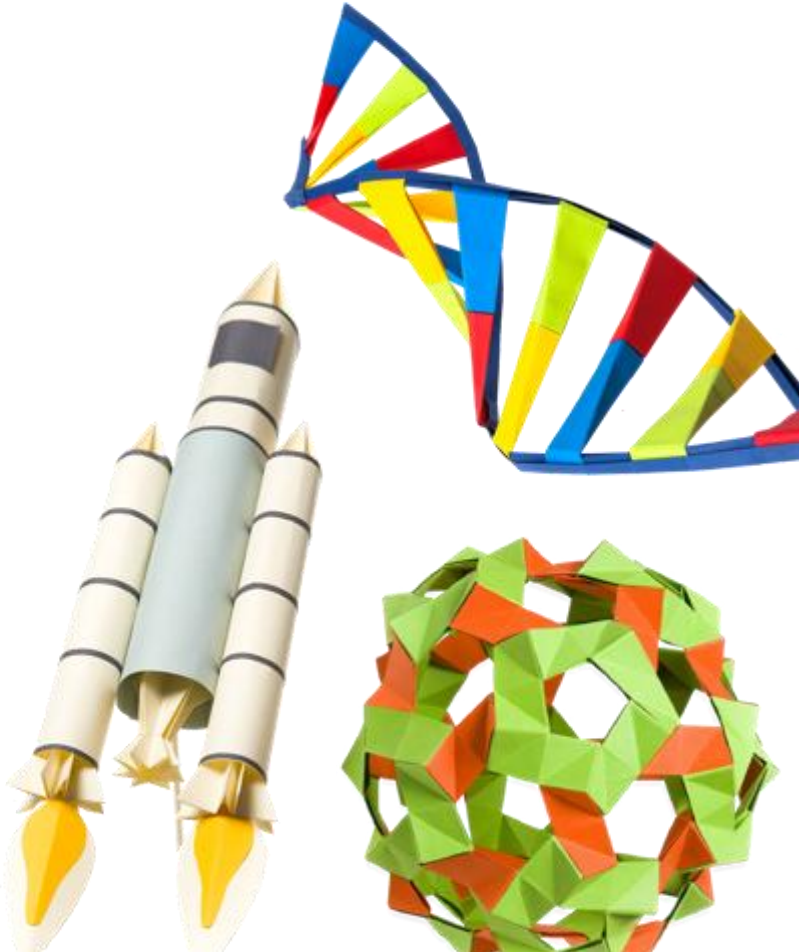
GCSE Combined Science

Teaching Maths Skills in GCSE Science



Welcome to this training event

We will be sharing innovative ideas on teaching the mathematical elements of science.

