GCSE
SCIENCE

Science hub meeting

Booklet 1: Guidance, student examples and commentaries

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Contents

GCSE science maths skills

This is the full list as set out by the DfE, but not all of them are assessed in all subjects – look at the individual specifications for the definitive list for that specification.

All the criteria for a specification have to be assessed over the lifetime of the specification, at all levels of demand.

In some instances the DfE consider a skill not to be applicable to a particular science – eg look at 4e (using the tangent to a curve to measure rate of change). In Physics or Chemistry that **would** count towards the maths marks, but it would not be assessed in Biology.

1	Arithmetic and numerical computation
a	Recognise and use expressions in decimal form
b	Recognise and use expressions in standard form
c	Use ratios, fractions and percentages
d	Make estimates of the results of simple calculations

2	Handling data
a	Use an appropriate number of significant figures
b	Find arithmetic means
c	Construct and interpret frequency tables and diagrams, bar charts and histograms
d	Understand the principles of sampling as applied to scientific data (biology questions only)
e	Understand simple probability (biology questions only)
f	Understand the terms mean, mode and median
g	Use a scatter diagram to identify a correlation between two variables (biology and physics questions only)
h	Make order of magnitude calculations

3	Algebra
a	Understand and use the symbols: =, <, <<, >>, >, ∝ , ~
b	Change the subject of an equation
c	Substitute numerical values into algebraic equations using appropriate units for physical quantities (chemistry and physics questions only)
d	Solve simple algebraic equations (biology and physics questions only)

4	Graphs
a	Translate information between graphical and numeric form
b	Understand that $y = mx + c$ represents a linear relationship
c	Plot two variables from experimental or other data
d	Determine the slope and intercept of a linear graph
e	Draw and use the slope of a tangent to a curve as a measure of rate of change (chemistry and physics questions only)
f	Understand the physical significance of area between a curve and the x-axis and measure it by counting squares as appropriate (physics questions only)

5	Geometry and trigonometry
a	Use angular measures in degrees (physics questions only)
b	Visualise and represent 2D and 3D forms including two dimensional representations of 3D objects (chemistry and physics questions only)
c	Calculate areas of triangles and rectangles, surface areas and volumes of cubes

Recognise and use expressions in standard form

General principles

- Standard form is Foundation content at GCSE Maths, so in GCSE science we would expect to assess it at standard demand or above. This means that questions involving standard form could appear on a Foundation tier paper, especially if the question is one that is common with the Higher tier paper.
- If a question says 'give your answer in standard form', there is a mark for the correct standard form. This mark will be at least standard demand, and probably standard/high or high demand, depending on the numbers involved and the rest of the calculation.
- As well as requiring students to use standard form in a calculation we might:
    - ask for an answer from one question (eg question 2.2) to be converted into standard form in the next question (eg 2.3)
    - give a number and ask students to state what it would be in standard form (this is likely to be in the form of a multiple-choice question).
- Many students don't make an attempt at putting their answer in standard form. So, to help students who miss or forget the instruction earlier in the question, from Summer 2020 it will be repeated on the answer line to remind them. For example:

  Acceleration (in standard form) = _____

Progression of demand in assessment of standard form

The table below shows how the features of GCSE Science assessments of the use of standard form progress from low to high demand.

How could you support your students operating at each of these levels of demand?

Low demand (Foundation tier only)	Standard demand (Foundation and Higher tier)	High demand (Higher tier only)
Use of standard form will not be assessed at low demand	An answer will be required in standard form	An answer will be required in standard form
	Numbers will be given as positive (eg $\times 10^{6}$) indices	Numbers will use positive (eg $\times 10^{6}$) **or** negative (eg $\times 10^{-6}$) indices
	Students expected to convert large or small numbers to standard form	Students expected to convert large or small numbers to standard form
	Students **not** expected to carry out calculations using numbers in standard form	Students **are** expected to carry out calculations using numbers in standard form

Example student responses

Example 1

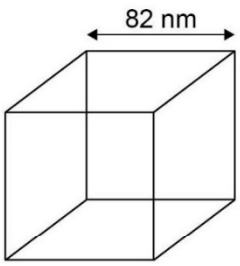
Question

Zinc oxide can be produced as nanoparticles and as fine particles.

A nanoparticle of zinc oxide is a cube of side 82 nm

Figure 15 represents a nanoparticle of zinc oxide.

Figure 15



Calculate the surface area of a nanoparticle of zinc oxide.

Give your answer in standard form.

[3 marks]

Surface area = _____ nm^2

Mark scheme

10.3		an answer of 4.0×10^4 (nm^2) scores **3** marks an answer of 40344 (nm^2) scores **2** marks		AO2 4.2.4.1
	(82^2 =) 6724 (nm^2)		1	
	(6 x 6724 =) 40344 (nm^2)	allow 40344 (nm^2) correctly rounded to any number of significant figures allow correct calculation using incorrectly calculated value of area of one face from step 1	1	
	= 4.0×10^4 (nm^2)	allow 4.0344×10^4 (nm^2) correctly rounded to 1 or more significant figures allow a correctly calculated and rounded conversion to standard form of an incorrect calculation of surface area	1	

Level of demand of question

This is a standard demand question from Chemistry Paper 1F question 10.3 (1H question 3.3). The following features make it standard demand:

- there is a straightforward calculation of surface area (82 x 82 x 6)
- giving a biggish number (40344 nm^2, rounds to 4.0 x 10^4 nm^2)
- there are no numbers given in standard form to do the calculation with – we are just asking to convert the answer to standard form
- the answer is a positive index.

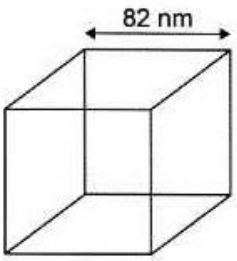
Student A

Zinc oxide can be produced as nanoparticles and as fine particles.

1 0 . 3 A nanoparticle of zinc oxide is a cube of side 82 nm

Figure 15 represents a nanoparticle of zinc oxide.

Figure 15



Calculate the surface area of a nanoparticle of zinc oxide.

Give your answer in standard form.

[3 marks]

$82^2 \times 6 = 40344$ nm.

4.0344×10^4

Surface area = 4.0344×10^4 nm^2

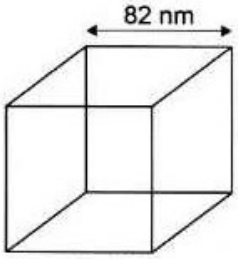
Student B

Zinc oxide can be produced as nanoparticles and as fine particles.

1 0 . 3 A nanoparticle of zinc oxide is a cube of side 82 nm

Figure 15 represents a nanoparticle of zinc oxide.

Figure 15



Calculate the surface area of a nanoparticle of zinc oxide.

Give your answer in standard form.

[3 marks]

82 × 82 = 6724 × 6 = 40344

Surface area = 0.40344 × 10^5 nm^2

Example 2: Physics Paper 1H question 5.3

This is a standard/high demand question

- Students need to recognise that 414 days is three half lives
- Then students needed to do three successive doublings of 1.45×10^{-4}
- Using numbers in standard form in a calculation
- Also using negative index (10^{-4})

We did not ask for the answer to be given in standard form so an answer of 0.00116 g was accepted. However, if students chose to give the answer in standard form it must have been correctly quoted as 1.16×10^{-3} to gain the final mark.

Mark scheme

5.3	$\frac{414}{138} = 3$ (half-lives) $1.45 \times 10^{-4} \times 2 \times 2 \times 2$ $= 1.16 \times 10^{-3}$ (g) **or** = 0.00116 (g)	an answer of 1.16×10^{-3} (g) scores **3** marks	1 1 1	4.4.2.3 AO2

Student C

0 5 . 3 A sample of polonium-210 was left for 414 days.

After this time it had a mass of 1.45×10^{-4} g

The half-life of polonium-210 is 138 days.

Calculate the initial mass of the sample.

[3 marks]

414 ÷ 138 = 3

3 half lives

$1.45 \times 10^{-4} \times 2 = 0.00029$ (1)

$\times 2 = 0.00058$ (2)

$\times 2 = 0.00116$ (3)

Initial mass = 0.00116 g

Student D

0 5 . 3 A sample of polonium-210 was left for 414 days.

After this time it had a mass of 1.45×10^{-4} g

The half-life of polonium-210 is 138 days.

Calculate the initial mass of the sample.

[3 marks]

$\frac{414}{138} = 3$ 3 half lives in 414 days

$1.45 \times 10^{-4} \times 2 = 2.9 \times 10^{-4}$

$2.9 \times 10^{-4} \times 2 = 5.8 \times 10^{-4}$

$5.8 \times 10^{-4} \times 2 = 1.16 \times 10^{-3}$

Initial mass = 1.16×10^{-3} g

Example 3: Combined Science Synergy Paper 2H question 4.5

This is a standard/high demand question

- Students need to recognise that the diagrams were not using the same units so some conversion was needed.
- **Either** convert 60 µm to standard form (6×10^{-5} m) and then carry out the calculation using standard form for both cells **or** convert 5.0×10^{-7} m into µm and carry out the calculation using 60 µm and 0.5 µm.
- Also uses negative indexes.

The answer was not required or expected in standard form.

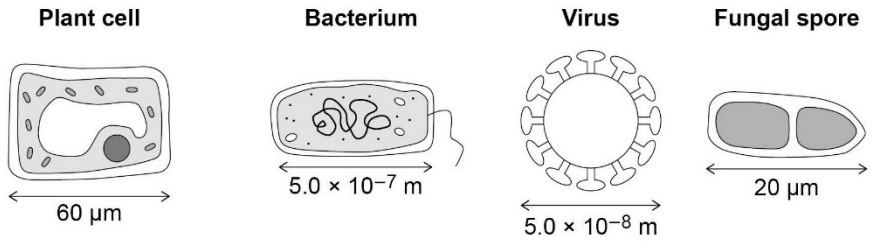
Mark scheme

04.5		an answer of 120 scores **3** marks		4.1.3.1
	(plant cell) (60 µm =) 6.0×10^{-5} m **or** (bacterial cell) (5.0×10^{-7} m) = 0.5 µm		1	AO2
	$\frac{6.0 \times 10^{-5}}{5.0 \times 10^{-7}}$ **or** $\frac{60}{0.5}$	allow incorrectly / not converted value for length correctly substituted	1	AO2
	(=) 120	allow a correctly calculated value using an incorrectly / not converted value for length	1	AO2

Diagrams for question

Figure 3 shows diagrams of a plant cell and three types of microorganism.

Figure 3



Student E

0 4 . 5 Calculate how many times longer the plant cell is than the bacterium. **[3 marks]**

60 Mm / 5×10⁻⁷ m 60 Mm / 5×10⁻⁷ m × 1000 × 1000

60 / 0.5

Number of times longer = 120

Student F

0 4 . 5 Calculate how many times longer the plant cell is than the bacterium. **[3 marks]**

.0000005 m = bacterium

= .0000600 m = plant cell

0000005 / 000600 600 ÷ 5 = 120

Number of times longer = 120

Example 4: Combined Science Trilogy Chemistry Paper 1H question 4.6

This is a high demand question

- The calculation is straightforward but requires students to carry out the calculation using the Avogadro number in standard form.
- It requires the answer to be given in standard form.

Mark scheme

04.6		an answer of 1.51×10^{22} scores **2** marks		AO2 5.3.2.1
	$\frac{1}{40} \times 6.02 \times 10^{23}$ **or** $0.025 \times 6.02 \times 10^{23}$		1	
	1.51×10^{22}	allow 1.505×10^{22}	1	

Student G

0 4 . 6 How many atoms are there in 1 g of argon?

The Avogadro constant is 6.02×10^{23} per mole.

Relative atomic mass (A_r): Ar = 40

[2 marks]

$40 \times 6.02 \times 10^{23} = 2.408 \times 10^{25}$

Number of atoms in 1 g = 2.408×10^{25}

Student H

0 4 . 6 How many atoms are there in 1 g of argon?

The Avogadro constant is 6.02×10^{23} per mole.

Relative atomic mass (A_r): Ar = 40

[2 marks]

mass = Mr × mole mole = $\frac{\text{mass}}{Mr}$ = $\frac{1}{40}$ = 0.025

$6.02 \times 10^{23} \times 0.025 = 1.505 \times 10^{22}$

Number of atoms in 1 g = 1.505×10^{22}

Use an appropriate number of significant figures

General principles

- The ability to round to a correct number of significant figures is considered to be at least standard demand, so questions asking for significant figures may be on a Foundation paper.
- At low demand, we may ask for an answer to be given to a certain number of decimal places. We will give the prompt 'give your answer to x decimal places'.
- In questions where the prompt 'give your answer to x significant figures' (or 'give your answer to x decimal places') is seen, there is a mark for doing so.
- The number of significant figures required will follow the recommended practice of having the same number of significant figures as the lowest number in the data used (in preparation for work at A-level).
- If we don't ask for correct significant figures in a question then the number of significant figures provided in the answer is generally inconsequential.
- However, if a student does decide to round their final answer, if the rounding is incorrect they might not get the final marking point.
- There may be a compensatory mark for an incorrect numerical answer quoted to correct number of significant figures – **but** only if the student has attempted a calculation using the data given. They would **not** gain that mark simply for quoting any correctly rounded number.
- Students should also be encouraged not to round in intermediate steps in a calculation, as this could result in their final answer being outside the acceptable range.
- Many students don't make an attempt at putting their answer to a required number of significant figures. So, to help students who miss or forget the instruction earlier in the question, from summer 2020 it will be repeated on the answer line to remind them. For example:

  Acceleration (2 significant figures) = _____

Progression of demand in assessment of significant figures

The table below shows how the features of GCSE Science assessment of use of significant figures progress from low to high demand.

How could you support your students operating at each of these levels of demand?

Low demand (Foundation tier only)	Standard demand (Foundation and Higher tier)	High demand (Higher tier only)
Significant figures **not** assessed at low demand, but students may be asked to give correct number of decimal places	Students will be expected to round down correctly	Students will be expected to round down correctly
		Students will also be expected to round up correctly

Example student responses

Example 5: Combined Science Trilogy Physics Paper 1F question 2.7

This question covers mixed demand levels. The calculation using a given equation is low demand (see autumn 2019 Hub materials for more on assessing application of equations). The answer should be rounded down to give 2 significant figures, which is expected at standard demand.

Mark scheme

02.7		an answer of 15 000 (J) scores **3** marks		AO2.1 6.2.4.2
	E = 490 × 31		1	
	E = 15 190	allow 15 200 if correct substitution is seen	1	
	E = 15 000 (J)	allow an answer to 2 s.f. consistent with their calculated value of E using E=QV	1	

Student I

0 2 . 7 Some homes have solar panels which generate electricity.

On a sunny day the potential difference across a solar panel is 31 volts.

A charge of 490 coulombs flows through the solar panel.

Calculate the energy transferred by the solar panel.

Use the equation:

energy transferred = charge flow × potential difference

Give your answer to 2 significant figures.

[3 marks]

490 × 31 = 15190

Energy transferred = 15200 J

Student J

0 2 . 7 Some homes have solar panels which generate electricity.

On a sunny day the potential difference across a solar panel is 31 volts.

A charge of 490 coulombs flows through the solar panel.

Calculate the energy transferred by the solar panel.

Use the equation:

energy transferred = charge flow × potential difference

Give your answer to 2 significant figures.

