specific latent heat

= 500 × 200

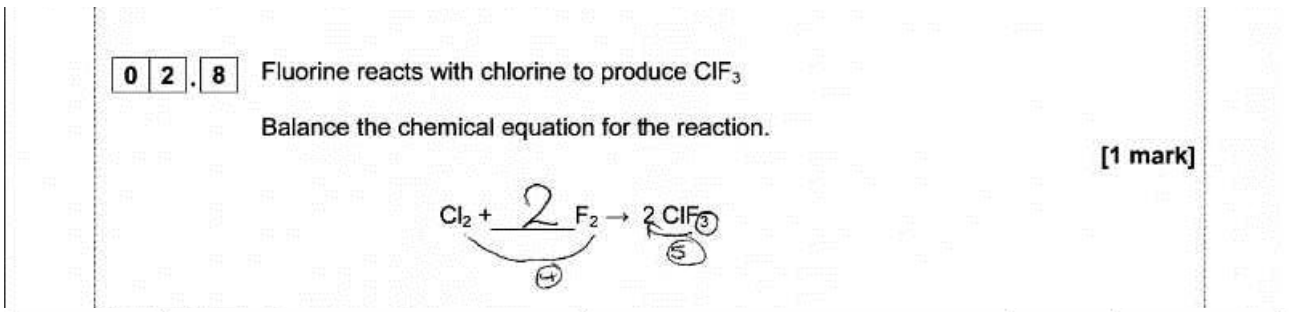
Energy = 100000 J

13

04.7	L = 200 000 (J/kg) E = 500 × 200 000 E = 100 000 000 (J)	an answer of 100 000 000 scores 3 marks allow 1×10^8 (J) allow correct calculation for incorrect conversion or no conversion of L for **2** marks	1 1 1	AC2 6.3.2.3	E

Example 19: 8464/C/1F question 2.8

This low-demand question asks students to balance a simple equation.



0 2 . 8 Fluorine reacts with chlorine to produce ClF_3

Balance the chemical equation for the reaction.

[1 mark]