Meet your trainers…

Glenn Patterson
Science Credible Specialist

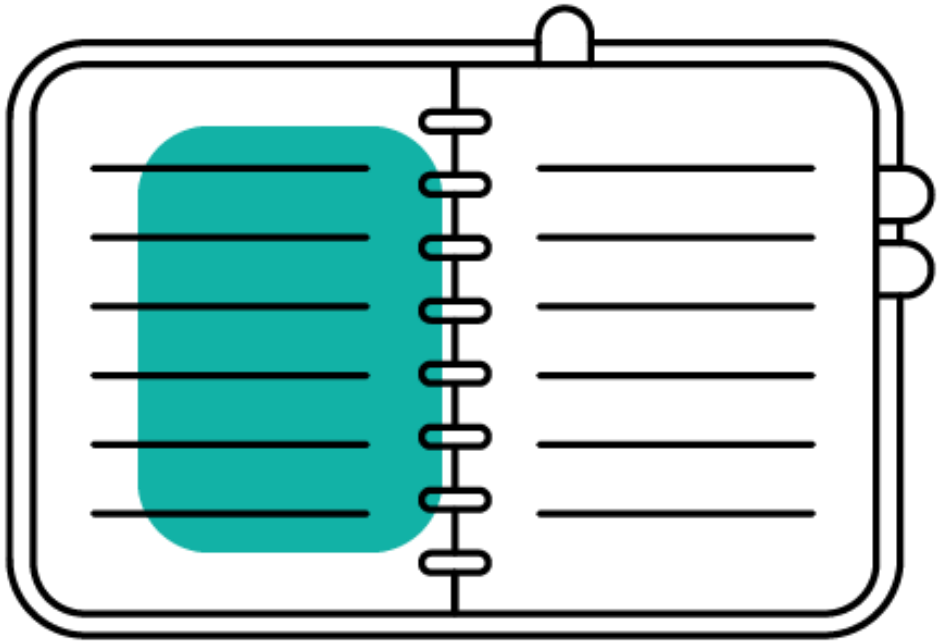
Mel Muldowney
Just Maths

Chris Seagal
Just Maths

Agenda

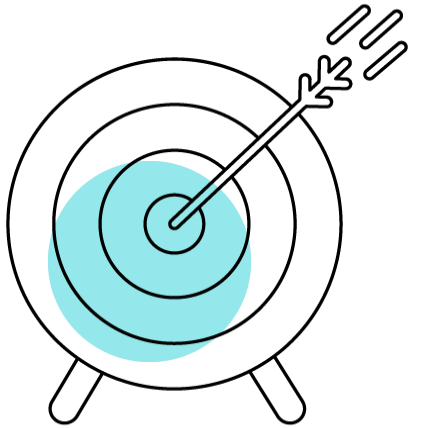
In this session we are going to look at:

- Maths requirements in GCSE Science
- Examiner feedback summer 2024
- Mathematical misconceptions – strategies for improvement
- Maths in Science resources
- Collaborative approach



Maths Requirements in GCSE Science

Poll



What is the highest level of Maths qualification you have attained?

- GCSE
- GCE
- Degree
- Postgraduate

Maths Requirements

It is an Ofqual requirement that all GCSE science exams include a certain amount of maths that is assessed over the life-time of the qualification, with the following percentage of marks:

- GCSE Biology 10%
- GCSE Chemistry 20%
- GCSE Physics 30%
- GCSE Combined Science 20% (ratio 1:2:3)

The minimum level of maths in the foundation tier examinations is not lower than key stage 3 mathematics.

The minimum level in higher tier examinations is not lower than foundation tier GCSE Maths.

Mathematical Skills

Mathematical skills are divided into five main key areas:

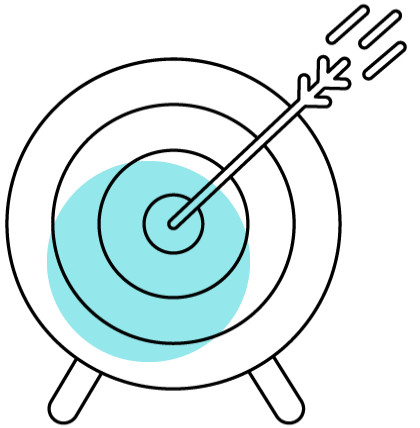
1. Arithmetic and numerical computation
2. Handling data
3. Algebra
4. Graphs
5. Geometry and Trigonometry

Mathematical skills

Details of the mathematical skills in other science subjects are given for reference.

		Biology	Chemistry	Physics
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	✓	✓	✓

Poll



How many of the mathematical skills areas do you feel confident to teach via your science lessons?

- None
- One
- Two
- Three
- Four
- All

Mathematical skills are divided into five main key areas:

1. Arithmetic and numerical computation
2. Handling data
3. Algebra
4. Graphs
5. Geometry and Trigonometry

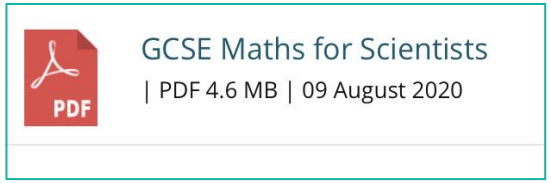
Mathematical Skills Self-Audit

- Skills assessment
- Professional development
- Collaborative teaching approaches
- Increased student success
- Resource identification

