GCSE SCIENCE

Virtual Communities

Resource booklet

Published: Summer 2021

Contents

Links to online resources

Below are links to the resources cited in the presentation:

- *Focus on success: Maths in science*
- GCSE Maths skills teaching guides
- Lesson activity: GCSE to A-level progression:
    - Biology
    - Chemistry
    - Physics
    - Environmental Science
- Maths skills briefings for A-level sciences
- Exampro
- ASE: *The Language of Mathematics in Science*

Example questions used in the presentation

Use of standard form is not specifically mentioned at KS3 science.

From the programme of study for KS3 maths:
Pupils should be taught to **interpret and compare** numbers in standard form $A \times 10^n$ $1 \leq A < 10$, where n is a positive or negative integer or zero

From the GCSE Maths criteria (basic Foundation criteria: no extra criteria for Higher tier):
N9 **calculate with and interpret** standard form $A \times 10^n$ $1 \leq A < 10$, where n is an integer (with and without a calculator)

From the GCSE science maths criteria:
1b Recognise and use expressions in standard form

From the A-level science maths criteria:
AO2 Recognise and use expressions in standard form

National curriculum in England: mathematics programme of study - Key Stage 3 Used under the Open Government Licence v3.0.

Remember that:

- **GCSE Foundation tier** level of maths must 'not be lower than that which is expected of learners at Key Stage 3, as outlined in the Department for Education's document *Mathematics programmes of study: Key stage 3*.'
- **GCSE Higher tier** level of maths must 'not be lower than that of questions and tasks in assessments for the foundation tier in a GCSE Qualification in Mathematics.'
- On **GCE** (AS and A-level) papers, mathematical skills must be 'at level 2 or above' (ie equivalent to Higher tier GCSE mathematics or above).

GCSE Subject Level Conditions and Requirements for Combined Science (2021) and GCE Subject Level Conditions and Requirements for Science. Used under the Open Government Licence v3.0.

Example 1

KS3 maths

In this question, students need to convert a very large number into standard form (9.43×10^{12} km).

One light year is approximately 9 430 000 000 000 kilometres.

Write this distance in standard form.

[1 mark]

Example 2

Q7.5, Biology 2F, June 2019

In this Standard demand question, students need to calculate the area of a pond, then multiply the area by the number they had calculated in the previous question. The resulting large number needs to be converted to standard form, which is equivalent to the demand of KS3 and what we ask at Standard demand GCSE.

The pond was a rectangular shape, measuring:

- length = 2.5 metres
- width = 1.5 metres
- depth = 0.5 metres.

Calculate the estimated number of Daphnia in the pond.

Use your answer from Question **07.4**.

Give your answer in standard form.

[4 marks]

Mark scheme

07.5		an answer of 2.625×10^4 **or** 2.63×10^4 **or** 2.6×10^4 scores **4** marks an answer of 26250 scores **3** marks allow ecf from Question **07.4**		AO2 4.7.2.1
	(volume of pond =) 1.875 **or** $2.5 \times 1.5 \times 0.5$	an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps	1	
	$14\,000 \times 1.875$	allow ecf from Question **07.4**	1	
	26250		1	
	2.625×10^4	allow 2.63×10^4 **or** 2.6×10^4	1	

Example 3

Q7.4, Synergy 3H, 2019

In this High demand question, students need to multiply a number in standard form by 1000 and quote the resulting number correctly in standard form. Negative indices are involved. This is a step up from the KS3 criteria and matches GCSE Maths.

Scientists could use a sample of silicon to define the Avogadro constant.

Copper is an impurity in the silicon sample.

There are 70 nanograms of copper in 1 g of the sample.

Calculate the mass of copper in grams in 1 kg of the sample.

Give your answer in standard form.

1 nanogram = 10^{-9} g

[2 marks]

Mark scheme

07.4		an answer of 7(.0) × 10^{-5} (g) scores **2** marks an answer of 0.00007 **or** 7 × 10^{-8} (g) scores **1** mark		AO2 4.5.2.4
	70 × 10^{-9} × 1000	allow 70 × 10^{-6}	1	
	= 7.0 × 10^{-5} (g)		1	

Example 4

Q2.1, AS Chemistry Paper 1, June 2018

The first parts of this calculation involve students multiplying a number in standard form (negative indices) by 42, to give an answer in 1 g of material, then multiplying that answer by 1000 to gain the amount in 1 kg of material. Compare the demand with that of Example 3.

Some toothpastes contain sodium fluoride.
The concentration of sodium fluoride can be expressed in parts per million (ppm).
1 ppm represents a concentration of 1 mg in every 1 kg of toothpaste.