$Cl_2 + 2\ F_2 \rightarrow 2\ ClF_3$

02.8	3	allow multiples	1	1x AO2/1 5.1.1.1 & 5.1.2.6

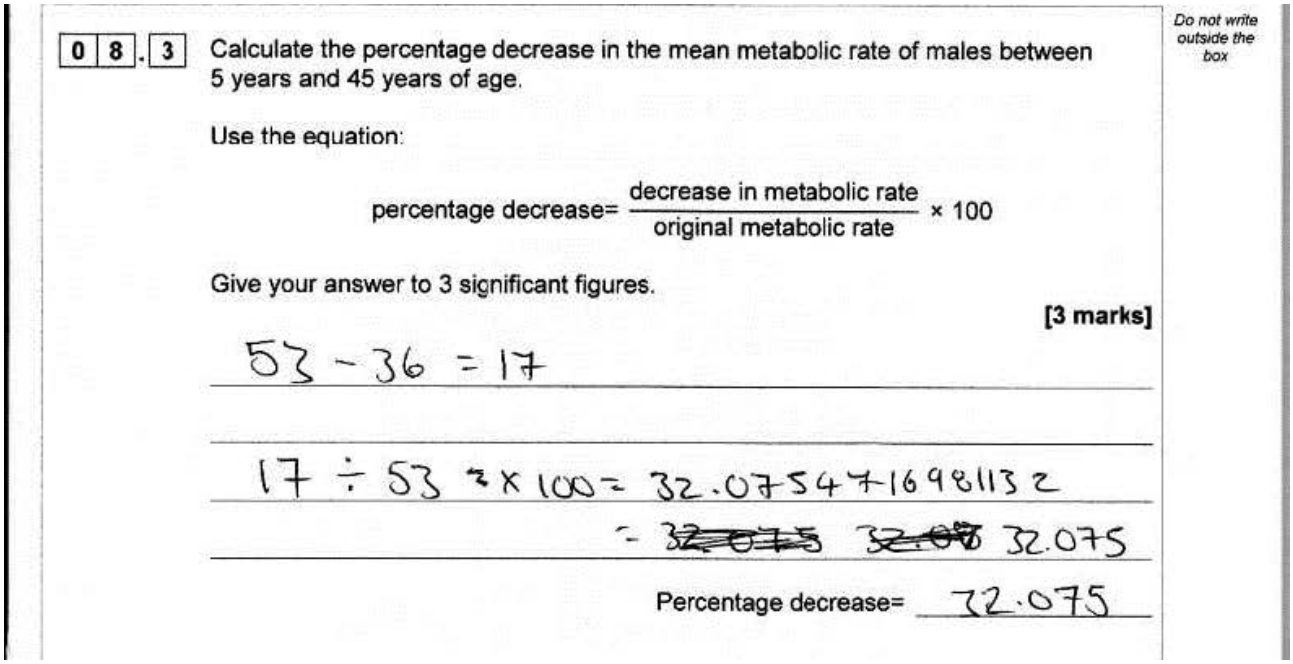
Example 20: 8461/1F question 8.3

In this Standard-demand question students need to interrogate a table of data and extract the values required to enable them to answer the question. The equation to use to calculate the required value is provided and students are asked to provide their answer to 3 sig figs.

Table 5 shows the mean metabolic rate of humans of different ages.

Table 5

Age in years	Mean metabolic rate in kJ/m^2/hour	
	Males	Females
5	53	53
15	45	42
25	39	35
35	37	35
45	36	35



0 8 . 3 Calculate the percentage decrease in the mean metabolic rate of males between 5 years and 45 years of age.

Use the equation:

$$\text{percentage decrease} = \frac{\text{decrease in metabolic rate}}{\text{original metabolic rate}} \times 100$$

Give your answer to 3 significant figures.

[3 marks]