[3 marks]

energy transfered = 490 x 31 = 15190

Energy transferred = 15 J

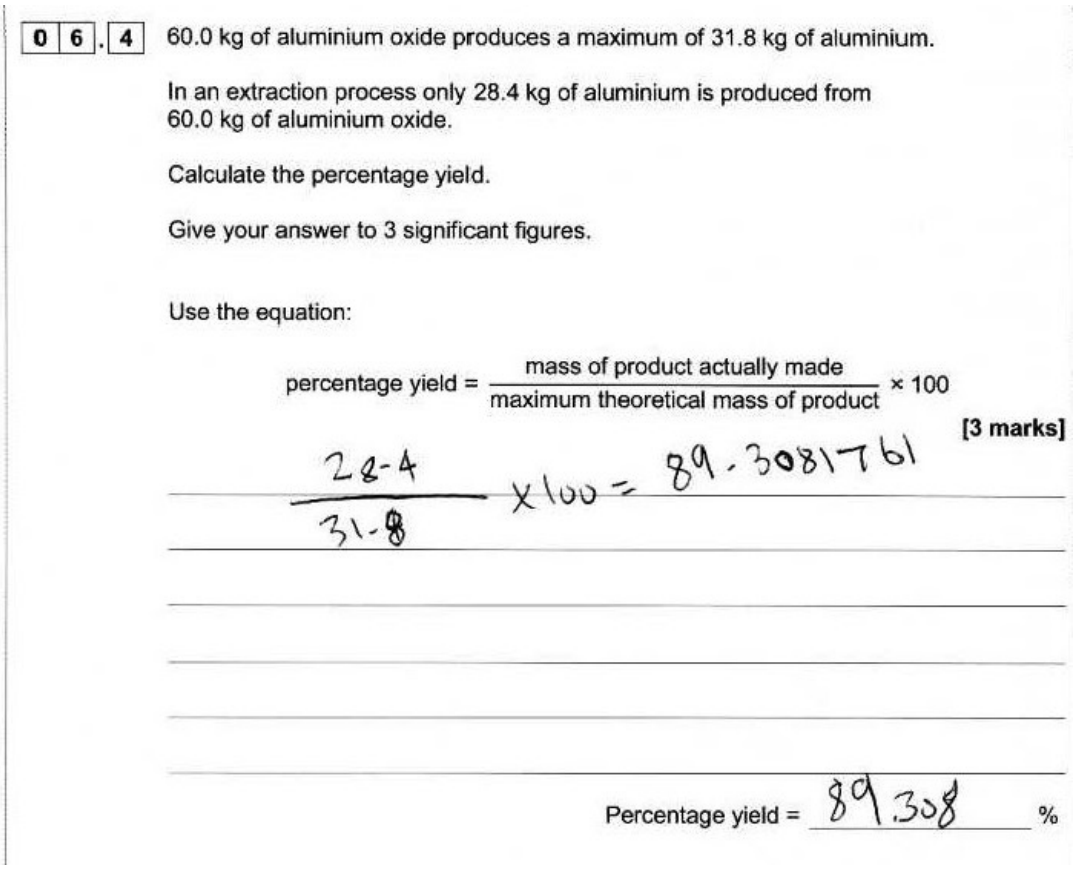
Example 6: Chemistry Paper 1F question 6.4

In this question, students need to carry out a percentage calculation and give their answer to 3 significant figures, which is the same as the lowest number of significant figures in the data.

Mark scheme

06.4	$\frac{28.4}{31.8} \times 100$	an answer of 89.3 (%) scores **3** marks	1	AO2 4.3.3.1
	= 89.3081761 (%)	allow 89.3081761(%) correctly rounded to at least 2 significant figures	1	
	= 89.3 (%)	allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses the masses in the question	1	

Student K



0 6 . 4 60.0 kg of aluminium oxide produces a maximum of 31.8 kg of aluminium.

In an extraction process only 28.4 kg of aluminium is produced from 60.0 kg of aluminium oxide.

Calculate the percentage yield.

Give your answer to 3 significant figures.

Use the equation:

$$\text{percentage yield} = \frac{\text{mass of product actually made}}{\text{maximum theoretical mass of product}} \times 100$$

[3 marks]

$\frac{28.4}{31.8} \times 100 = 89.3081761$

Percentage yield = 89.308 %

Student L

0 6 . 4 60.0 kg of aluminium oxide produces a maximum of 31.8 kg of aluminium.

In an extraction process only 28.4 kg of aluminium is produced from 60.0 kg of aluminium oxide.

Calculate the percentage yield.

Give your answer to 3 significant figures.

Use the equation:

$$\text{percentage yield} = \frac{\text{mass of product actually made}}{\text{maximum theoretical mass of product}} \times 100$$

[3 marks]

$\frac{31 \cdot 8}{28 \cdot 4} \times 100 = 111.971831$

112

Percentage yield = 112 %

Example 7: Synergy Paper 2F question 7.6

In this question, students are required to round down their calculated answer to 4 significant figures, which matches the data given in the table. It is a standard demand question.

Mark scheme

07.6	152.62 152.6 (ms)	an answer of 152.6 scores **2** marks allow correct rounding of an incorrect calculated value	1 1	4.2.1.6 AO2

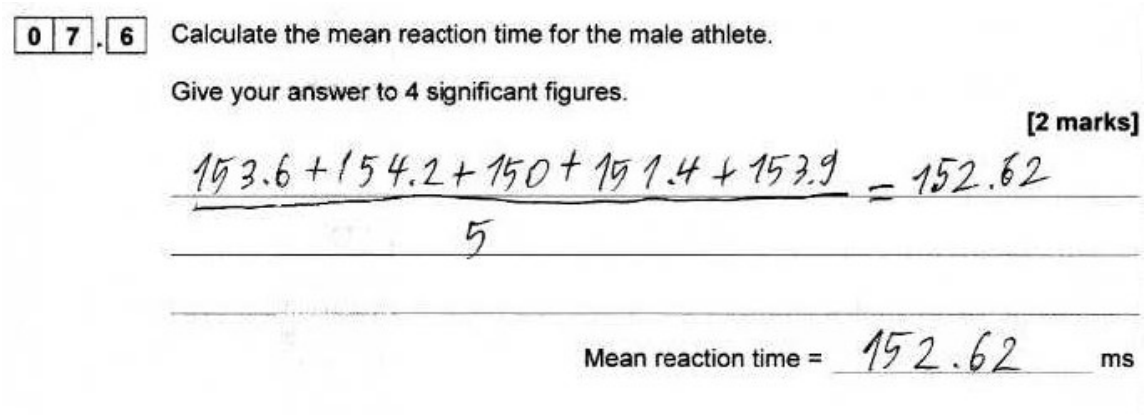
Data table

Table 4 shows the results.

Table 4

	Reaction time in milliseconds (ms)	
	Male athlete	**Female athlete**
Test 1	153.6	138.2
Test 2	154.2	145.7
Test 3	150.0	149.1
Test 4	151.4	142.9
Test 5	153.9	140.6

Student M



0 7 . 6 Calculate the mean reaction time for the male athlete.

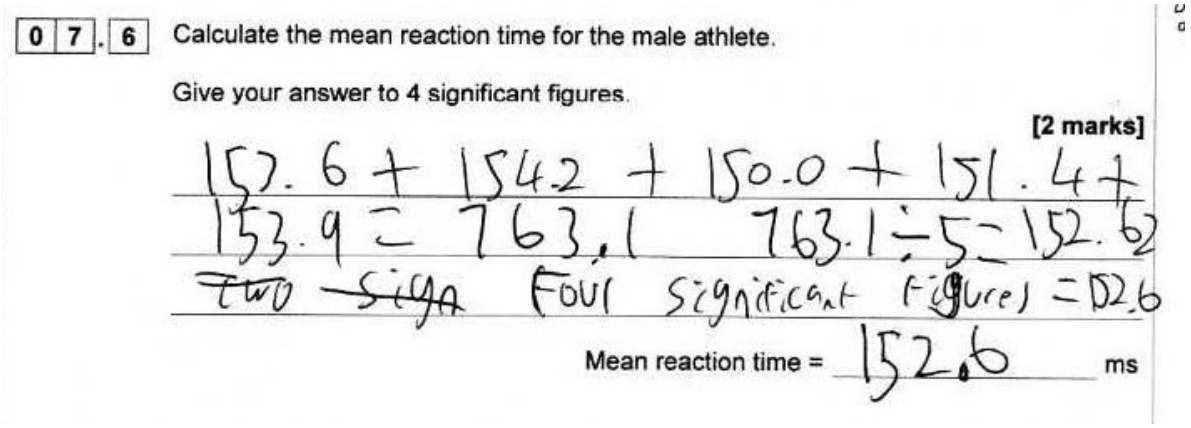
Give your answer to 4 significant figures.

[2 marks]

$\frac{153.6 + 154.2 + 150 + 151.4 + 153.9}{5} = 152.62$

Mean reaction time = 152.62 ms

Student N



0 7 . 6 Calculate the mean reaction time for the male athlete.

Give your answer to 4 significant figures.

[2 marks]

157.6 + 154.2 + 150.0 + 151.4 + 153.9 = 763.1 763.1 ÷ 5 = 152.62

~~two sigA~~ four significant figures = 152.6

Mean reaction time = 152.6 ms

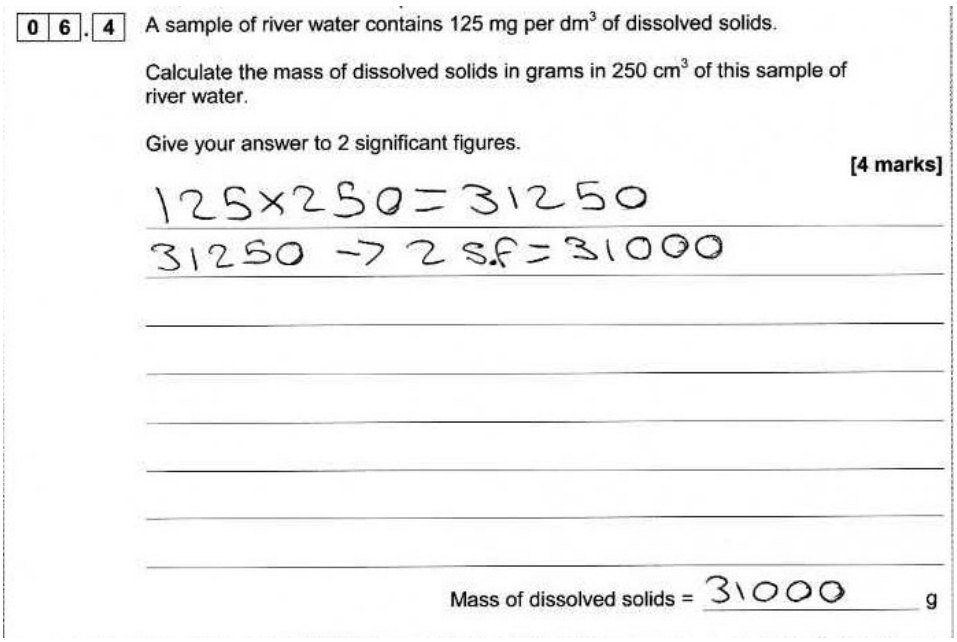
Example 8: Trilogy Chemistry Paper 2F question 6.4/2H question 1.4

This is a standard demand question, students being required to round their calculated answer down to 2 significant figures. It also tests students' understanding of how zeros following a decimal point are treated in determination of significant figures.

Mark scheme

06.4		an answer of 0.031 (g) scores **4** marks		AO2 5.3.2.5 10.2.13
	(conversion of cm^3 to dm^3) (250 cm^3 =) $\frac{250}{1000}$ or 0.25 (dm^3)		1	
	(conversion of mg to g) (125 mg =) $\frac{125}{1000}$ or 0.125 (g)		1	
	(0.25 × 0.125) = 0.03125	allow correct calculation from incorrect attempt(s) at conversion	1	
	=0.031 (g)	allow an answer correctly rounded to 2 significant figures from an incorrect calculation that uses the values in the question	1	

Student 0



0 6 . 4 A sample of river water contains 125 mg per dm^3 of dissolved solids.

Calculate the mass of dissolved solids in grams in 250 cm^3 of this sample of river water.

Give your answer to 2 significant figures.

[4 marks]

125×250=31250

31250 → 2 s.f = 31000

Mass of dissolved solids = 31000 g

Student P

0 1 . 4 A sample of river water contains 125 mg per dm^3 of dissolved solids.

Calculate the mass of dissolved solids in grams in 250 cm^3 of this sample of river water.

Give your answer to 2 significant figures.

[4 marks]

$250cm^3 \longrightarrow 250{,}000\,dm^3$

$125mg \longrightarrow 0.125g$

$0.125 \times 250{,}000 = 31250$

$= 31000$

Mass of dissolved solids = 31000 g

Example 9: Synergy Paper 1H question 3.3

This is a standard/high demand calculation, requiring the calculated answer to be rounded up.

Mark scheme

03.3		an answer of 0.231 scores **4** marks an answer of 0.23073753 scores **3** marks		AO2 4.3.1.3
	$\left(\frac{636}{12\,562} \times 100 =\right)$ 5.06288808		1	
	$\left(\frac{606}{12\,541} \times 100 =\right)$ 4.83215055		1	
	(subtraction =) 0.23073753		1	
	(answer to 3 significant figures =) 0.231		1	

Question stem and data

0 3 . 3 A new CHD drug has been trialled to reduce the concentration of cholesterol in the blood.

Patients were given the new CHD drug or a placebo.

One possible side effect of the new CHD drug is an increased risk of diabetes.

Table 1 shows some of the results.

Table 1

	Group 1: New CHD drug	**Group 2: Placebo**
Number of patients	12 562	12 541
Number of patients developing diabetes during the trial	636	606

Calculate the difference between the percentage of patients developing diabetes in group 1 compared to group 2.

Give your answer to 3 significant figures.

[4 marks]

Student Q

Calculate the difference between the percentage of patients developing diabetes in group 1 compared to group 2.

Give your answer to 3 significant figures.

[4 marks]

$\frac{636}{12562} \times 100 = 5.0628...\%$

$\frac{606}{12541} \times 100 = 4.8321...\%$

$5.0628... - 4.8321... = 0.2306...$

$= 0.23\%$ (3sf)

Difference = 0.23 %

Student R

Calculate the difference between the percentage of patients developing diabetes in group 1 compared to group 2.

Give your answer to 3 significant figures.