0 2 . 1 A 1.00 g sample of toothpaste was found to contain 2.88×10^{-5} mol of sodium fluoride.

Calculate the concentration of sodium fluoride, in ppm, for the sample of toothpaste.
Give your answer to 3 significant figures.

[4 marks]

Mark scheme

2.1	M_r NaF = 42(.0)	Incorrect M_r loses M1 & M4	1
	Mass NaF in 1 g = $2.88 \times 10^{-5} \times 42.0$ (= 1.210 (1.2096) $\times 10^{-3}$ g)		1
	Mass NaF in 1 kg = 1.210 (1.2096) g (Mass in mg = 1210 (1209.6) mg)	M3 = M2 x 1000 (g) Units, if given, must match answer	1
	Concentration of NaF = <u>1210</u> (ppm)	Allow 1.21×10^3 ppm	1

Example 5

Chemistry 2H, 2018

In this High demand question, students need to recognise the 2:1 ratio and divide the number in standard form by 2 to choose the correct option. This is a step up from KS3, in that students are doing more than simply interpreting numbers in standard form.

In industry, methanol is produced by reacting carbon monoxide with hydrogen.

The equation for the reaction is:

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

How many moles of carbon monoxide react completely with 4.0×10^3 moles of hydrogen?

[1 mark]

Tick **one** box.

1.0×10^3 moles ☐

2.0×10^3 moles ☐

4.0×10^3 moles ☐

8.0×10^3 moles ☐

Example 6

Q2.2, AS Chemistry Paper 1, June 2018

In this question, students need to multiply the number in standard form by 75 then by 1000 to determine an answer in milligrams. Negative indices are involved. Compare the demand with that of Example 5.

0 2 . 2 Sodium fluoride is toxic in high concentrations.
Major health problems can occur if concentrations of sodium fluoride are greater than 3.19×10^{-2} g per kilogram of body mass.

Deduce the maximum mass of sodium fluoride, in mg, that a 75.0 kg person could swallow without reaching the toxic concentration.

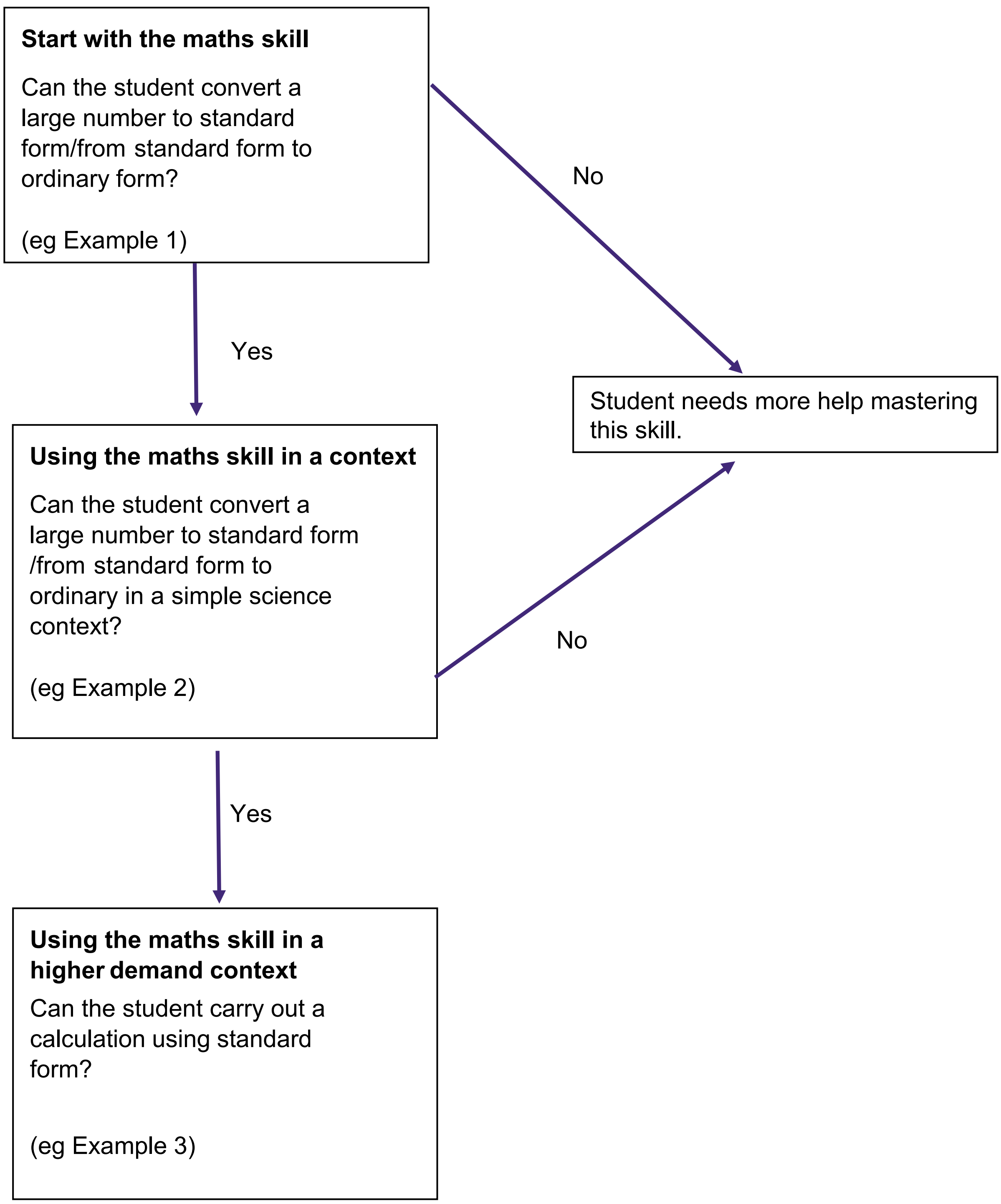
[1 mark]