Do not write outside the box

53 − 36 = 17

17 ÷ 53 × 100 = 32.075471698113 2

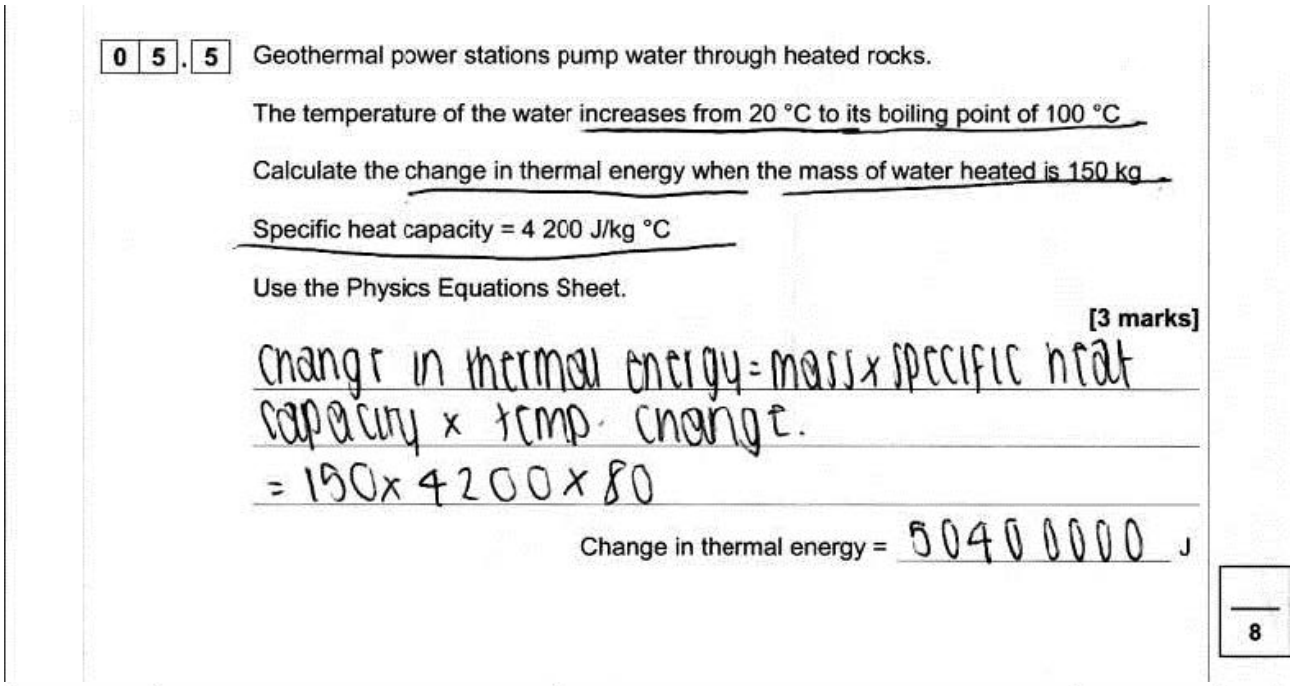
= ~~32.075~~ ~~32.08~~ 32.075

Percentage decrease= 32.075

08.3	$\frac{17}{53}$ x 100	an answer of 32.1 scores **3** marks	1	AO2.2 4.4.2.3
	32.075472…	allow correct rounding of this to at least 4 significant figures.	1	
	32.1	allow a correct reduction to 3 significant figures from an incorrect calculation for MP2	1	

Example 21: 8464/P/1F question 5.5

This Standard-demand question requires students to select and use the correct equation from the Physics Equation Sheet and extract relevant data from the rubric of the question before undertaking the substitution.



0 5 . 5 Geothermal power stations pump water through heated rocks.

The temperature of the water increases from 20 °C to its boiling point of 100 °C

Calculate the change in thermal energy when the mass of water heated is 150 kg

Specific heat capacity = 4 200 J/kg °C

Use the Physics Equations Sheet.

[3 marks]

change in thermal energy = mass x specific heat capacity x temp. change.