Mathematical concept	Level of confidence	Differentiate?
1. Arithmetic and numerical computation		
1a. Recognise and use expressions in decimal form		
1b. Recognise and use expressions in standard form		
1c. Use ratios, fractions and percentages		
1d. Make estimates of the results of simple calculations		
2. Handling Data		
2a. Use an appropriate number of significant figures		
2b. Find arithmetic means		
2c. Construct and interpret frequency tables and diagrams, bar charts and histograms		
2d. Understand the principle of sampling as applied to scientific data (Biology only)		
2e. Understand simple probability (Biology only)		
2f. Understand the terms mean, median and mode		
2g. Use a scatter diagram to identify a correlation between two variables (Biology and Physics)		
2h. Make order of magnitude calculations		

Maths Guide for GCSE Science

Edexcel provide a 'Guide to Maths for Scientists' that can be downloaded from the Teaching and Learning Materials section, under Maths and Practical support on the Edexcel GCSE Science website:



You can use this guide to help you understand how different areas are approached in maths and therefore support your teaching of mathematical concepts in science.

Guide to Maths for Scientists

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Maths Specific Examiner Feedback – Summer 2024

Examiner Feedback

Positives

Questions where marks could be gained by extracting and interpreting information from graphs were well answered by candidates.

Calculations where candidates were provided with the equation were generally well done.

Challenges

In Chemistry and Biology – lines of best fit.

Not showing working out in calculations – error carried forward could not be applied.

Incorrect use of units.

Students unable to use standard form correctly.

Not following instructions to give answers to a specific number of significant figures

Misconceptions Identified

Biology	Chemistry	Physics
Calculating an average	Significant figures	Incorrect application of formula
Line of best fit	Ratios	Unit conversion
Describing a trend		Significant figures
Unit conversion		Standard form
		Gradient of a graph

Difference between Science and Maths

Skill	Maths	Science
Equations	Rarely in context	Often linked to a science context
Line of best fit	Straight line	Straight or curved line
Trends	Very rare – correlation in scatter graphs	Describing trends from graphs

Discussion

What effective strategies have you used to integrate Maths skills into the GCSE Science curriculum

Mathematical misconceptions – strategies for improvement

Significant areas of maths in science…

Misconception	Description
Incorrect application of formulas Ph1f (5c)/(8a)/(8b)/(9bii)	Students unable to rearrange formula to apply it to a different scenario.
Calculating an average Bi1f(Q2bii)	Candidates knew to add the numbers all together but lost marks by not dividing by the correct number.
Line of best fit Bi1f(8a)	Candidates could effectively plot points from table to graph, difficulty in plotting line/curve of best fit.
Describing a trend Bi1f(Q8bii)	Candidates unable to describe a trend from a graph, as well as paying attention to the command word.
Unit conversion (related to magnification) Bi1h (6ci) **Ph1h (5aii)**	Find it difficult to substitute equations and convert units, specifically mm to m. Also, conversion of nm to m.

Significant areas of maths in science…

Misconception	Description
Significant figures Bi1h(8bi) Ch1f (10aiii)/Ph1h (9b)	Candidates were able to complete the relevant calculations in the question, but found it challenging to provide the answer to the correct sf.
Ratios Ch1f (5b)	Working out simplest whole number ratios.
Standard form Ph1h (1b)	Unable to subtract figures in standard form.
Gradient of graph Ph1h (7cii)	Candidates unable to calculate the gradient of graph.

Remember:

- Maths is 2 tiers:

  Higher (grades 9–4 with grade 3 available although no grade 3 ‘content’)

  Foundation (grades 5–1)

  Almost a 50/50 split in year 11.

- The ‘stronger’ mathematicians will be sitting the higher tier.
- Foundation has more ‘number’ content with higher having more ‘algebra’ content.
- Both tiers now have more problem solving than previous GCSE.