Mark scheme

2.2	Toxic mass = $3.19 \times 10^{-2} \times 75 \times 1000$ = 2390 mg	Allow 2393	1

Starter activity flowchart

Using starter activities to ascertain student confidence with using standard form – a simple flowchart



Example lesson activities relating to use of standard form

Chemistry

Activity 14 Moles

The amount of a substance is measured in moles (the SI unit). The mass of one mole of a substance in grams is numerically equal to the relative formula mass of the substance. One mole of a substance contains the same number of the stated particles, atoms or ions as one mole of any other substance. The number of atoms, molecules or ions in a mole of a given substance is the Avogadro constant. The value of the Avogadro constant is

6.02×10^{23} per mole.

Complete the table. Use the periodic table on page 21 to help you.

Substance	Mass of substance ingrams	Amount in moles	Number of particles
Helium			18.12×10^{23}
Chlorine (Cl)	14.2		
Methane		4	
Sulfuric acid	4.905		

Physics

Activity 11 Standard form

1. Write the following numbers in standard form.

   a. 379 4

   b. 0.0712

2. Use the data sheet to write the following as ordinary numbers.

   a. The speed of light

   b. The charge on an electron

3. Write one quarter of a million in standard form.

Environmental science

Activity 12 Maths skills

1. In 2017, the city of Manchester began a ‘City of Trees’ project. The project plans to plant 3 million trees over the next 25 years.

   It was suggested that the council plant 3.6×10^5 trees in the first year. The rest of the trees would be planted in equal numbers over the remaining years.

   Calculate how many trees would need to be planted in each of the remaining years.

   Give your answer in standard form.

Progression of demand in other maths skills in science

The examples given demonstrate the progression in demand of the specified skill from KS3 science through to KS4 and into KS5.

You might like to discuss further with colleagues in Science and in Maths to devise common approaches to teaching and learning of these skills to enable all students to progress smoothly through their science courses.

The programme of study for KS3 science is not specific in what maths skills must be taught:

Pupils should be taught to apply mathematical concepts and calculate results.

Use of significant figures

From the programme of study for KS3 maths
Pupils should be taught to round numbers and measures to an appropriate degree of accuracy [for example, to a number of decimal places or significant figures].

From GCSE maths criteria (Foundation: no extra criteria for Higher tier)
N15 (basic Foundation content) round numbers and measures to an appropriate degree of accuracy (eg to a specified number of decimal places or significant figures); (additional Foundation content) use inequality notation to specify simple error intervals due to truncation or rounding

From the GCSE science maths criteria
2a Use an appropriate number of significant figures

From the A-level science maths criteria
A1.1 Use an appropriate number of significant figures

Remember that:

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- On GCSE Higher tier papers the level of maths must be: 'not lower than that of questions and tasks in assessments for the foundation tier in a GCSE Qualification in Mathematics'
- On GCE (AS and A-level) papers mathematical skills must be 'at level 2 or above' (ie equivalent to Higher tier GCSE mathematics or above).

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Example Key Stage 3 questions in a science context

Question 1

Annie swims on average 0.87 km in 30 minutes.

If she continues at the same speed, how far will she swim in 2 hours, rounded to one decimal place?

Circle your answer.

3.2 km   3.3 km   3.4 km   3.5 km   3.6 km

[1 mark]

Question 2

Owls eat small mammals.

They regurgitate the bones and fur in balls called pellets.

The table shows the contents of **62** pellets from long-eared owls.