[4 marks]

Group 1: Group 2:

$\frac{636}{12562} \times 100$ $\frac{606}{12591} \times 100$

$= 5.062888075\%$ $= 4.832150546\%$

Difference = 0.231 %

Group 1 (5.062888075)
− Group 2 (4.832150546)
0.230737529

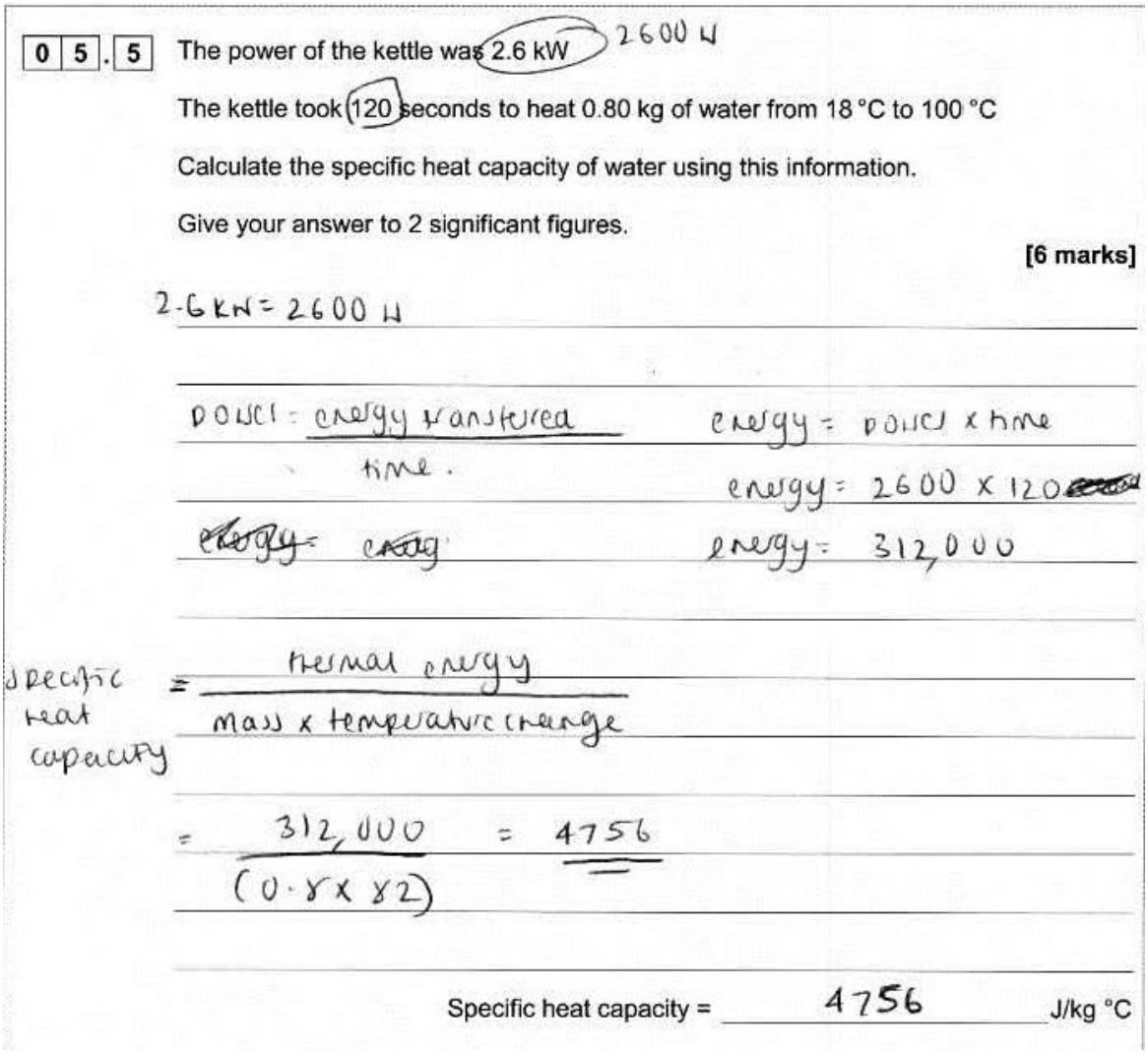
Example 10: Trilogy Physics Paper 1H question 5.5

This is a high demand multi-step calculation, requiring students to round their final answer correctly to 2 significant figures. As with other questions requiring correct significant figures, a student who has attempted a calculation using the data given and correct equations, but has made errors in the calculation, may still gain a compensation point for correct rounding of their incorrect answer.

Mark scheme

05.5		an answer of 4800 (J/kg °C) scores **6** marks a correct answer given to more than 2 s.f. scores **5** marks		AO2.1 6.3.2.2 6.1.1.3 6.1.1.4 WS 3.3
	$E = 2600 \times 120$	allow a correct substitution of an incorrectly/not converted value of P and/or t.	1	
	$E = 312\,000$ (J)	this answer only the equation E=Pt must have been used to score subsequent marks.	1	
	$312\,000 = 0.80 \times c \times (100-18)$ **or** $312\,000 = 0.80 \times c \times (82)$	allow use of their value of E calculated using E =Pt for this and subsequent steps	1	
	$c = \frac{312\,000}{0.80 \times 82}$		1	
	$c = 4\,756$		1	
	c = 4 800 (J/kg °C) (2 s.f.)	this mark can only be scored for a correct rounding of a value of c calculated using correct equations	1	

Student S



0 5 . 5 The power of the kettle was 2.6 kW 2600 W

The kettle took 120 seconds to heat 0.80 kg of water from 18 °C to 100 °C

Calculate the specific heat capacity of water using this information.

Give your answer to 2 significant figures.

[6 marks]

2.6 kW = 2600 W

power = energy transferred / time

energy = power x time

energy = 2600 x 120

energy = 312,000

specific heat capacity = thermal energy / mass x temperature change

= 312,000 / (0.8 x 82) = 4756

Specific heat capacity = 4756 J/kg °C

Student T

0 5 . 5 The power of the kettle was 2.6 kW

The kettle took 120 seconds to heat 0.80 kg of water from 18 °C to 100 °C

Calculate the specific heat capacity of water using this information.

Give your answer to 2 significant figures.

[6 marks]

$E = mc\theta$ $E = Pt = 2600 \times 120$

$c = \frac{E}{m \times \theta}$ $= E = 2600 \times 120\,s = 312000\,J$

$c = \frac{312000}{0.8 \times 82} = 4756 = 4700$

Specific heat capacity = 4700 J/kg °C

Graphing skills

General points

- Students should be encouraged to use crosses when plotting data points rather than dots so that:
    - it is easier for the examiner to see that the plotting is accurate and within tolerance
    - the points will be clearly visible when the line of best fit is drawn (dots can disappear under a line and make it impossible to see whether the plotting has been accurate enough to gain the marks).
- There is usually a tolerance on plotting of plus or minus half a small square on the grid.
- We only ever ask students to plot a maximum of 6 points on a graph for 2 marks.
- To be credited with a single mark, students will need to plot 3/4 or 5/6 points correctly.
- If the data table includes 0,0 that point should also be plotted for full marks.
- The axis to be labelled will be indicated, except at high demand.
- Students should be encouraged to use the headings given in the table of data as a clue to what the label should be, and the data itself to decide on a suitable scale.
- We would expect a graph to cover at least half of the grid supplied. The grids in the paper are always drawn so that there is room to do this.
- We will indicate where we are expecting a line of best fit to be drawn, by the words ‘draw a line of best fit’. Students should understand by this that we are expecting them to do something other than simply join the data points using straight lines and a ruler. See below for more information on drawing lines of best fit.
- From summer 2020, we include an instruction that makes it clear that students can use pencil for drawing (although pencil-drawn graphs have always been accepted).

Assessment principles

- The level of demand depends to a large extent on the complexity of the data to be processed.
- At all levels we may ask students to label or give a scale to one of the axes. There will be a prompt at lower demands as to which axis this should be; at higher demands students will be expected to understand what is needed.

At low demand:

- data points will be simple numbers (whole numbers or simple decimals)
- students will be asked to plot a single variable
- scales will be clear and straightforward
- numbers to be plotted will be on a straight line
- a line of best fit will be all points on a straight line
- we may ask students to extrapolate the line.

At standard demand:

- data points will be more complex numbers
- may be a more complex scale
- data may be on a straight line or a curve
- a line of best fit will be:
    - a straight line where points do not all sit on the line **or**
    - a straight line, with an anomaly that needs to be ignored **or**
    - a curve, where all points sit on the curve
- students may need to extrapolate from a curved line.

At higher demands:

- data points may include negative values
- may be a complex scale and/or multiple variables
- may be required to label and choose an appropriate scale for both axes
- a line of best fit will be:
    - a curve, where all the points do not sit on the line **or**
    - a curve, where there is an anomaly that must be identified and ignored without prompting
- students may need to extrapolate from a curved line.

Drawing lines of best fit

Whether students should draw a line of best fit or a dot-to-dot graph depends on the data that they are plotting.

For example, if students were plotting a table of patient's blood pressure measured at certain time periods, the assumption is that each value for blood pressure is the actual value for that particular time and we cannot tell what happens to the blood pressure between the data points. So we draw a line that passes through all the points – a dot-to-dot.

If, however, they were plotting data about the extension of a spring with mass added, the assumption is that there is a simple relationship between the two variables so that the true values all lie on the line and that if all the values could be measured accurately then they would lie in the line. In practice, because the measurements are not completely accurate we would draw a line of best fit.

As a rule of thumb, when drawing a line of best fit there should be as many points on one side of the line as the other. Often the line should pass through, or very close to, the majority of plotted points. A line of best fit should be continuous and drawn thinly so that it does not obscure the points below.

Students need to realise that an appropriate line of best fit is not necessarily a straight line through the origin as they may have been taught in their Maths lessons. In Science, it often is a curve because the underlying relationship in the data is non-linear.

The Association for Science Education has produced an excellent guide, *The Language of Mathematics in Science: A Guide for Teachers of 11-16 Science*, which explains very clearly examples of when a line of best fit is to be drawn or when a dot-to-dot would be accepted. You can download it free here. On pages 29 and 30 of this guide they give very clear examples of the type of line to draw.

The ASE guide also explains very clearly in Chapter 7 (specifically Section 7.7) about plotting lines of best fit in linear and non-linear relationships.

They also have a booklet of teaching approaches as a complement to this guide, which you may also find helpful.

In questions at all levels of demand, we will prompt students with the instruction 'Draw a line of best fit', which they should take as an indication that a line of best fit, and not a dot-to-dot drawing, is required.

Progression of demand in assessment of graphing skills

The table below shows how the features of GCSE Science assessment of graphing skills progress from low to high demand.

How could you support your students operating at each of these levels of demand?

Low demand (Foundation tier only)	Standard demand (Foundation and Higher tier)	High demand (Higher tier only)
Scale or labels for one axis Axis to be completed will be indicated	Scale and/or label for one axis Axis to be completed will be indicated	Scale and label for one or both axes No prompting as to scale or labels
Simple numbers or simple decimals	More complex numbers	Complex numbers, including negative values
Single variable	Single variable	Multiple variables or scales
Clear, straightforward and simple scales	Scales will be more complex	Complex scales
Numbers to be plotted will fall on grid lines	Numbers may not all fall on grid lines	Numbers may not fall on grid lines
Numbers to plot will be on a straight line	Numbers to plot will be on a straight line **or** on a curve	Numbers to plot on a curve
Line of best fit will be a straight line with all points on the line	Line of best fit more demanding: a straight line where all points do not sit on the line **or** with an anomaly that needs to be ignored (with prompt), **or** a clear curve with all points on the curve	Line of best fit more demanding: a curve, where points do not all sit on the curve **or** where there is an anomaly that must be identified and ignored with no prompting
Students may be asked to extrapolate from a straight line	Students may be asked to extrapolate from a curve	Students may be asked to extrapolate from a curve

Example 11: Combined Science Synergy Paper 4F question 5.4

This is a low demand physics-based question, requiring students to plot four data points for 2 marks and draw a line of best fit. Correct plotting of 3 of the 4 points will gain 1 mark.

- The numbers on the *x*-axis are all simple whole numbers, on the *y* axis simple decimals.
- The data points on the *x*-axis all fall on major grid lines.
- The scale on the *y*-axis is smaller, but is clear and all points fall on grid lines.
- The line of best fit is a straight line, with all the points on the line.
- Two points have already been plotted, as a prompt to using the scale.

Mark scheme

05.4	4 points correctly plotted straight line of best fit	allow tolerance of ±½ a small square allow **1** mark for 3 points correctly plotted	2 1	AO2 4.7.2.2

Data table and question

Table 4 shows the student's results.

Table 4

Number of resistors	Total resistance in ohms
1	2.2
2	4.4
3	6.6
4	8.8
5	11.0
6	13.2

0 5 . 4 Complete **Figure 4** using data from **Table 4**.

You should:

- plot the rest of the results
- draw a line of best fit.

[3 marks]

Student U

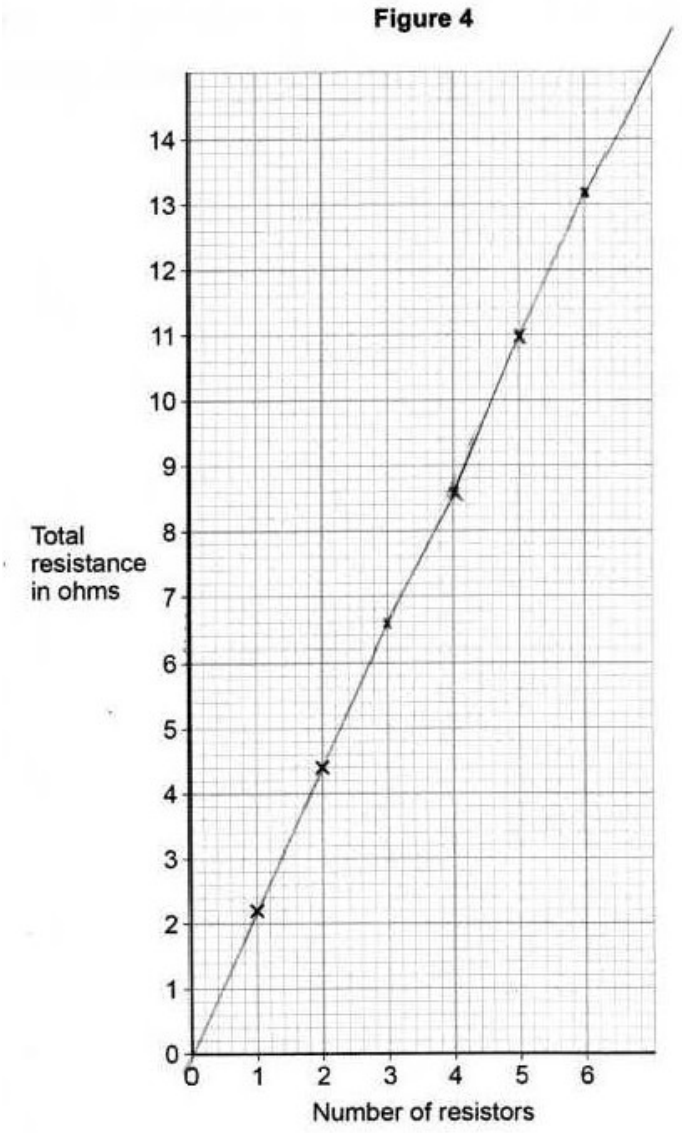
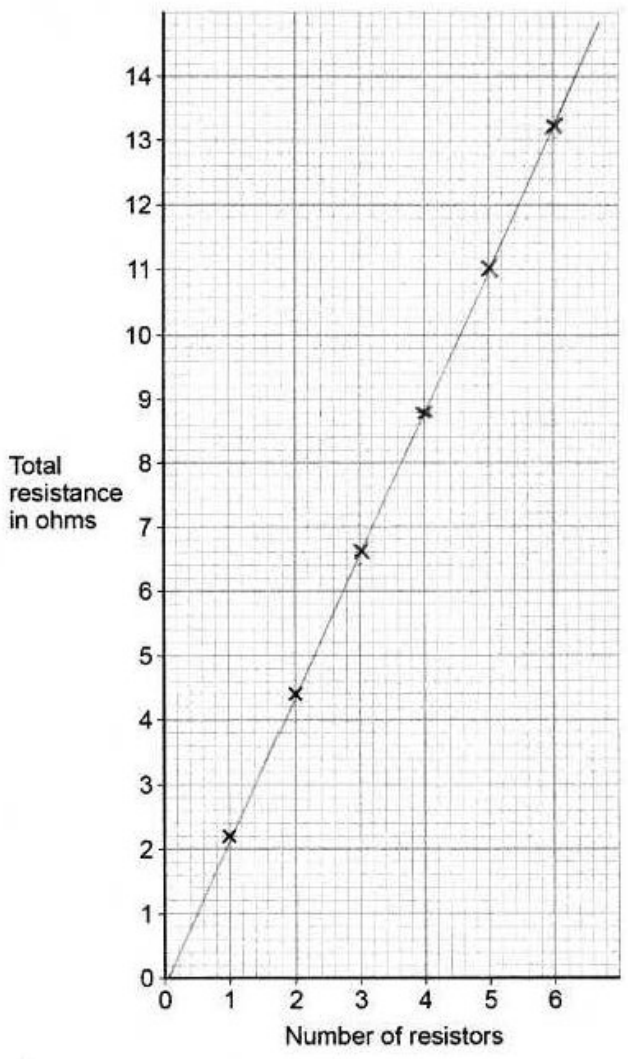


Figure 4
Total resistance in ohms
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
0
1
2
3
4
5
6
Number of resistors

Student V

Figure 4



Example 12: Biology Paper 1F question 9.5/Paper 1H question 3.5

This is a standard demand common question.