Science point: Students unable to rearrange formula to apply it to a different scenario

Maths response: Very rarely in a context in Maths, but a common question as below on both tiers

(b) Make p the subject of the formula $d = 3p + 4$

(c) Make g the subject of the formula $f = 3g + 11$

(b) Make p the subject of the formula $d = 3p + 4$

Make a the subject of the formula $p = 3a - 9$

Make x the subject of the formula $y = \dfrac{4(2x - 7)}{5x + 3}$

Science point: Candidates knew to add the numbers all together but lost marks by not dividing by the correct number

Maths response: Same for maths!
Particularly when in a table

(dividing by the number of rows instead!)

Here are 6 numbers

13 5 4 9 3 8

Work out the mean

Seija works at a weather station.
The table gives information about the temperature, T °C, at midday for each of 50 cities in the UK on Tuesday.

Temperature (T °C)	Frequency
$10 < T \leqslant 15$	2
$15 < T \leqslant 20$	8
$20 < T \leqslant 25$	13
$25 < T \leqslant 30$	21
$30 < T \leqslant 35$	6

(a) Calculate an estimate for the mean temperature.

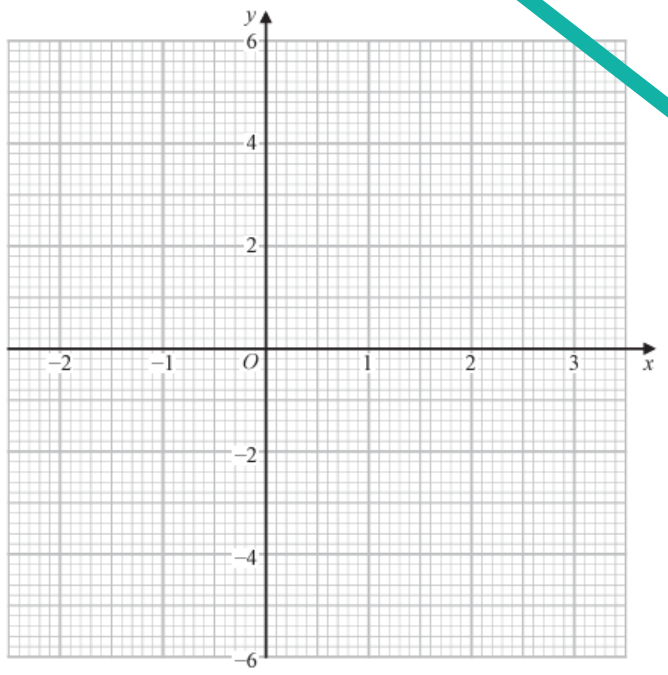
Science point: Candidates could effectively plot points from table to graph, difficulty in plotting line/curve of best fit

20 (a) Complete the table of values for $y = x^2 - x - 2$

x	−2	−1	0	1	2	3
y	4			−2		

(2)

(b) On the grid, draw the graph of $y = x^2 - x - 2$ for values of x from −2 to 3



(2)

(Total for Question 20 is 4 marks)