Number of mammals found in the pellet	1	2	3	4	5	6
Frequency	9	17	24	6	5	1

The total number of mammals found is 170

Calculate the **mean** number of mammals found in each pellet.

Show your working and give your answer correct to 1 decimal place.

[2 marks]

Question 3

The approximate volume, V, of a planet with radius r is given by

$$V = \frac{4}{3}\pi r^3$$

Assume the radius of Mercury is 2400 km.

Calculate the volume of Mercury.

Give your answer, to 1 significant figure, in standard form.

[2 marks]

Examples from GCSE Science

Progression of demand in GCSE assessments.

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

In questions where there is a mark for significant figures (or decimal places) the prompt 'give your answer to x significant figures' (or 'give your answer to x decimal places') will be given.

Calculation questions are often set at a mixture of levels of demand.

Example 7: Q7.5, SAMs 1, GCSE Chemistry 1F

This question is a mixture of Standard and Low demand – three marks for the overall calculation are set at Standard demand, but the requirement for giving the answers to 2 decimal places is set at Low demand.

0 7 . 5 There are two isotopes of element **A**. Information about the two isotopes is shown in **Table 4**.

Table 4

Mass number of the isotope	6	7
Percentage abundance	92.5	7.5

Use the information in **Table 4** to calculate the relative atomic mass of element **A**.
Give your answer to 2 decimal places.

[4 marks]

Mark scheme

07.5	92.5×6 and 7×7.5 $\frac{607.5}{100}$ 6.075 6.08	allow 6.08 with no working shown for **4** marks	1 1 1 1	AO2/2 4.1.1.6

Example 8: Q7.6, June 2019, GCSE Synergy 2F

This question is set at Standard demand – students need to use the values from the table to calculate the mean and round their answer down to 4 significant figures.

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

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

Give your answer to 4 significant figures.

[2 marks]

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

Example 9: Q5.2, GCSE Synergy 4H, June 2019

In this High demand question, students need to round their answer up correctly to 3 significant figures.

05.2 In one indigestion tablet the mass of magnesium carbonate is 64.0 mg

Calculate the number of moles of magnesium carbonate in this indigestion tablet.

Give your answer to 3 significant figures.

Relative formula mass (M_r) of magnesium carbonate = 84

[3 marks]

Mark scheme

05.2		an answer of 0.000762 **or** 7.62×10^{-4} (moles) scores **3** marks an answer of 0.762 **or** 0.00076190476 (moles) scores **2** marks an answer of 0.76190476 (moles) scores **1** mark		AO2 4.5.2.4
	(conversion 64.0 mg to) 0.0640 g		1	
	(moles =) $\frac{0.0640}{84}$	allow 0.00076190476 allow correct expression using an unconverted or incorrectly converted value for mass	1	
	= 0.000762 (moles) **or** = 7.62×10^{-4} (moles)	allow an answer correctly rounded to 3 significant figures from an incorrect calculation using the masses in the question	1	

Examples from AS science

The A-level sciences subject criteria states that students may be tested on their ability to:

- report calculations to an appropriate number of significant figures given raw data quoted to varying numbers of significant figures
- understand that calculated results can only be reported to the limits of the least accurate measurement.

Example 10: Q2.1, AS Chemistry Paper 1, June 2018

Students are instructed to give their answer to a specified number of significant figures. Compare the demand with that in Example 8 – the numbers are, however, more challenging as they involve calculation using standard form.

Some toothpastes contain sodium fluoride.
The concentration of sodium fluoride can be expressed in parts per million (ppm).
1 ppm represents a concentration of 1 mg in every 1 kg of toothpaste.

0 2 . 1 A 1.00 g sample of toothpaste was found to contain 2.88×10^{-5} mol of sodium fluoride.

Calculate the concentration of sodium fluoride, in ppm, for the sample of toothpaste.
Give your answer to 3 significant figures.

[4 marks]

Mark scheme

2.1	M_r NaF = 42(.0)	Incorrect M_r loses M1 & M4	1
	Mass NaF in 1 g = $2.88 \times 10^{-5} \times 42.0$ (= 1.210 (1.2096) $\times 10^{-3}$ g)		1
	Mass NaF in 1 kg = 1.210 (1.2096) g (Mass in mg = 1210 (1209.6) mg)	M3 = M2 x 1000 (g) Units, if given, must match answer	1
	Concentration of NaF = <u>1210</u> (ppm)	Allow 1.21×10^{3} ppm	1

Example 11: Q7.4, AS Chemistry Paper 1, 2018

Further on in AS papers, the number of significant figures to use is no longer stated: students are simply instructed to use ‘an appropriate number of significant figures’. This is a step up in demand from the GCSE Higher demand question in Example 9, and matches the additional Foundation content of GCSE maths.