- Students are expected to choose a suitable scale and label for the *x*-axis.
- Although it was expected that students would choose 50 W for each big square, as long as the scale chosen covers at least half the grid it would gain the marks.
- The numbers to be plotted on the *x*-axis are whole numbers and if an appropriate scale was chosen fall clearly on grid lines.
- The numbers for the *y*-axis are simple decimals and all – except for the calculated point – fall on minor grid lines.
- Students needed to plot 5 points for 2 marks (3 or 4 correctly plotted gain 1 mark).
- The line of best fit is a curve, with all points fitting on the curve.
- In the previous question, students had to calculate one of the points (X in the table). They then needed to include that point in their plot. If the student calculated X incorrectly, but used that number correctly in their plotting, they were allowed error carried forward and could still achieve the plotting marks.

Mark scheme

09.5	correct scale **and** axis labelled	max **3** marks for bar chart	1	4.4.1.2 AO2
	all points plotted correctly	allow points plotted to within ± ½ small square allow 3 or 4 correct plots for **1** mark allow correct plot from incorrect value calculated in question **09.4**	2	
	correct curved line of best fit	ignore line extended beyond 60 / 250 (W) ignore line joined point to point with straight lines	1	

Data table and question

Table 9 shows the student's results.

Table 9

Power output of bulb in watts	Volume of oxygen collected in 20 minutes in cm^3	Rate of photosynthesis in cm^3/hour
60	0.5	1.5
100	0.8	2.4
150	1.1	X
200	1.2	3.6
250	1.2	3.6

0 9 . 5 Complete **Figure 15**.

[4 marks]

You should:

- label the x-axis
- use a suitable scale
- plot the data from **Table 9** and your answer to Question **09.4**
- draw a line of best fit.

Student W

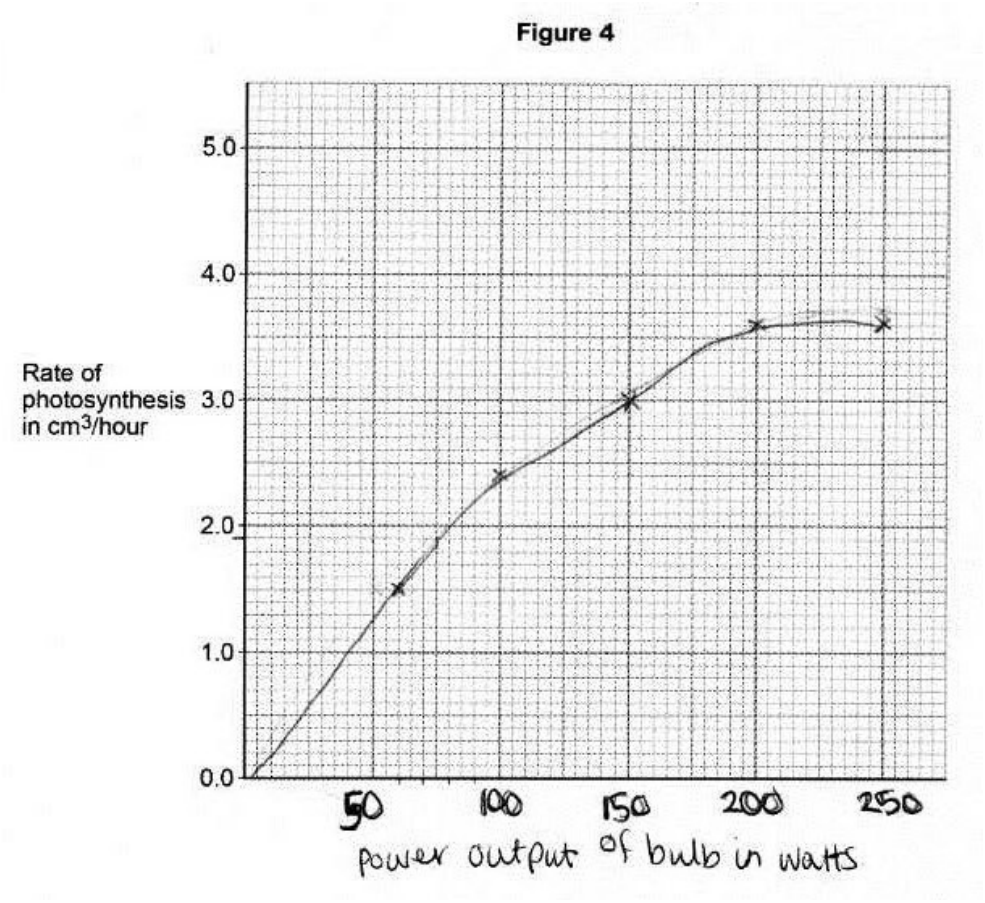
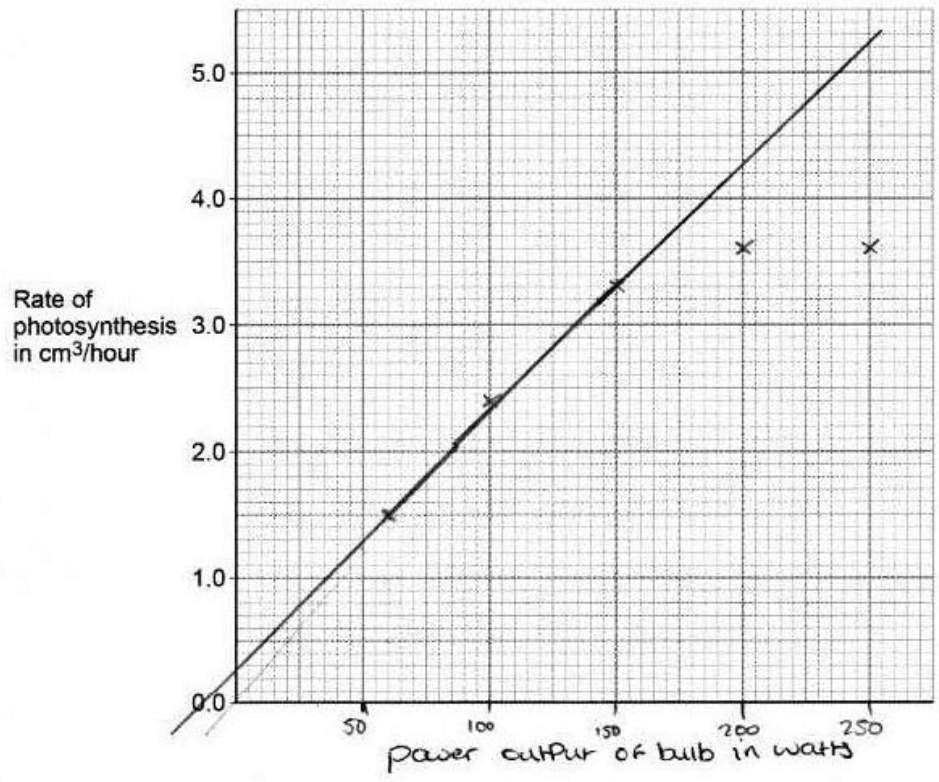


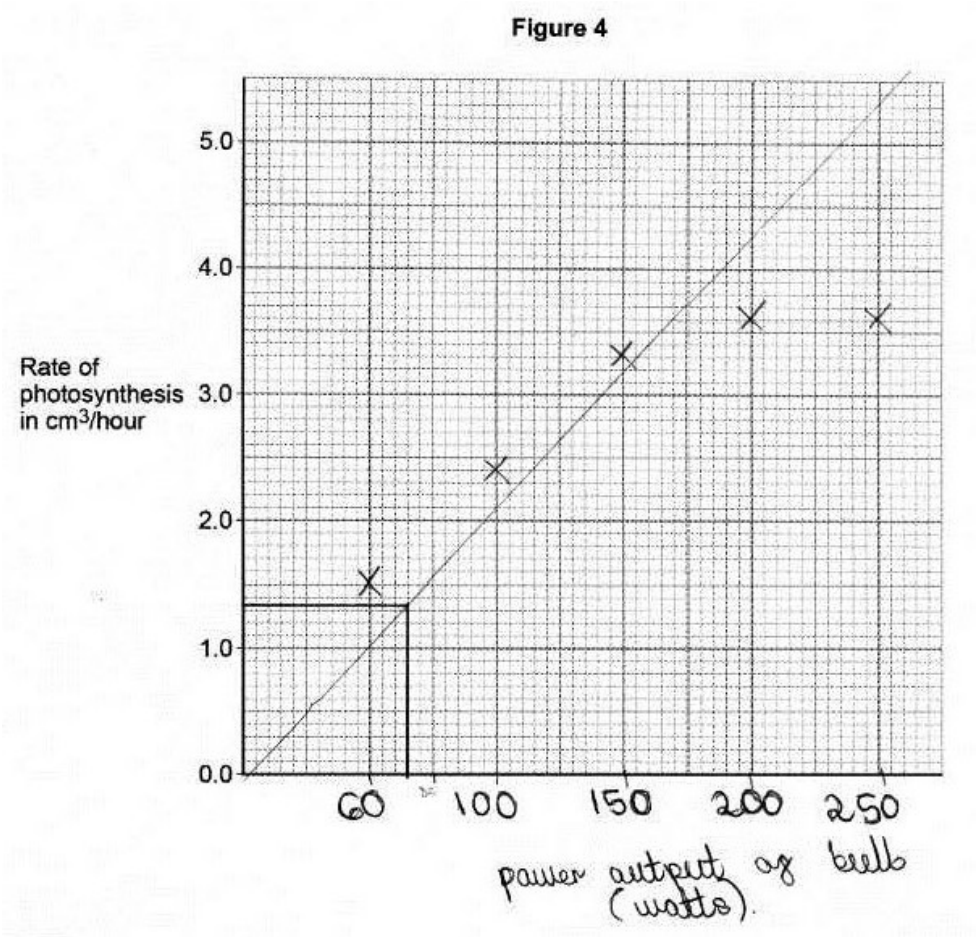
Figure 4
Rate of photosynthesis in cm3/hour
5.0
4.0
3.0
2.0
1.0
0.0
50
100
150
200
250
power output of bulb in watts

Student X

Figure 4



Student Y



Example 13: Chemistry Paper 1H question 9.2

- In this question students needed to plot 6 data points from the table for 2 marks (3, 4 or 5 correctly plotted would gain 1 mark).
- Both sets of numbers are decimal (not whole numbers) and none fall on obvious grid lines.
- The curve of the line of best fit is slight, which increases the demand of choosing an appropriate line, although all the points do fit on the curve.
- Students then needed to continue the curve on both lines to ensure a correct crossing point.

Mark scheme

09.2	all six points plotted correctly	allow a tolerance of ± ½ a small square allow **1** mark for at least 3 points plotted correctly	2	AO2 4.5.1.1
	line of best fit through points plotted from Table 6		1	
	both lines of best fit extrapolated correctly until they cross		1	

Data table and question

Table 6 shows some of the student's results.

Table 6

Volume of dilute sulfuric acid added in cm^3	Temperature in °C
0.0	18.9
2.0	21.7
4.0	23.6
6.0	25.0
8.0	26.1
10.0	27.1

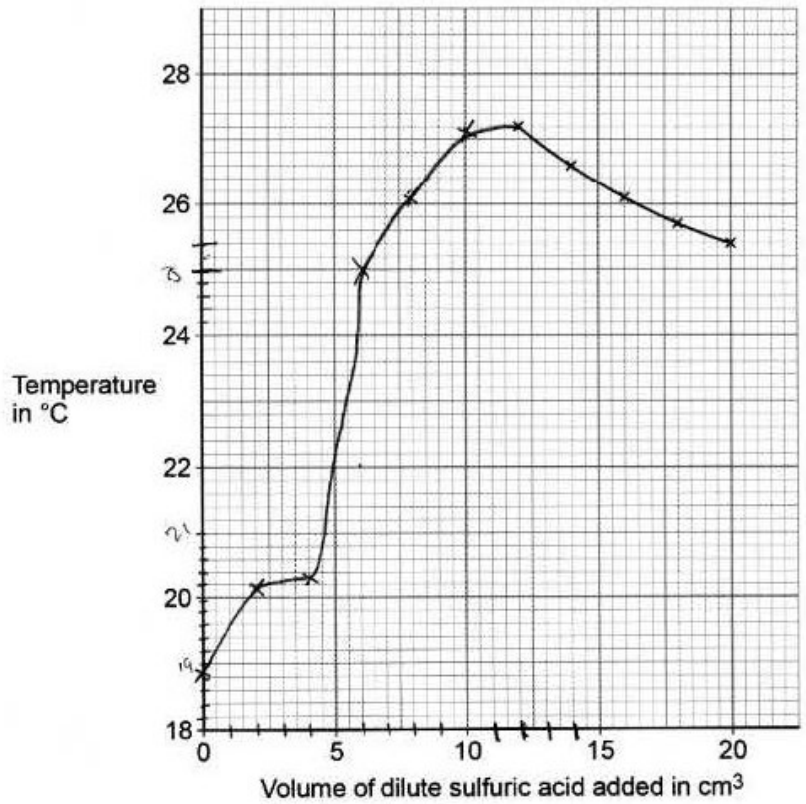
0 9 . 2 Complete **Figure 11**:

- plot the data from **Table 6**
- draw a line of best fit through these points
- extend the lines of best fit until they cross.