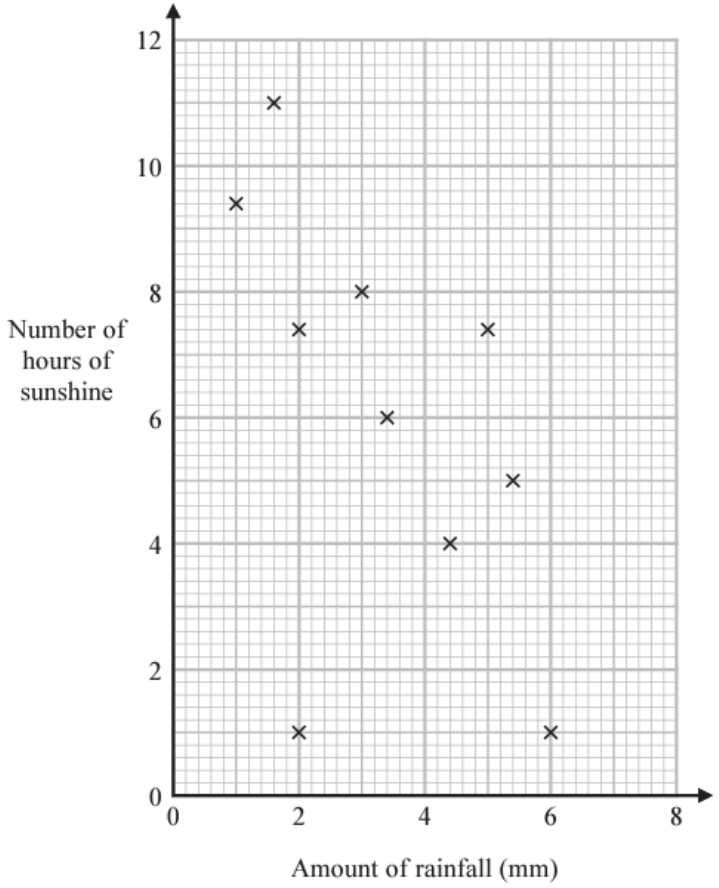
Maths response: No curve of best fit in maths

'Line of best fit' occurs in scatter graphs only (sometimes explicit in questions, sometimes not)

Students seem much better at getting these types of values recently… the table function in the new calculators help!

A line of best fit is not often requested in question but would be needed to help read values

The scatter graph shows information about the amount of rainfall, in mm, and the number of hours of sunshine for each of ten English towns on the same day.



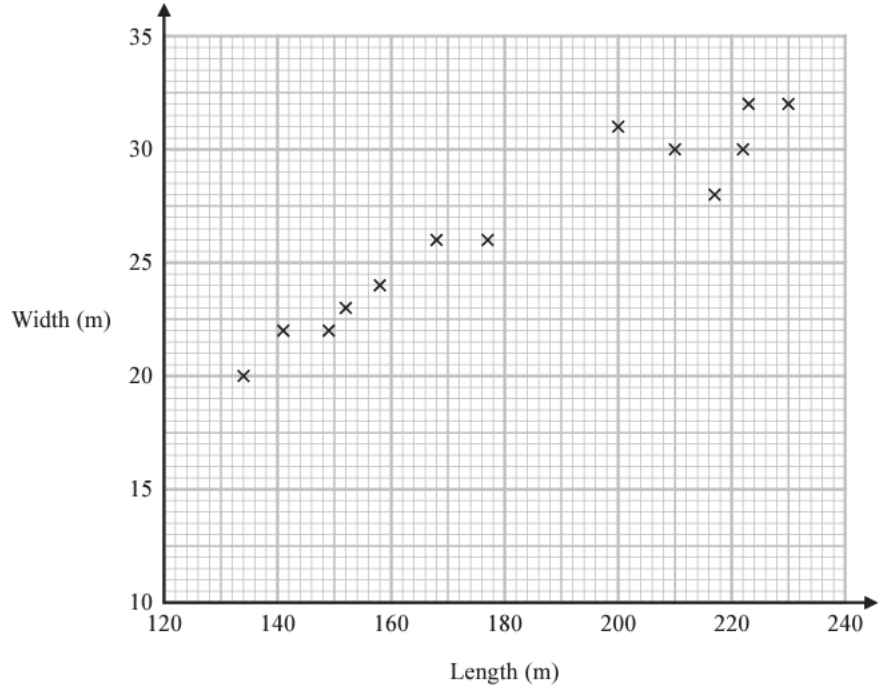
One of the points is an outlier.

(a) Write down the coordinates of this point.

Science point: Candidates unable to describe a trend from a graph, as well as paying attention to the command word

Maths response: Very rare in maths to describe trend other than a **correlation** or **relationship** in scatter graphs or maybe a time series. When we had moving averages pre-2017 they were very popular questions. Popular now in GCSE Statistics.

The scatter graph shows information about some ships.
It shows the length and the width of each ship.