= 150 x 4200 x 80

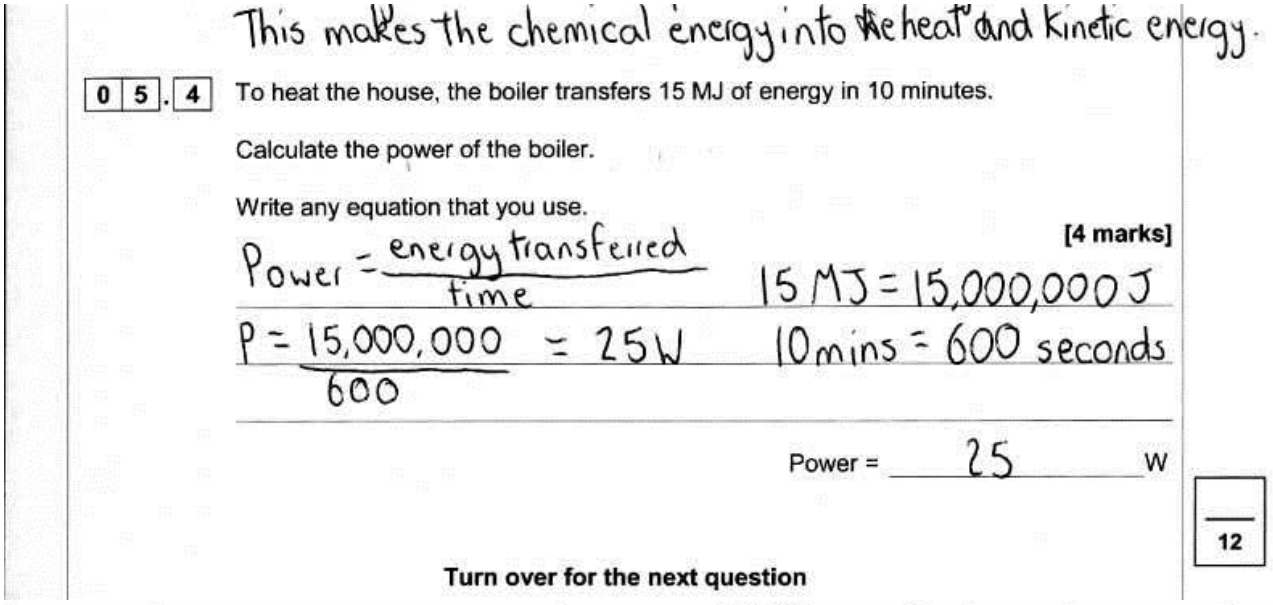
Change in thermal energy = 50400000 J

8

05.5	$\Delta\theta = 80$ °C $E = 150 \times 4200 \times 80$ $E = 50\,400\,000$ (J)	an answer of 50 400 000 scores **3** marks 1 1 allow 50 000 000 (J) 1 allow maximum 2 marks for correct calculation using incorrect value of $\Delta\theta$ allow 1 mark for correct calculation using $\theta = 20$ or $\theta = 100$	AO2 6.3.2.2	E

Example 22: 8464/P/1H question 5.4

In this high-demand question students are asked to write any equations they need to use to answer the question; they also need to convert both the value of energy and time into the correct units.



This makes the chemical energy into the heat and kinetic energy.

0 5 . 4 To heat the house, the boiler transfers 15 MJ of energy in 10 minutes.

Calculate the power of the boiler.

Write any equation that you use.

[4 marks]