[4 marks]

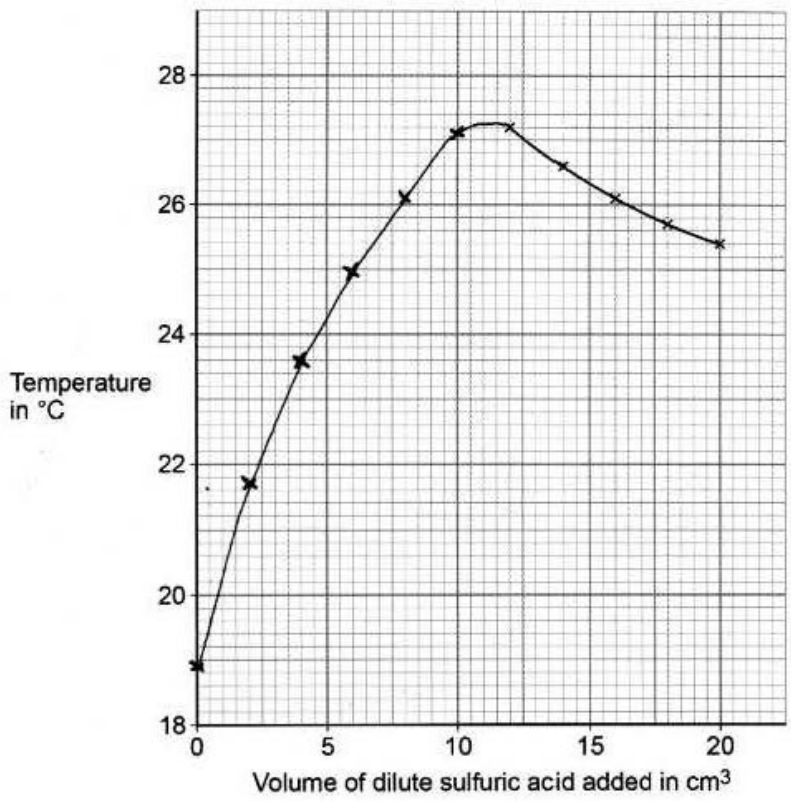
Student Z

Figure 11

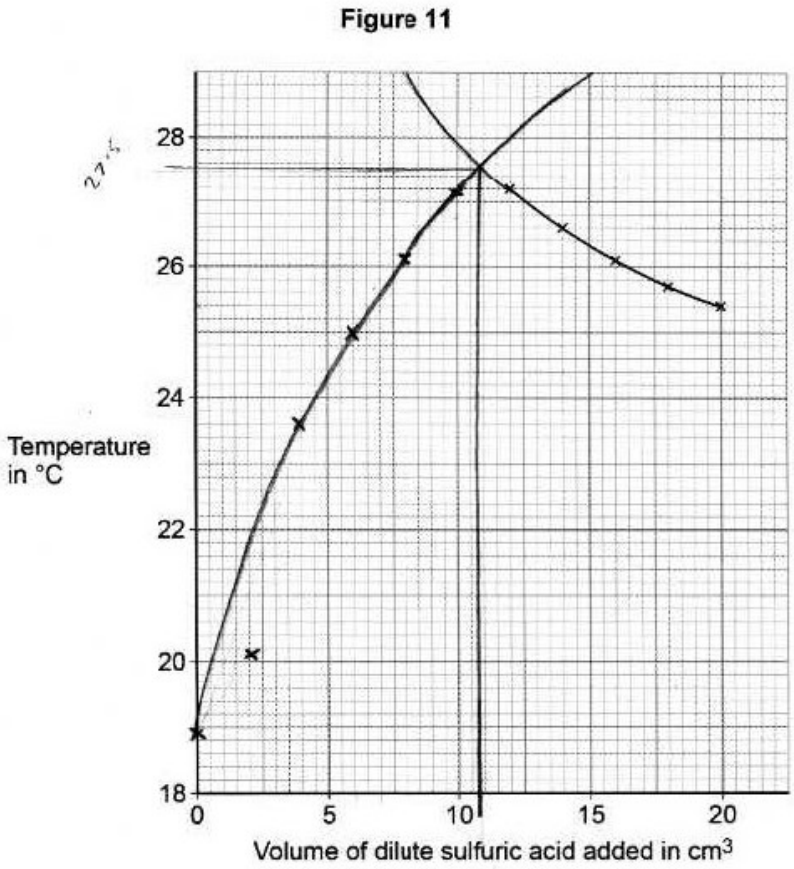


Student AA

Figure 11



Student AB



Example 14: Combined Science Trilogy Biology Paper 1H question 3.4

- In this question students needed to plot 6 points for 2 marks (4 or 5 for 1 mark).
- The data is all whole numbers, falling on major grid lines on the *x*-axis but less simple to plot on the *y*-axis.
- The line of best fit is a straight line, but does not go through all the points.

Mark scheme

03.4	points plotted correctly suitable line of best fit	allow +/- ½ a square allow 1 mark for 4/5 correct plots	2 1	AO2 4.2.3.2

Data table and question

0 3 . 4 **Table 4** shows the results from investigation **B**.

Table 4

Time in minutes	Position of air bubble in mm
0	0
1	6
2	16
3	22
4	30
5	42

Plot the data from **Table 4** on **Figure 4**.

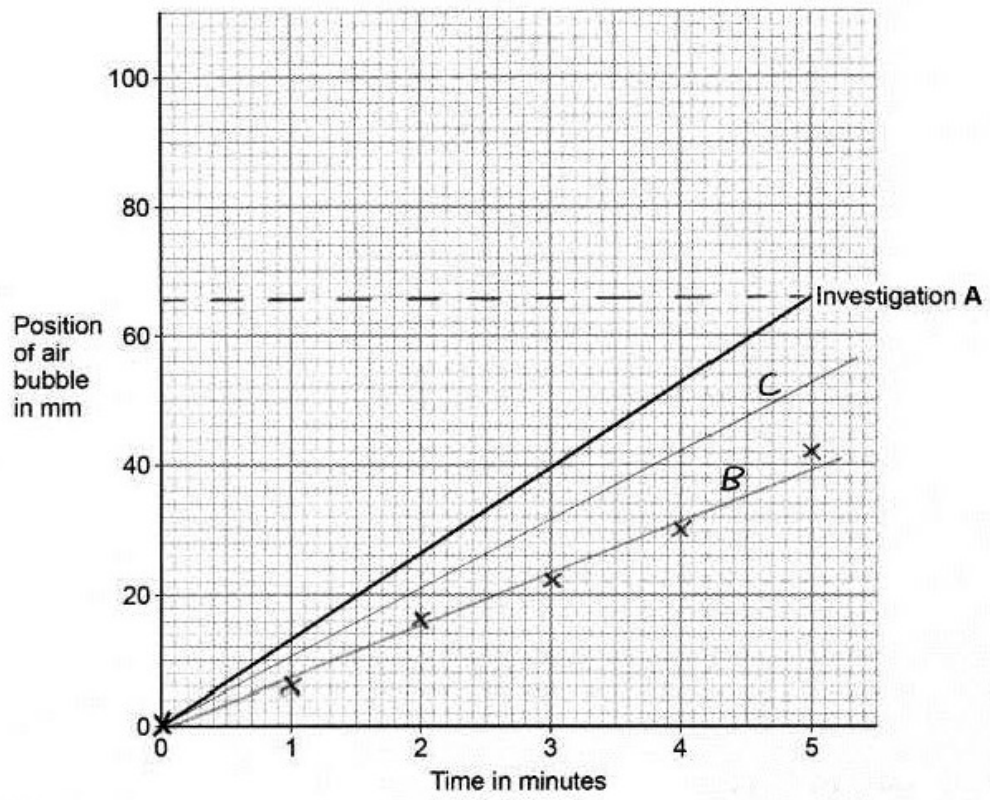
You should:

- draw a line of best fit
- label the line **B**.

[3 marks]

Student AC

Figure 4



Student AD

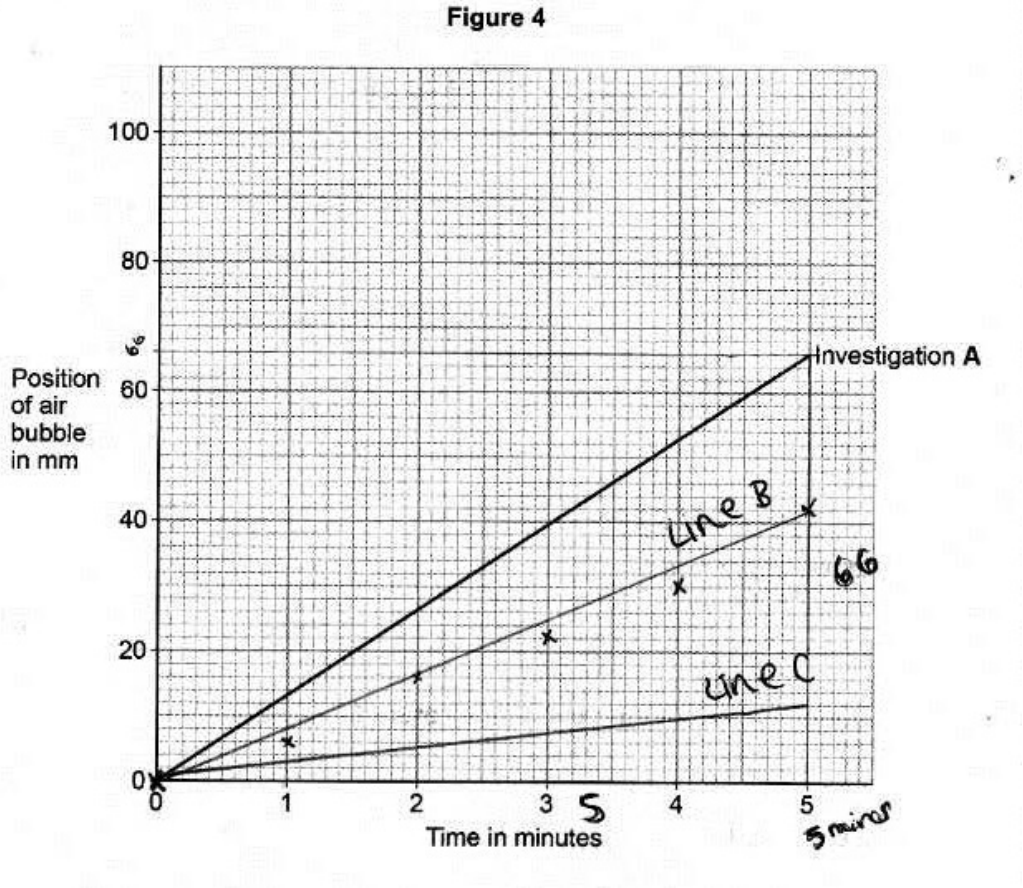
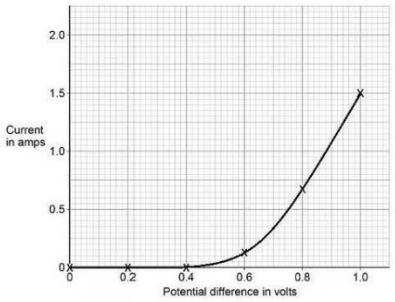


Figure 4
Position of air bubble in mm
100
80
60
40
20
0
0
1
2
3
4
5
Time in minutes
Investigation A
Line B
Line C
66
5 mins

Example 15: Combined Science Synergy Paper 4H question 4.4

- In this physics question students need to plot 6 points for 2 marks (4 or 5 for 1 mark).
- Data points are all on clear grid lines on the *x*-axis, but need to be plotted between the lines on the *y*-axis, which increases the level of demand.
- The line of best fit is a clear curve, with all data points fitting on the curve.

Mark scheme

04.4	all points plotted correctly line of best fit drawn through points	allow ± ½ a small square allow **1** mark for 4 or 5 points plotted correctly 	2 1	AO2 4.7.2.2

Data table and question

Table 2 shows the student's results.

Table 2

Potential difference in volts	Current in amps
0.00	0.00
0.20	0.00
0.40	0.00
0.60	0.13
0.80	0.68
1.00	1.50

0 4 . 4 Complete **Figure 5**.

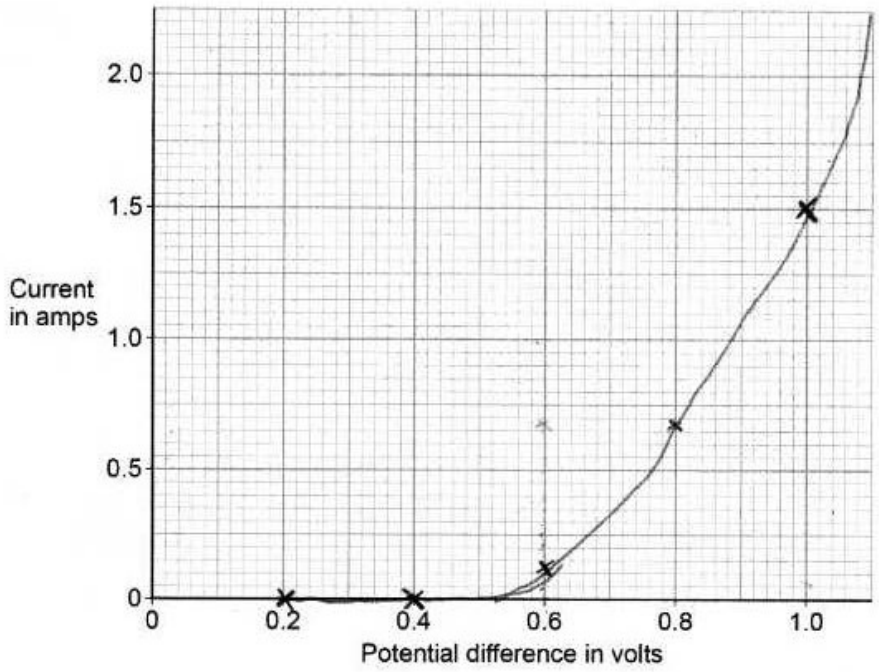
You should:

- plot the data from **Table 2**
- draw a line of best fit.

[3 marks]

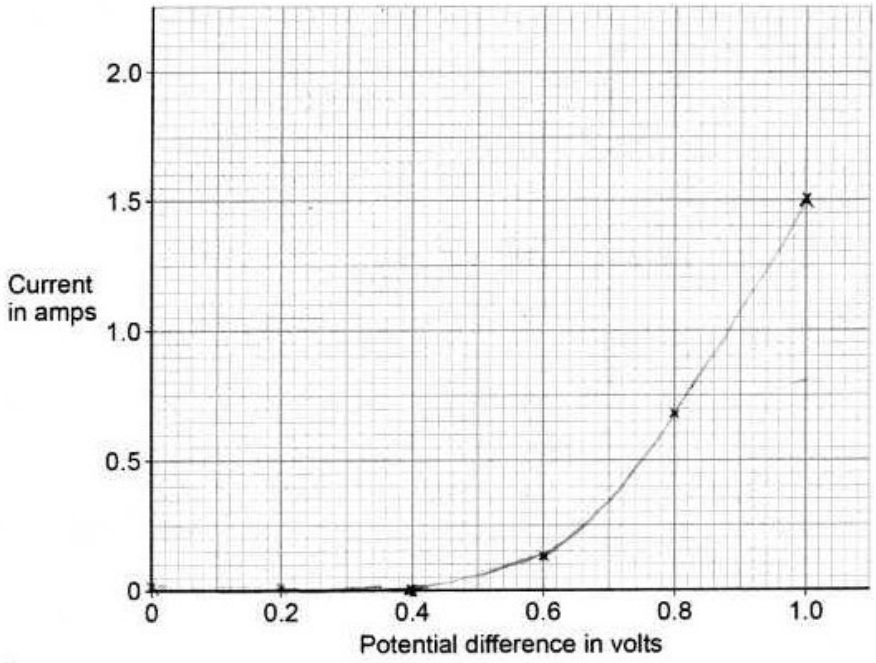
Student AE

Figure 5



Student AF

Figure 5



Bar charts

- Drawing bar charts is likely to be seen only on a Foundation tier paper, as most bar charts would be considered low demand.
- If negative values are to be plotted, a question would be considered standard demand, so might be seen on a Higher tier paper.
- Some examples from 2019 papers are given below.

Example 16: Combined Science Trilogy Chemistry Paper 2F question 5.2

In this low demand question, students needed to draw one bar correctly, for 1 mark.