0 7 . 4 The concentration of ClO^- ions in bleach solution can be found by reaction with iodide ions.

The overall equation for this reaction is shown.

$$ClO^- + 2I^- + 2H^+ \rightarrow I_2 + Cl^- + H_2O$$

A sample of bleach solution was found to contain ClO^- ions with a concentration of 0.0109 mol dm^{-3}
Potassium iodide is added to a 20.0 cm^3 portion of this bleach solution.

Calculate the mass, in mg, of potassium iodide needed to react with all of the ClO^- ions in the sample of bleach.
Give your answer to the appropriate number of significant figures.
Give **one** observation during this reaction.

[4 marks]

Mark scheme

7.4	mol ClO^- = conc × vol = 0.0109 × 0.02 = 0.000218 / 2.18 x 10^{-4} mol		1
	mol KI = 0.000218 × 2 = 0.000436 mol	M2 = M1 x2 If incorrect ratio, M2 & M3 = 0	1
	mass KI = M_r ×mol = 166.0 × 0.000436 = 0.072376 g = 72.4 (mg)	M3 = M1 x 2 x 166.0 x 1000 Must be to 3 sig figs	1
	black solid/ppt appears/forms (in a colourless solution) or (colourless solution) turns brown (solution)	Not purple. Not red. Not brown ppt/solid Ignore grey.	1

Rearranging equations

From the programme of study for KS3 maths
Pupils should be taught to:

- substitute numerical values into formulae and expressions, including scientific formulae
- understand and use standard mathematical formulae; rearrange formulae to change the subject

From the GCSE Maths subject criteria (Foundation; no extra criteria for Higher tier)

- A2 substitute numerical values into formulae and expressions, including scientific formulae
- A5 understand and use standard mathematical formulae; rearrange formulae to change the subject

From the GCSE science maths criteria

- 3b change the subject of an equation
- 3c substitute numerical values into algebraic equations using appropriate units for physical quantities

From the A-level science maths criteria

- 2.2 change the subject of an equation
- 2.3 substitute numerical values into algebraic equations using appropriate units for physical quantities

Remember that:

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- On GCSE Higher tier papers the level of maths must be: 'not lower than that of questions and tasks in assessments for the foundation tier in a GCSE Qualification in Mathematics'
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National curriculum in England: mathematics programme of study - Key Stage 3 Used under the Open Government Licence v3.0.

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Example from Key Stage 3 science

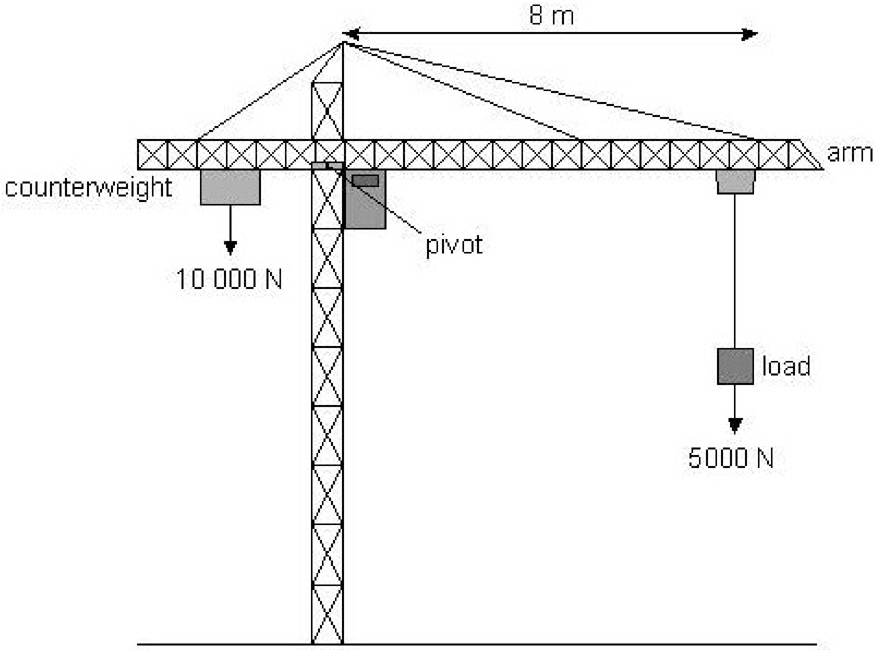
In this sequence of questions students are tested on their ability to use the scientific equation

moment = force × distance

In the second and third questions, students need to rearrange this equation to calculate the answers.

The diagram shows a crane lifting a load of 5000 N.

The load of 5000 N is placed 8 m from the pivot.