Power = energy transferred / time

15 MJ = 15,000,000 J

P = 15,000,000 / 600 = 25 W

10 mins = 600 seconds

Power = 25 W

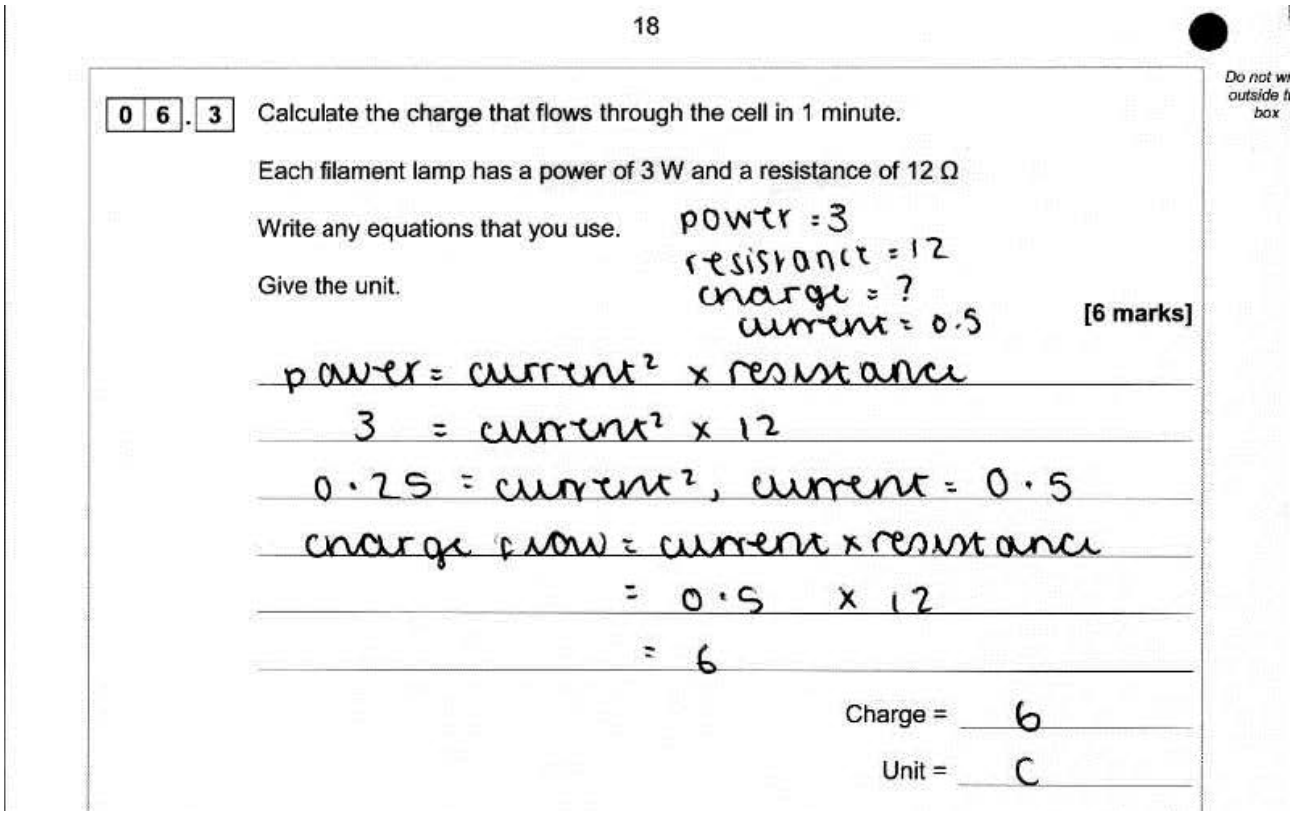
12

Turn over for the next question

05.4	E = 15 000 000 (J) t = 600 (s) P = 15 000 000 / 600 P = 25 000 (W)	an answer of 25 000 scores **4** marks allow a correct substitution of incorrectly/not converted values of E and/or t allow a correct calculation using incorrectly/not converted values of E and/or t	1 1 1 1	4 x AO2 6.1.1.4	E

Example 23a and 23b: 8464/P/1H question 6.3

This high-demand question requires students to write the equations they use to calculate the charge, complete the substitution and then identify the unit for the value they have calculated. Examples of the work of two students are provided for comparison.



18

Do not w outside t box

0 6 . 3 Calculate the charge that flows through the cell in 1 minute.

Each filament lamp has a power of 3 W and a resistance of 12 Ω

Write any equations that you use.

Give the unit.

power = 3
resistance = 12
charge = ?
current = 0.5

[6 marks]