Mark scheme

05.2	correct bar to 2.1 (%)	allow a tolerance of ± ½ a small square	1	AO2 5.10.1.1

Question

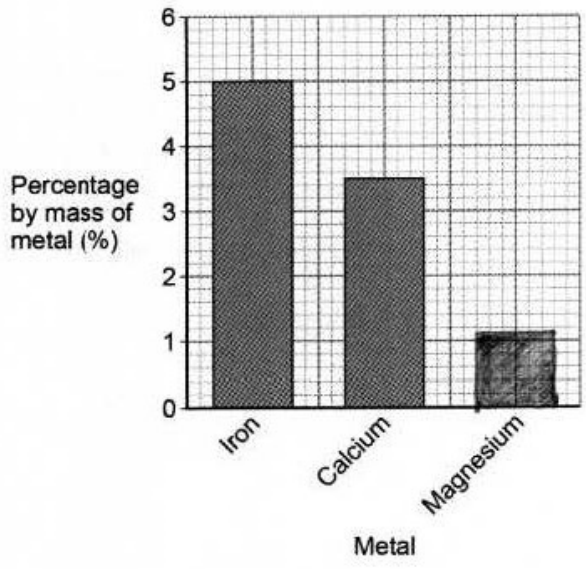
0 5 . 2 The percentage by mass of magnesium in the Earth's crust is 2.1%

Draw the bar for magnesium on **Figure 6**.

[1 mark]

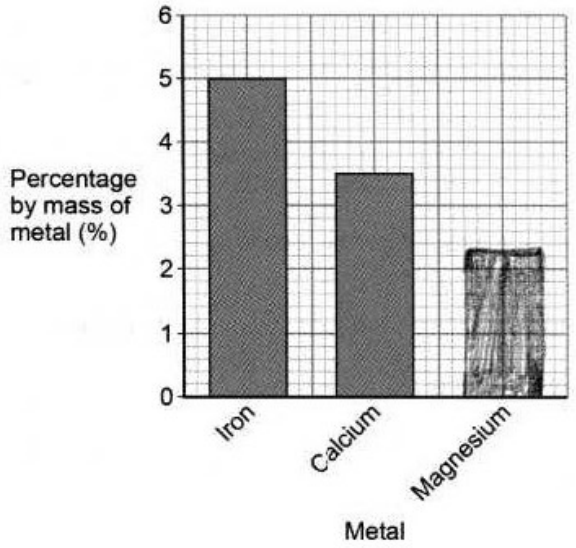
Student AG

Figure 6



Student AH

Figure 6



Example 17: Physics Paper 2F question 4.8

In this question, students needed to draw and label two bars for 3 marks. Simple scale, whole numbers to plot on minor grid lines.

Mark scheme

4.8	one bar drawn to 68.0 (°C) one bar drawn to 28.0 (°C) tallest bar labelled Matt black and shortest bar labelled Shiny silver	ignore the position of the bars on the x-axis	1 1 1	AO2/2 4.6.2.2 WS3.1

Data table and question

Table 1 shows the results.

Table 1

Type of surface	Temperature in °C
Matt black	68.0
Matt white	65.5
Shiny black	66.3
Shiny silver	28.0

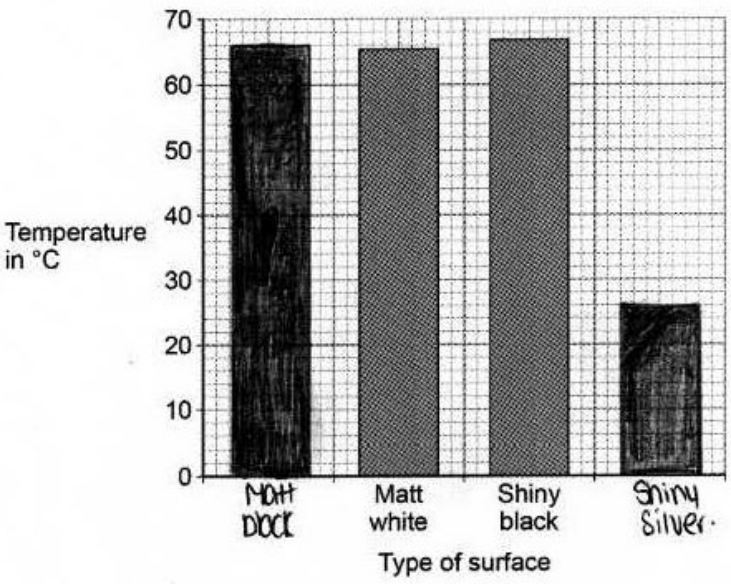
0 4 . 8 Complete the bar chart to show all of the results.

[3 marks]

Student AI

The bar chart in **Figure 14** shows two of the results.

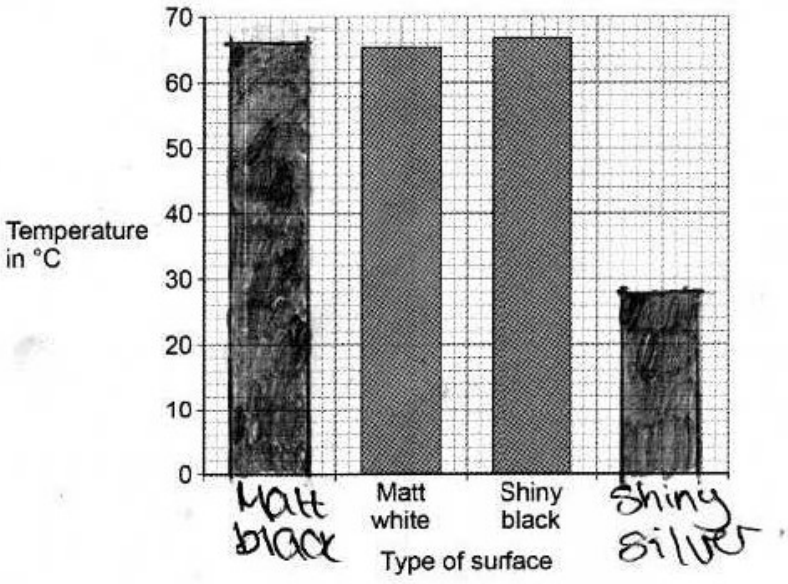
Figure 14



Student AJ

The bar chart in **Figure 14** shows two of the results.

Figure 14



Example 18: Combined Science Trilogy Biology Paper 2F question 5.5

Straightforward whole numbers to be plotted, falling clearly on grid lines.

Mark scheme

05.5	label biomass in g(rams) three bars plotted correctly	 allow ± half small square allow **1** mark for 2 bars correct ignore width and spacing of bars	1 2	AO2 4.7.2.1

Data table

Table 2 shows the estimated biomass of organisms in the garden.

Table 2

Organism	Biomass in g
Bean plants	225
Blackflies	115
Spiders	65
Blackbirds	10

Student AK

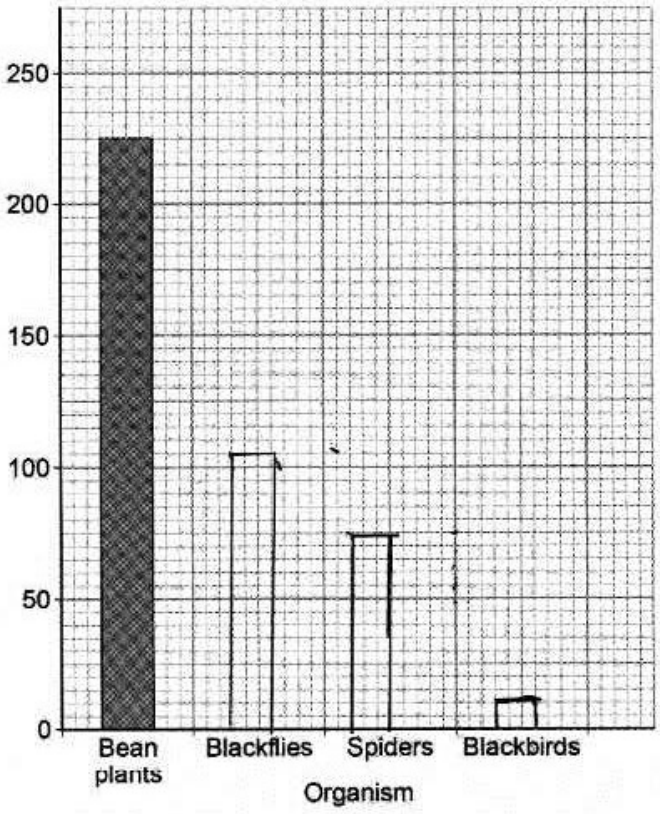
0 5 . 5 Complete **Figure 5**.

You should:

- label the y-axis
- plot the data from **Table 2**.

[3 marks]

Figure 5



Student AL

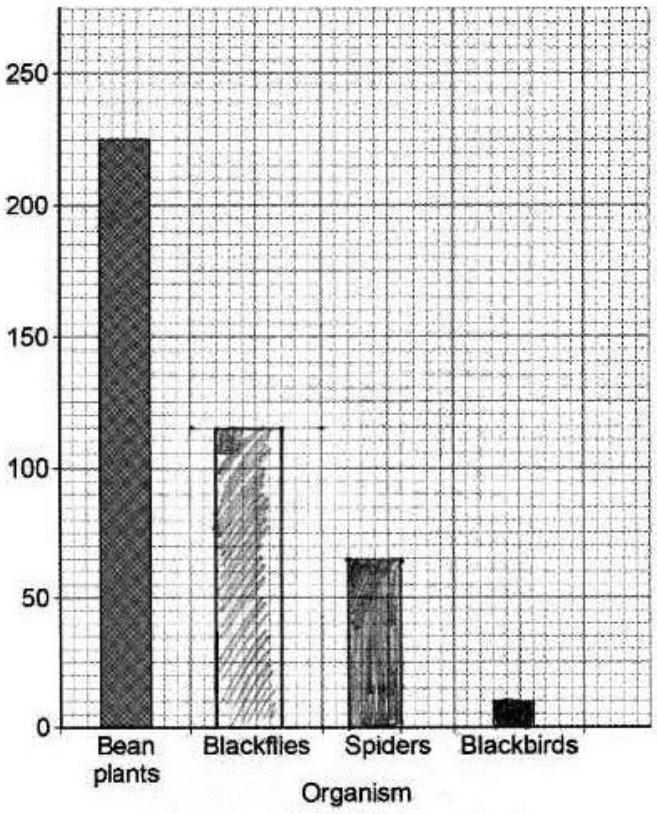
0 5 . 5 Complete **Figure 5**.

You should:

- label the y-axis
- plot the data from **Table 2**.

[3 marks]

Figure 5



Commentaries and marks

Recognise and use expressions in standard form (examples 1-4)

Student A

This student has carried out the calculation correctly and given their answer in standard form. Although ideally the answer would be rounded as in the left-hand column of the mark scheme, the number the student has given is allowed for the mark.

Total for student A: 3 marks

Student B

The student has carried out the calculation correctly and has attempted to give the answer in standard form. However, standard form is a form in which numbers are recorded as a number between 1 and 10 multiplied by a power of 10, and the answer the student has given is not correct standard form. They therefore do not gain the third mark.

Total for Student B: 2 marks

Student C

This student has carried out the calculation correctly, having converted the standard form number into decimals, and given the correct answer. They have not given the answer in standard form, but were not asked to do so, so this answer is perfectly acceptable for full marks.

Total for Student C: 3 marks

Student D

This student has used standard form correctly throughout and has reported the answer correctly in standard form.

Total for Student D: 3 marks

Student E

The student has converted from m to mm then μm by successive divisions by 1000, showing a clear understanding of the units, then has carried out the correct sum to get the correct answer.

Total for Student E: 3 marks

Student F

Although this student has taken an approach that is not anticipated in the mark scheme, the approach shows understanding of what is required and is mathematically correct. Examiners will always check unusual or alternative approaches to ensure that students gain credit where it is due.

Total for Student F: 3 marks

Student G

This student does not appear to have understood the relationship between mass and relative atomic mass or that the relative atomic mass of 40 is one mole of argon and therefore would contain 6.02×10^{23} atoms. Although they have given their calculated answer in standard form, the attempted calculation demonstrates a lack of understanding of the underlying chemistry and so no marks can be gained.

Total for student G: 0 marks

Student H

The student has correctly worked out that 1g of argon is 1/40 of a mole of argon and so has carried out the correct calculation using the Avogadro constant. The answer is given in standard form (matching the 'allow' for the second mark point).

Total for Student H: 2 marks

Use an appropriate number of significant figures (examples 5-10)

Student I

The student has carried out the calculation correctly, but has incorrectly rounded 15 190 to 15 200.

Total for Student I: 2 marks

Student J

This student has carried out the calculation correctly, so gains the first 2 marks. However, they have rounded incorrectly and so do not gain the mark for significant figures.

Total for Student J: 2 marks

Student K

The student has carried out the calculation correctly, so gains the first 2 marks. However, they have rounded their answer to 3 decimal places, rather than to 3 significant figures, and so cannot gain the third mark.

Total for Student K: 2 marks

Student L

This student gains no marks for the calculation, which is incorrect. However, because their calculation does use the masses given in the question, they gain the compensatory mark for quoting their answer to 3 significant figures.

Total for Student L: 1 mark

Student M

The student has carried out the mean calculation correctly, but has not rounded to the required number of significant figures.

Total for Student M: 1 mark

Student N

This student has calculated the mean correctly and rounded correctly.

Total for Student N: 2 marks

Student O

The student has not gained either of the first 2 marks (the unit conversion marks). However, they have carried out a correct calculation (using their unconverted values for the data given: the 'allow' for the third mark point), and because of this their incorrect answer given to 2 significant figures also gains the compensation mark.

Total for Student O: 2 marks

Student P

The student has attempted to convert cm^3 to dm^3, but has multiplied by 1000 rather than divided by 1000 so does not gain the first mark. They have correctly converted milligrams to grams, and carried out a correct calculation (using their incorrectly converted units), so gain the second mark point and the 'allow' for the third mark point. Because they have used the values given in the question, they also gain the compensation mark for giving the (incorrect) answer correctly to 2 significant figures.

Total for Student P: 3 marks

Student Q

This student has carried out the calculation correctly, but has rounded to 2 significant figures not 3 and so does not gain the final mark.

Total for Student Q: 3 marks

Student R

This student has clearly set out their working, has carried out the calculation correctly and has rounded their answer correctly to the required number of significant figures.

Total for Student R: 4 marks

Student S

This student has carried out the calculation correctly, but has omitted to give the answer to the required number of significant figures.

Total for student S: 5 marks

Student T

This student has correctly calculated the specific heat capacity and has attempted to round to 2 significant figures. However, they have rounded incorrectly so do not gain the final mark.

Total for Student T: 5 marks

Graphing skills (examples 11-15)

Student U

The student has plotted only three of the four data points correctly: the one at four resistors should be 8.8 and they have plotted 8.6, which is outside the tolerance allowed so only 1 mark can be gained for the plotting. The line of best fit has a distinct kink in it at this point and cannot be accepted.

Total for Student U: 1 mark

Student V

All four data points are plotted within tolerance and the line of best fit is acceptable.

Total for Student V: 3 marks

Student W

The student has chosen an appropriate scale (50 W per large square) **and** has labelled the x axis clearly and correctly (using the wording from the table heading), so they gain the first marking point. This student's calculated number from the previous question was incorrect: they gave the answer as 3.0 and it should have been 3.3. However, they have plotted their incorrect number correctly and all the plotting is within the tolerance of half a small square, so both plotting marks can be awarded. They have attempted a line of best fit through the data but it is too messy to get the mark.

Total for Student W: 3 marks

Student X

This student has chosen an appropriate scale and correctly labelled the *x*-axis, and has plotted the data within tolerance. However, their attempt at a line of best fit is not appropriate.