What is the turning moment of the load? Give the unit.

....

....

[2 marks]

How far from the pivot must the 10000 N counter weight be placed in order to balance the load?

.... m

[1 mark]

The counterweight is placed 3 m from the pivot.

What load could now be balanced 8 m from the pivot?

....

.... N

[1 mark]

Examples from GCSE science

Progression of demand in GCSE assessments.

Low demand (Foundation tier only)	Standard demand (Foundation and Higher tier)	High demand (Higher tier only)
In questions that require recall of equations from the 'recall' list students will be asked to identify a formula from a list.	Students will be expected to recall the equations from the 'recall' list. They will be prompted to do so (eg 'write down the equation which links mass (m), momentum (ρ) and velocity (v)	Students will be expected to recall the equations from the 'recall' list without prompting.
In questions where students need to apply an equation, the equation will be given in the body of the question.	In questions where students need to apply an equation they will be prompted to recall the equation in an earlier part of the question.	In questions where students need to apply an equation they will be expected to recall or choose the correct formula without prompting.
Application will involve simple substitution with numbers that are easy to manipulate. Students may be asked to carry out a simple unit conversion	Application will involve substitution with something 'extra' such as transformation, changing a quantity, obtaining data from a graph or selecting appropriate data to use.	Application will also involve transformation, use of more complex equations, or multi-step calculations with no lead in or guidance given.
Students will **not** be expected to rearrange equations.	Students **will** be expected to be able to rearrange equations.	Students **will** be expected to be able to rearrange even complex equations.

Example 12: Q1.5, GCSE Trilogy Physics 1F, 2019

Low demand question: students are simply required to substitute the numbers given into the equation, matching both the KS3 and GCSE maths criteria.

0 1 . 5 When the potential difference across the resistor was 0.80 V, the current in the resistor was 0.020 A

Calculate the power dissipated by the resistor.

Use the equation:

power = potential difference × current

[2 marks]

Mark scheme

01.5		an answer of 0.016 (W) scores **2** marks		AO2.1
	power = 0.80 × 0.020		1	6.2.4.1 WS 3.3
	power = 0.016 (W)		1	

Example 13: Q4.3, GCSE Trilogy Biology 1F, 2019

This is also a Low demand question: the equation to use is given and students need to substitute into it. There is a Low demand 'extra' here, in that there is a simple unit conversion.

0 4 . 3 The length of cell **X** is 25 mm when viewed at a magnification of ×800

Calculate the real length of cell **X**.

Give your answer in micrometres (µm).

1 mm = 1000 µm

Use the equation:

$$\text{real length of cell} = \frac{\text{size of image}}{\text{magnification}}$$

[3 marks]

Mark scheme

04.3		an answer of 31.25 (µm) scores 3 marks allow 2 marks for $\frac{25\,000}{800}$		AO2 4.1.1.5
	(real length of cell =) $\frac{25}{800}$		1	
	0.03125		1	
	31.25 (µm)	allow 31 or 31.3 allow correct unit conversion of incorrect answer	1	

Example 14: Q 6.6, GCSE Trilogy Physics 1F, 2019

Students need to substitute into the equation they recalled in the previous question (V = I R), then rearrange the equation to find R, all of which is Standard demand, and equivalent to the demand at KS3 and GCSE maths.

0 6 . 6 The current in the resistor was 0.12 A when the potential difference across the resistor was 3.0 V

Calculate the resistance of the resistor.

[3 marks]

Mark scheme

06.6	$3.0 = 0.12 \times R$ $R = \frac{3.0}{0.12}$ $R = 25\ (\Omega)$	an answer of 25 (Ω) scores **3** marks	1 1 1	AO2/1 6.2.1.3 RP 16 WS 3.3

Example 15: Q8.4, GCSE Physics 1H, 2019

This is a High-demand question, in which students need to select and rearrange the equation $\Delta E = m\ c\ \Delta\theta$ in order to calculate the mass of an ice cube.

0 8 . 4 An ice cube has a temperature of –15.0 °C

The total thermal energy needed to raise the temperature of this ice cube to 0.0 °C and completely melt the ice cube is 5848 J

specific heat capacity of ice = 2100 J/kg °C
specific latent heat of fusion of ice = 334 000 J/kg

Calculate the mass of the ice cube.