power = current² × resistance

3 = current² × 12

0.25 = current², current = 0.5

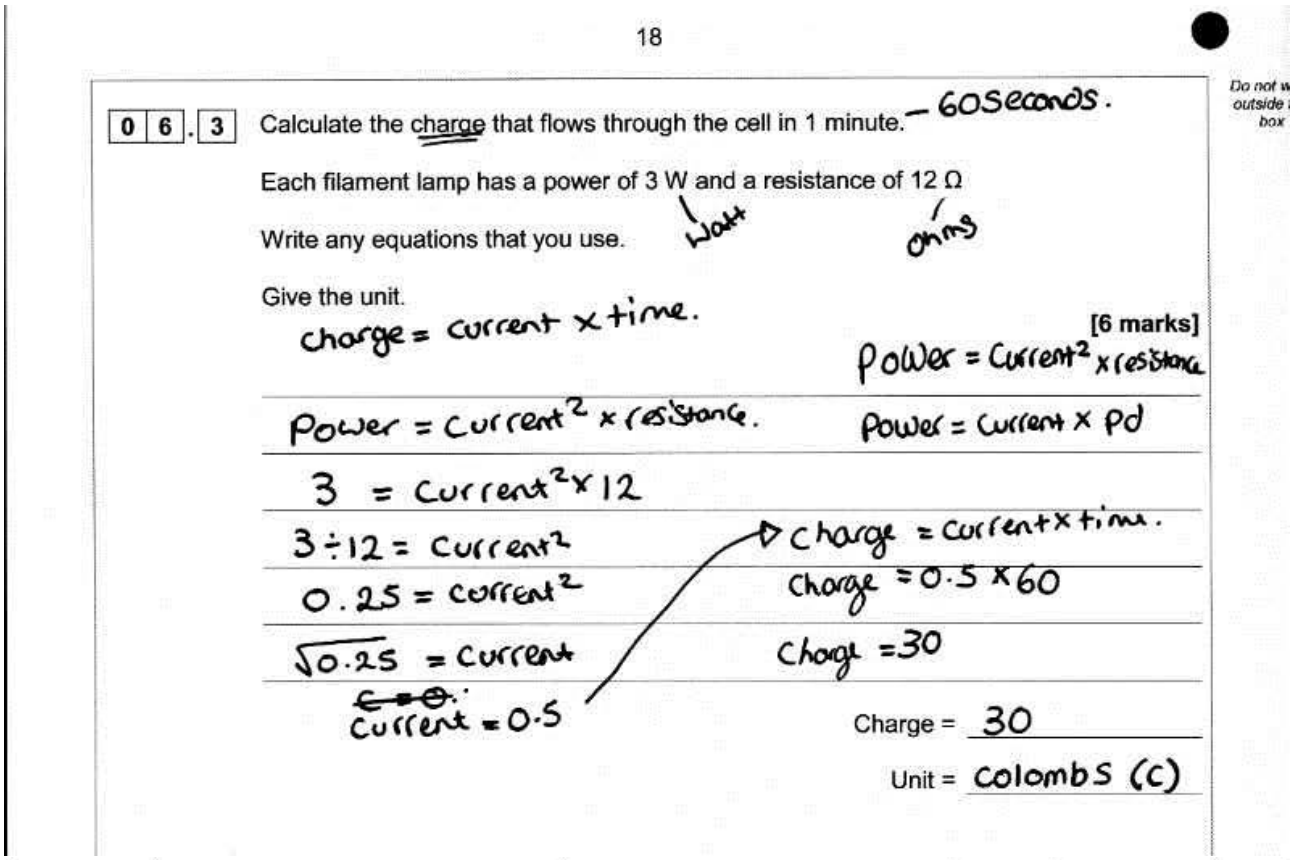
charge flow = current × resistance

= 0.5 × 12

= 6

Charge = 6

Unit = C



06.3		an answer of 60 gains **5** calculation marks		AO2 6.2.4.1 6.2.4.2	E
	$3 = I^2 \times 12$		1		
	$I = \sqrt{(3/12)}$		1		
	$I = 0.5$ (A)		1		
	$Q = 0.5 \times 60 = 30$	allow Q = their calculated I × 60	1		
	$Q_{total} = 60$ **OR**	allow an answer that is consistent with their calculated value of I	1		
	$3 = I^2 \times 12$ (1)				
	$I = \sqrt{(3/12)}$ (1)				
	$I = 0.5$ (A) (1)				
	$I_{total} = 1.0$ (A) (1)	allow I_{total} = their I × 2			
	$Q = 1.0 \times 60 = 60$ (1)	allow an answer that is consistent with their calculated value of I			
	coulombs **or** C		1		

Marks awarded

a) Calculations

Example 1
Total 1 mark.

Example 2
Total 3 marks.

Example 3
Total 2 marks.

b) More calculations

Example 4
Total 1 mark.

Example 5
Total 1 mark.

Example 6
Total 1 mark.

Example 7
Total 2 marks.

Example 8
Total 1 mark.

Example 9
Total 4 marks.

c) Mean and range

Example 10
Total 1 mark.

Example 11
Total 1 mark.

Example 12a
Total 0 marks.

Example 12b
Total 1 mark.

Example 13a
Total 1 mark

Example 13b
Total 2 mark.

Example 14
Total 2 marks.

Example 15
Total 1 mark.

Example 16
Total 2 marks.

d) Use of equations and formulae

Example 17
Total 1 mark.

Example 18
Total 2 marks.

Example 19
Total 0 marks.

Example 20
Total 2 marks.

Example 21
Total 3 marks.

Example 22
Total 3 marks.

Example 23a
Total 3 marks.

Example 23b
Total 4 marks.

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