Total for Student X: 3 marks

Student Y

The student has started their *x*-axis at 60 W, not 50 W, so their scale is inconsistent and cannot gain the first mark. However, they have correctly plotted the data points based on their incorrect choice of scale so do gain the plotting marks. The line of best fit is not appropriate to the data so does not gain the mark.

Total for Student Y: 2 marks

Student Z

The student has plotted 4 of the 6 points within the tolerance allowed, so gains 1 mark. Their attempt at a line of best fit is not appropriate, and they have not extended either line correctly to a crossing point, so no further marks can be gained.

Total for Student Z: 1 mark

Student AA

The student has plotted all 6 data points correctly within tolerance, and has drawn an appropriate line of best fit. However, they have not followed the instruction to extend both lines to a crossing point (rather choosing to join them with a continuous curve) so do not gain the final mark.

Total for Student AA: 3 marks

Student AB

The student has mis-plotted the second data point as 20.1 rather than 21.7, so gains only 1 mark for the plotting. They have drawn a good line of best fit for the data (ignoring their anomalously plotted point) and have correctly extended both lines to a crossing point.

Total for Student AB: 3 marks

Student AC

The student has plotted all the data points within tolerance and drawn a reasonable line of best fit, with roughly equal numbers of points above and below the line.

Total for Student AC: 3 marks

Student AD

The plotting is within tolerance, but the line of best fit is not acceptable: all points are on or below the line.

Total for Student AD: 2 marks

Student AE

The student has not plotted the data point at 0,0 so, although the other points are plotted within tolerance, gains only 1 mark for the plotting. The line of best fit is inaccurate and ragged, not of sufficient quality to be credited.

Total for Student AE: 1 mark

Student AF

The student has plotted all 6 points within tolerance, and the line of best fit is sufficient.

Total for Student AF: 3 marks

Bar charts (examples 16-18)

Student AG

The student has drawn the bar to 1.1%, not 2.1%, and so does not gain the mark.

Total for Student AG: 0 marks

Student AH

The top of the bar is curved and uneven, so is not considered accurately enough drawn for the mark.

Total for Student AH: 0 marks

Student AI

Although the student has mis-plotted the values for both bars, they gain the mark for correct labelling.

Total for Student AI: 1 mark

Student AJ

The student has plotted the shorter bar correctly, but has placed the Matt black bar at 66 rather than 68. They have correctly labelled both bars.

Total for Student AJ: 2 marks

Student AK

The student has plotted the Blackbirds bar within tolerance, but has mis-plotted the other two, so gains no marks here. They have not labelled the *y*-axis as instructed.

Total for Student AK: 0 marks

Student AL

The student has plotted all three bars within the tolerance allowed, but has not labelled the *y*-axis.

Total for Student AL: 2 marks

Resources

Please note that the Science pages on the AQA website are being updated. Information in the following tables was correct at time of going to print, but some materials may have been relocated.

Previous Hub meetings

Meeting session	Material covered	Location
Autumn 2019	How we assess recall and application of equations at different levels of demand; some headlines on Summer 2019 results	Available on current Hub page aqa.org.uk/subjects/science/hub-schools-network
Summer 2019	How we assess AO3 at different levels of demand; using Legacy ISA materials as extra resource.	Available on current Hub page aqa.org.uk/subjects/science/hub-schools-network
Spring 2019	Marking extended response questions using student examples from Summer 2018.	Available on current Hub page aqa.org.uk/subjects/science/hub-schools-network
Autumn 2018	Discussion of student work from summer 2018 exams covering marking of complex calculations.	Archive of Hub materials: access from link on current Hub page
Summer 2018	What went well with the new GCSEs; what to expect on results day; using ERA to analyse results.	Archive of Hub materials: access from link on current Hub page
Spring 2018	Marking extended response questions.	Archive of Hub materials: Access from link on current Hub page
Autumn 2017	Discussion of practical work and AO2-focused questions.	Archive of Hub materials: access fromlink on current Hub page
Summer 2017	Discussions on maths in science. Required practicals, stretch and challenge.	Archive of Hub materials: access fromlink on current Hub page

Spring 2017	Sample high demand questions, practical work, structure of the new papers, which includes explanation of how physics equationswill be assessed.	Archive of Hub materials: access fromlink on current Hub page

General information and guidance

Resource	Description	Location Plan/Teach/Assess are allfound on the subject pageof our website
Teacher self-guided modular training packs	Guidance for running in-school CPD on Extended response and AO2 questions	Plan
Feedback on the exams Autumn 2019	Presentation slides, examples and commentaries from the feedback meetings for the 2019 series	Secure Key Materials (e-AQA), Teacher support materials tab for the specification required
Results insights	Insight reports from the Summer 2019 exam series	Assess
Guidance on tiering	Link to specific guidance on choosing the appropriate tier for your students.	Plan
How the 9 to 1 grading scale is applied to GCSE Combined Science	Updated information on awarding grades for the GCSE Combined Science specifications. A similar document is available directed at the separate science GCSEs.	Assess
Co-teaching combined science and separate sciences	List of topics common between combined science and each separate science. Shows extra content that is separates only.	Plan
Command word document	List of command words and an explanation of what is expected in a response.	Teach

Subject-specific vocabulary	Definitions of working scientifically terms.	Teach
Our exams explained	Booklet covering the different types of questions used in our papers.	Assess
Making questions clear	Booklet covering how we make our assessments accessible to students and how we develop questions during the question paper process.	Assess
Teaching guide: sample AO2 questions and mark	A simple explanation of what AO2 is and the type of questions that cover AO2.	Teach
Switching guides	Brief comparison of AQA specification and assessment with those of other boards to help in decision making	Plan

Maths in science

Resource	Description	Location
Autumn Hub materials	How we assess recall and application of equations at different levels of demand	Available on current Hub page aqa.org.uk/subjects/science/hub-schools-network
Maths PowerPoints	Slides to incorporate into lessons to support the teaching of the maths skills.	Teach
Practical support for practicals and maths	Presentation and link to a webcast	Teach
GCSE Science: Delivering the mathematical requirements Summer 2018	Powerpoint looking at basic maths skills and putting them into a science context.	Teacher support tab of any of the GCSE sciences on Secure Key Materials (e-AQA)

The language of mathematics in Science: A guide for teachers of 11-16 science	Guidance produced by the Association for Science Education, in conjunction with the Nuffield Foundation, intended to achieve common understanding of important terms and techniques related to the use of mathematics in the science curriculum. There is an associated book on teaching approaches.	Link on Teach

Practical work

Resource	Description	Location
Practical support for practicals and maths	Presentation and link to a web cast	Teach
Technician Advisors	Practical experts with classroom experience, who can answer questions on setting up practical work-based lessons.	Teach
Practical handbooks	Teacher and technician notes and student worksheets covering suggested methods for the required practicals.	Teach
Practical work and learning outcomes	This summary shows possible aims and learning outcomes which teachers could use for each of the RPAs.	Spring 2017 Hub meeting
Teaching guide: effective use of practicals	Series of slides summarising all our information about practical requirements and a suggested teaching approach to make the most out of practical lessons.	Teach
Supporting effective practical work	Presentation on practical work based on the Combined Science practicals, which could also be used for separate sciences.	Teacher support tab for Combined Science on Secure Key Materials (e-AQA)

Entry Level Certificate

Resource	Description	Location
Co-teaching ELC and Combined Science: Trilogy, Co-teaching ELC and Combined Science: Synergy	Guidance on teaching ELC science with Foundation tier Combined Science.	Plan
ELC teaching guide	Background information on the course, suggestions for practical activities, supporting information on outcomes, keywords.	Teach
ELC Schemes of work	Guidance on teaching the individual components.	Teach
Specimen Teacher Devised Assignments	Example writing frames for TDAs for each component.	Assess
Maximising outcomes for Foundation learners	Guidance on co-teaching ELC with Foundation tier Combined Science.	Secure Key Materials (e-AQA), Teacher support materials tab for ELC Science on SecureKey Materials (e-AQA)
Feedback on the 2019 assessment portfolios	Presentation slides, examples and commentaries from the feedback meetings for the 2019 series	Secure Key Materials (e-AQA), Teacher support materials tab for ELC Science

Ofqual resources

Resource	Description	Location
Guide to GCSE results for England, 2019	Information about standards, grades, entry patterns in all GCSEs. Includes information about the 4-3 boundary in HT Combined Science and an infographic summarising all results.	gov.uk/government/news/guide-to-gcse-results-for-england-2019
Ofqual blog: 11 things we know about marking and 2 we don't… yet	Some insights into marking in UK exams from the regulator's point of view.	ofqual.blog.gov.uk/2019/03/05/14572/

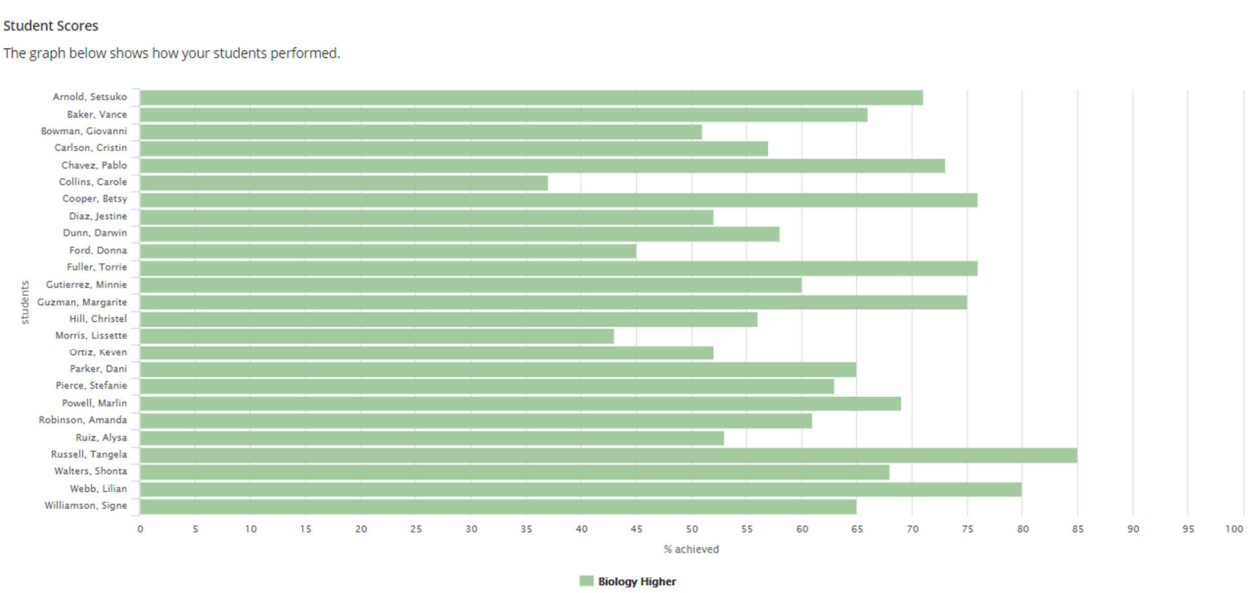
GCSE grading scale Factsheets	Information on grading of the new GCSEs for FE and HE, and for parents	gov.uk/government/publications/gcse-new-grading-scale-factsheets
Ofqual blog: how do we achieve fairnessin exams?	Gives some insights on how Ofqual ensures that the qualifications system is fair.	ofqual.blog.gov.uk/2019/04/26/how-do-we -achieve- fairness-in-exams/
How grade boundaries are set	Video from Ofqual outlining the awarding process.	twitter.com/ofqual/status/1122417684946268160

Using MERiT

This section shows some of the features of Exampro's MERiT analysis tool, and the information you can obtain from it regarding your students' mocks. The screenshots are for illustration only as they use data from a fake cohort, and the population data was not complete at time of printing.

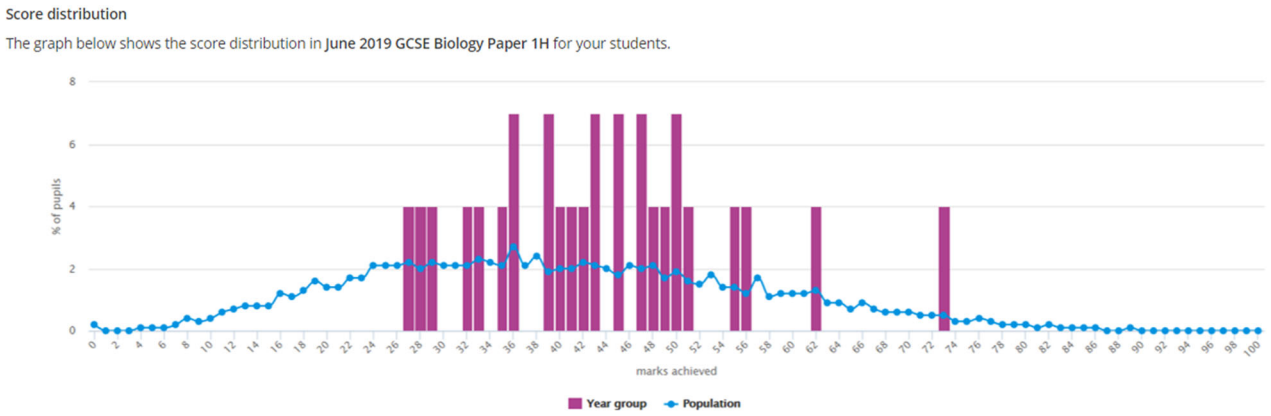
Overview of student performance vs population sample

Test	Number of students	Marks available	Class Mean score	POPULATION Mean score
Biology Higher	25	100		###
• June 2019 GCSE Biology Paper 1H	25	100	62.3	###



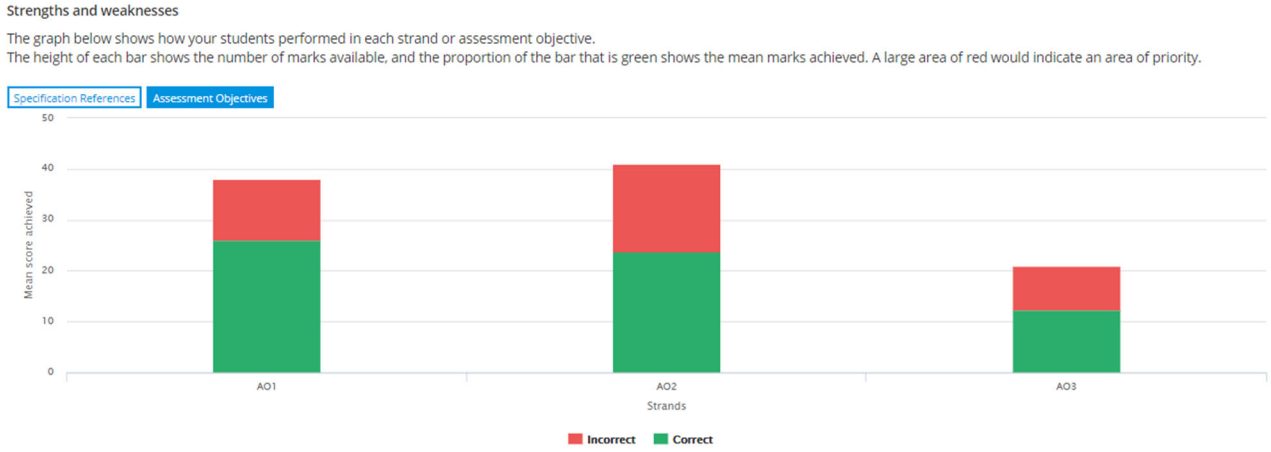
- This screen shows an overview (for the Biology 1H paper) of the performance of the fake cohort (the overall population data is not available here: it will show in the right-hand column once it is complete).
- The table gives overall information for the (fake) cohort, and the bar chart breaks the data down by student. Each bar is an individual student.
- Once the overall population data is complete, the population mean will show as a vertical line on the graph so you can see your students above or below the mean.