[5 marks]

Mark scheme

8.4		an answer of 0.016 (kg) scores **5** marks		4.3.2.2 4.3.2.3 AO2
	$E = m \times 2100 \times 15$		1	
	$E = m \times 334\,000$		1	
	$5848 = 31\,500\ m + 334\,000\ m$ **or** $5848 = 365\,500\ m$		1	
	$m = \dfrac{5848}{(31\,500 + 334\,000)}$ **or** $m = \dfrac{5848}{(365\,500)}$		1	
	$m = 0.016$ (kg)		1	
		allow **2** marks for an answer that rounds to 0.186 or 0.0175 if no other mark scored allow **1** mark for either $5848 = m \times 2100 \times 15$ **or** $5848 = m \times 334\,000$		

Examples from AS science

Students may be tested on their ability to use and manipulate equations, for example

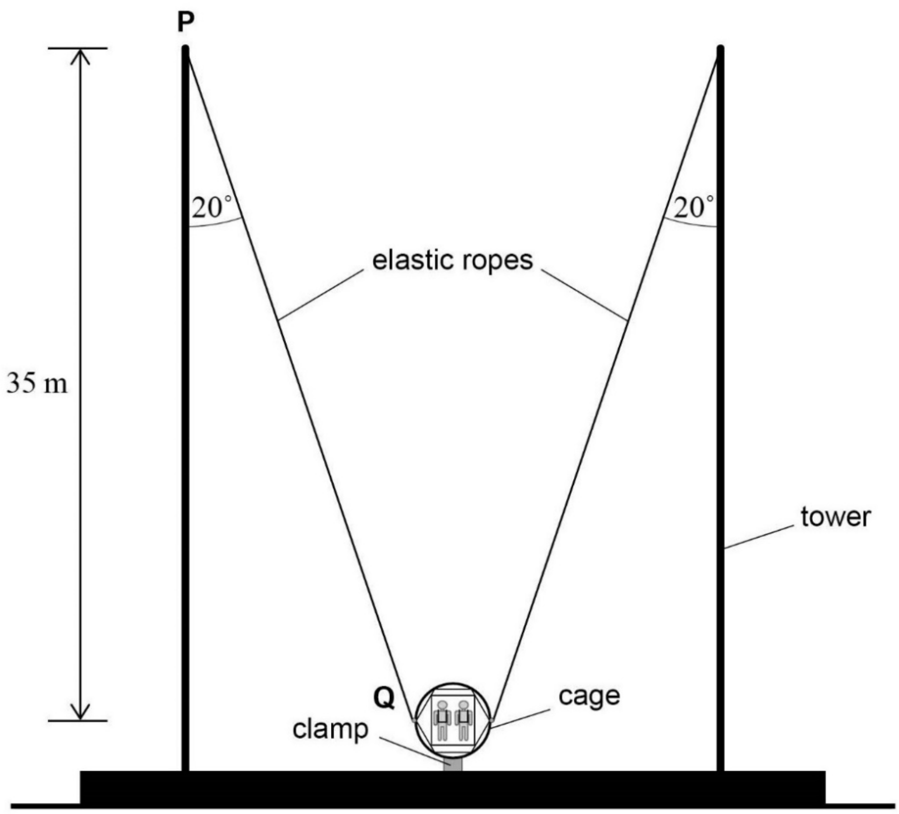
- in Biology, magnification
- in Chemistry, structured and unstructured mole calculations (eg calculate a rate constant k from a rate equation)
- in Physics, rearrange $E = mc^2$ to make m the subject.

Example 16: Q3.2, AS Physics Paper 1, 2019

In this question, students need to rearrange the equation $F = m a$ (given on the data sheet) to calculate the acceleration of the loaded cage. Compare the demand of the skill with that of Example 14, although the numbers are more challenging as they are given in standard form.

0 3 **Figure 3** shows a fairground ride called a 'reverse bungee'.

Figure 3



Two identical stretched elastic ropes are fixed to a cage with passengers inside. The loaded cage is held in place by a clamp. When the clamp is released the elastic ropes accelerate the loaded cage vertically into the air.

P is the point where the rope attaches to the top of the vertical tower.
Q is the point where the rope attaches to the cage. **Q** is level with the centre of mass of the loaded cage.

Before release, the tension T in each elastic rope is 3.7×10^4 N and each rope makes an angle of $20°$ with the vertical tower.

The total mass M of the loaded cage is 1.2×10^3 kg and the mass of the elastic ropes is negligible.

0 3 . 2 Calculate the initial acceleration of the loaded cage when the clamp is released.

[2 marks]

Mark scheme

03.2	Use of $F = ma$ with 6×10^4 N or their 03.1 ✓ 50 (m s^{-2}) ✓	Allow 48 (m s^{-2}).	2

Example 17: Q2.4, AS Chemistry Paper 1, June 2019

A multi-step calculation, in which students need to rearrange the equation given to determine the mass of 1 mole of germanium ions. Compare the demand of the skill with that in Example 15: again, the numbers are more challenging, using standard form.

0 2 . 4 In the TOF mass spectrometer, a germanium ion reaches the detector in 4.654×10^{-6} s

The kinetic energy of this ion is 2.438×10^{-15} J

The length of the flight tube is 96.00 cm

The kinetic energy of an ion is given by the equation $KE = \frac{1}{2}mv^2$

where

m = mass / kg

v = speed / m s^{-1}

The Avogadro constant $L = 6.022 \times 10^{23}$ mol^{-1}

Use this information to calculate the mass, in g, of one mole of these germanium ions.
Use your answer to state the mass number of this germanium ion.

[5 marks]

Mark scheme

02.4	M1 v = length/t = 0.96 / 4.654 x 10^{-6} v = 206274 m s^{-1} m = $2KE/v^2$	Notes: M1 = working (or answer)	1
	M2 mass of one ion = 1.146 x 10^{-25} kg	M2 = answer conseq on M1	1
	M3 mass of 1 mole ions = 1.146 x 10^{-25} x 6.022 x 10^{23} = (0.06901 kg)	M3 = M2 x 6.022 x 10^{23}	1
	M4 = 69(.01) g	M4 = M3 x 1000 M3/M4 could be in either order	1
	M5 mass number = 69	M5 must have whole number for mass no	1

Hub resources on the website

The following table lists the resources available for the GCSE Science Hub meetings, from Summer 2016 to Autumn 2020. It also includes a brief description of what each document is about.

All resources can be downloaded from the science Hub pages on our website: aqa.org.uk/subjects/science/hub-schools-network. Usually only materials from the most recent three meetings are on this page, but all other materials can be found on the Hub archive page: aqa.org.uk/subjects/science/hub-schools-network/science-meeting-materials-archive

Meeting session	Title of document	What it's about
Autumn 2020 (Virtual Communities meetings)	Presentation slides	Focal points for group discussions
	Supporting materials	Reminder of situation for 2020/2021 as known at the time. Points to consider in breakout groups for discussions on practical work and importance of mock exams; details of Apparatus and Techniques criteria covered in the Required Practical Activities for each GCSE science
Spring 2020	Presentation slides	Reflections on mocks and brief reminder on how to use MERiT. How we assess maths skills in GCSE sciences at different levels of demand, using examples of student work; discussion activity on ways of including opportunities for development of particular maths skills in schemes of work (using AQA schemes as examples); update on resources and draft plans for summer 2020 meetings
	Booklet 1	Guidance on assessment of particular maths skills. Student examples and commentaries for discussion in meeting and in school; update on where to find resources
	Booklet 2	Extracts from AQA schemes of work for use in the exercise in the meeting
	Booklet 3	Extracts from AQA specifications for use in the exercise in the meeting
	Booklet 4	Guide to Hub resources on the website (now superseded by this table)
	Maths skills in science: Precision and decimal places	Link to Teachit resource referred to in meeting

	Maths skills in science: Significant figures	Link to Teachit resource referred to in meeting
	Mock analysis: Trilogy paper	Examples of how analysis of the Trilogy Paper 1 could be undertaken (repeated from Autumn 2019 meeting, by request)
Autumn 2019	Presentation slides	Provisional national GCSE and GCE results from summer 2019. GCSE entry patterns 2019 Insight and examples of areas of weakness across all subjects; assessing equations at different demand levels; using key questions for mock analysis to drive focused intervention
	Resource booklet	AQA results statistics 2019 – GCE and GCSE; example student responses in key areas of challenge in 2019 exams; assessing equations at different levels of demand – example responses and commentaries
	Physics equations flashcards	An example of one of the free resources available from Teachit
	Research update: 7402 A-level Biology essay	Background information on a number of areas related to the 7402 essay that haven't previously been looked at in detail and highlights to information already produced for this particular aspect of the assessment.
	A-level sciences endorsement Cycle 3 timeline	Printout of the timeline available on the website here: aqa.org.uk/resources/science/as-and-a-level/teach/practicals
	Exampro MERiT timeline	Timeline of when data input and analysis for MERiT is available for the 2019/20 mocks
	UAS flyer	Information on the AQA Unit Award Scheme
	Mock analysis Paper 1 sheets	Examples of how analysis of the Trilogy Paper 1 could be undertaken
Summer 2019	Presentation slides	Feedback from spring meeting; how we assess AO3 at different levels of demand; using Legacy ISA materials as extra resource; making the best use of ERA; results day
	Booklet 1	Examples from 2018 papers of questions that assess AO3; guide through ERA features; update on resources
	Booklet 2	List of legacy ISAs, how they relate to the required practical, examples of data sheets and ideas on how could be incorporated into teaching

Notes

Contact us

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

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