Mark distribution graph



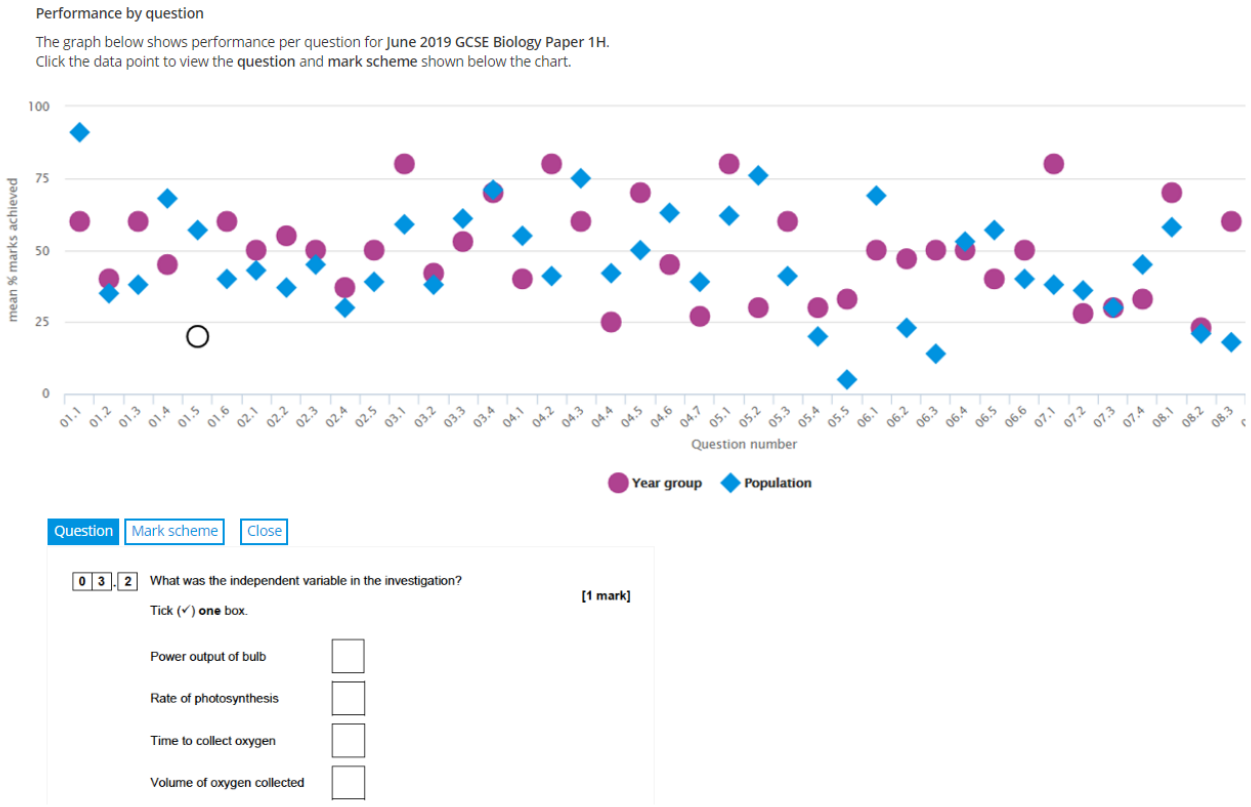
- In this example, the marks for the fake cohort (purple bars) are shown for the Biology 1H paper. The blue line shows the scores for the sample population.
- This shows how the paper performed: overall population marks spread out across the full range of marks, with some bunching in the middle.

Information on different strands



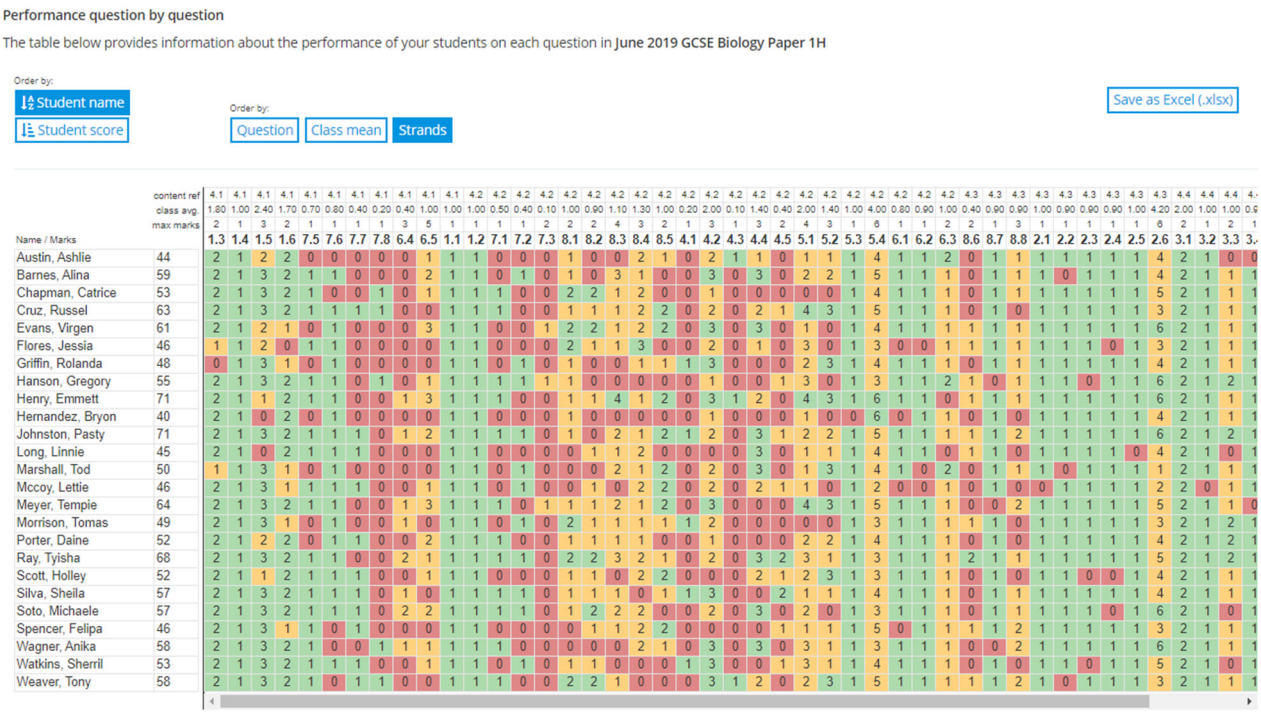
- You can look at how your students performed in the particular AOs or by specification reference.
- This table shows the AO data; clicking on the left-hand blue box brings up the performance by area of specification content.
- Heads of science may find this useful to look at with the department.
- It can highlight particular areas of the specification where students are struggling and aid focusing of interventions if necessary.

Student performance by question (1)



- This screen will be useful for class teachers, as it shows particular areas of weakness.
- It gives a question-by-question analysis – the sample population mean mark (blue diamonds) versus the (fake) cohort mean mark (purple circles).
- This is useful to see the distance between population score and your students' score: if there is a big gap below the population then it's an area you may want to look at further.
- You can click on a dot on the graph to see the question and mark scheme it relates to without leaving the analysis.
- In this example, we've highlighted Question 3.2.

Student performance by question (2)



Performance question by question

The table below provides information about the performance of your students on each question in **June 2019 GCSE Biology Paper 1H**

Order by: Student name | Student score

Order by: Question | Class mean | Strands

Save as Excel (.xlsx)

Name / Marks		1.3	1.4	1.5	1.6	7.5	7.6	7.7	7.8	6.4	6.5	1.1	1.2	7.1	7.2	7.3	8.1	8.2	8.3	8.4	8.5	4.1	4.2	4.3	4.4	4.5	5.1	5.2	5.3	5.4	6.1	6.2	6.3	8.6	8.7	8.8	2.1	2.2	2.3	2.4	2.5	2.6	3.1	3.2	3.3	3.
content ref		4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.4	4.4	4.4	4.4	4.
class avg.		1.80	1.00	2.40	1.70	0.70	0.80	0.40	0.20	0.40	1.00	1.00	1.00	0.50	0.40	0.10	1.00	0.90	1.10	1.30	1.00	0.20	2.00	0.10	1.40	0.40	2.00	1.40	1.00	4.00	0.80	0.90	1.00	0.40	0.90	0.90	1.00	0.90	0.90	0.90	1.00	2.00	1.00	1.00	0.
max marks		2	1	3	2	1	1	1	1	3	5	1	1	1	1	2	2	2	4	3	2	1	3	1	3	2	4	3	1	6	1	1	2	2	1	3	1	1	1	1	1	6	2	1	2	1
Austin, Ashlie	44	2	1	2	2	0	0	0	0	0	1	1	1	0	0	0	1	0	0	2	1	0	2	1	1	0	1	1	1	4	1	1	2	0	1	1	1	1	1	1	1	4	2	1	0	0
Barnes, Alina	59	2	1	3	2	1	1	0	0	0	2	1	1	0	1	0	1	0	3	1	0	0	3	0	3	0	2	2	1	5	1	1	1	0	1	1	1	0	1	1	1	4	2	1	1	1
Chapman, Catrice	53	2	1	3	2	1	0	0	1	0	1	1	1	1	0	0	2	2	1	2	0	0	1	0	0	0	0	0	1	4	1	1	1	0	1	1	1	1	1	1	1	5	2	1	1	1
Cruz, Russel	63	2	1	3	2	1	1	1	1	0	0	1	1	1	0	0	1	1	1	2	2	0	2	0	2	1	4	3	1	5	1	1	1	0	1	0	1	1	1	1	1	3	2	1	1	1
Evans, Virgen	61	2	1	2	1	0	1	0	0	0	3	1	1	0	0	1	2	2	1	2	2	0	3	0	3	0	1	0	1	4	1	1	1	1	1	1	1	1	1	1	1	6	2	1	1	1
Flores, Jessia	46	1	1	2	0	1	1	0	0	0	0	1	1	0	0	0	2	1	1	3	0	0	2	0	1	0	3	0	1	3	0	0	1	1	1	1	1	1	1	0	1	3	2	1	1	1
Griffin, Rolanda	48	0	1	3	1	0	1	0	0	0	0	1	1	0	1	0	1	0	0	1	1	1	3	0	0	0	2	3	1	4	1	1	1	0	1	1	1	1	1	1	1	4	2	1	1	1
Hanson, Gregory	55	2	1	3	2	1	1	0	1	0	1	1	1	1	1	1	1	0	0	0	0	0	1	0	0	1	3	0	1	3	1	1	2	1	0	1	1	1	0	1	1	6	2	1	2	1
Henry, Emmett	71	2	1	1	2	1	1	0	0	1	3	1	1	1	0	0	1	1	4	1	2	0	3	1	2	0	4	3	1	6	1	1	0	1	1	1	1	1	1	1	1	6	2	1	1	1
Hernandez, Bryon	40	2	1	0	2	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	6	0	1	1	0	1	0	1	1	1	1	1	4	2	1	1	1
Johnston, Pasty	71	2	1	3	2	1	1	1	0	1	2	1	1	1	1	0	1	0	2	1	2	1	2	0	3	1	2	2	1	5	1	1	1	1	1	2	1	1	1	1	1	6	2	1	2	1
Long, Linnie	45	2	1	0	2	1	1	1	0	0	0	1	1	0	0	0	0	1	1	2	0	0	0	0	3	0	1	1	1	4	1	1	0	1	1	0	1	1	1	1	0	4	2	1	0	1
Marshall, Tod	50	1	1	3	1	0	1	0	0	0	0	1	1	0	1	0	0	0	2	1	2	0	2	0	3	0	1	3	1	4	1	0	2	0	1	1	1	0	1	1	1	1	2	1	1	1
Mccoy, Lettie	46	2	1	3	1	1	1	1	0	0	1	1	1	0	1	0	0	1	0	2	2	0	2	0	2	1	1	0	1	2	0	0	1	0	1	0	0	1	1	1	1	2	2	0	1	1
Meyer, Tempie	64	2	1	3	2	1	1	0	0	1	3	1	1	1	0	1	1	1	2	1	2	0	3	0	0	0	4	3	1	5	1	1	1	0	0	2	1	1	1	1	1	5	2	1	1	0
Morrison, Tomas	49	2	1	3	1	0	1	0	0	1	0	1	1	0	1	0	2	1	1	1	1	1	2	0	0	0	0	0	1	3	1	1	1	1	1	0	1	1	1	1	1	3	2	1	2	1
Porter, Daine	52	2	1	2	2	0	1	1	0	0	2	1	1	1	0	0	1	1	1	1	0	0	1	0	0	0	2	2	1	4	1	1	1	0	1	0	1	1	1	1	1	4	2	1	2	1
Ray, Tyisha	68	2	1	3	2	1	1	0	0	2	1	1	1	1	1	0	2	2	3	2	1	0	2	0	3	2	3	1	1	3	1	1	1	2	1	1	1	1	1	1	1	5	2	1	2	1
Scott, Holley	52	2	1	1	2	1	1	1	0	0	1	1	1	0	0	0	1	1	0	2	2	0	0	0	2	1	2	3	1	3	1	1	1	0	1	0	1	1	0	0	1	4	2	1	1	1
Silva, Sheila	57	2	1	3	2	1	1	1	0	1	0	1	1	1	1	0	1	1	1	0	1	1	3	0	0	0	2	1	1	4	1	1	1	0	1	1	1	1	1	1	1	4	2	1	1	1
Soto, Michaele	57	2	1	3	2	1	1	1	0	2	2	1	1	1	1	0	1	2	2	2	0	0	2	0	3	0	2	0	1	3	1	1	1	0	1	1	1	1	1	0	1	6	2	1	0	1
Spencer, Felipa	46	2	1	3	1	1	0	1	0	0	0	1	1	0	0	0	0	1	1	2	2	0	0	0	0	1	1	1	1	5	0	1	1	1	1	2	1	1	1	1	1	3	2	1	1	1
Wagner, Anika	58	2	1	3	2	1	0	0	1	1	1	1	1	0	0	0	0	0	0	2	1	0	3	0	3	0	3	1	1	3	1	1	1	0	0	2	1	1	1	1	1	6	2	1	1	1
Watkins, Sherril	53	2	1	3	2	1	1	1	0	0	1	1	1	0	1	0	1	1	0	0	0	1	3	0	0	1	3	1	1	4	1	1	1	0	1	0	1	1	0	1	1	5	2	1	0	1
Weaver, Tony	58	2	1	3	2	1	0	1	1	0	0	1	1	1	0	0	2	2	1	0	0	0	3	1	2	0	2	3	1	5	1	1	1	1	1	2	1	0	1	1	1	3	2	1	1	1

- This is useful to show question-by-question breakdown of marks for each student.
- The RAG rating gives an easy way to see where individuals may be struggling (red = 0 marks, amber = partial marks, green = full marks).
- The table can be ordered by student name or their total mark.
- Questions can be ordered by their number in the paper or by their performance from the cohort – ie it can show question-level performance from best to worst.
- If time and resources are limited you could just select particular students you might already have concerns about for data entry and see how well they are performing.

Contact us

Our friendly team will be happy to support you between 8am and 5pm, Monday to Friday.

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