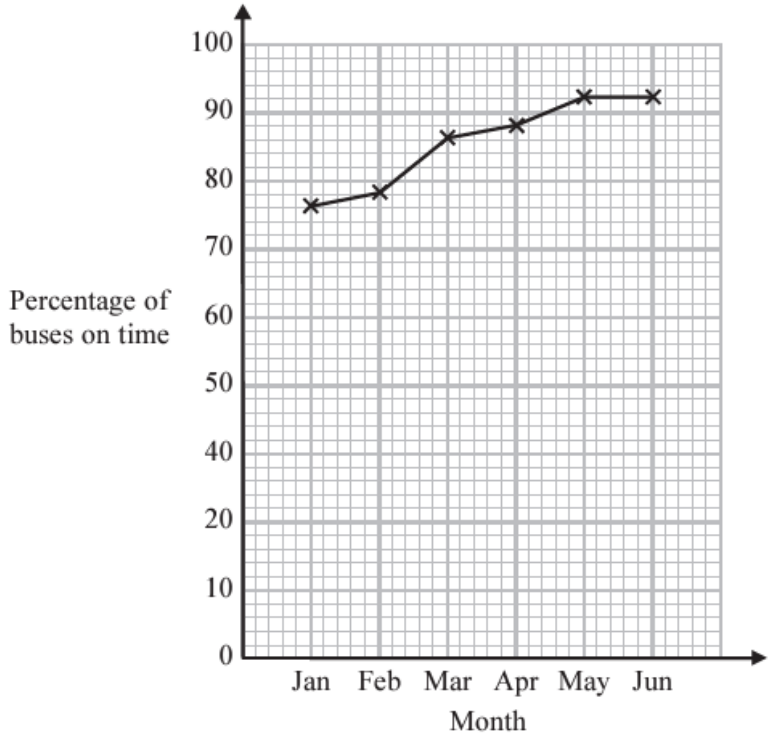
(a) What type of correlation does this scatter graph show?

(1)

(b) Draw a line of best fit on the scatter graph.

(1)

Chrissy drew this graph to show the percentage of buses that got to a bus stop on time for six months.



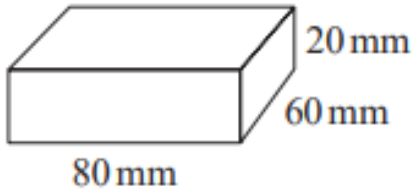
(b) Describe the trend in the percentage of buses that got to the bus stop on time.

(1)

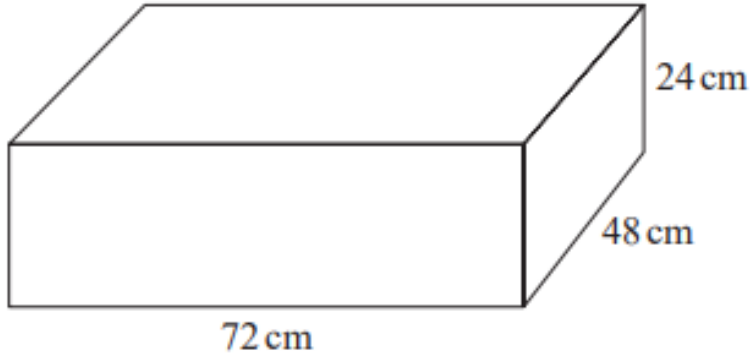
Science point: Find it difficult to substitute equations and convert units, specifically mm to m. Also, conversion of nm to m

Maths response: We quite often have conversions as 1 markers on foundation, but also embedded within questions. Students find converting cm^2 to m^2 etc. confusing particularly at foundation.

Packets of sweets are put into boxes.



Packet



Box

Each packet is a cuboid, 80 mm by 60 mm by 20 mm.
Each box is a cuboid, 72 cm by 48 cm by 24 cm.

Work out the greatest number of packets that can be put into each box.

(a) Change 8000 cm^3 to m^3

Science point: Find it difficult to substitute equations and convert units, specifically mm to m. Also, conversion of nm to m

Conversion graphs regularly appearing on foundation

One Marker Starters

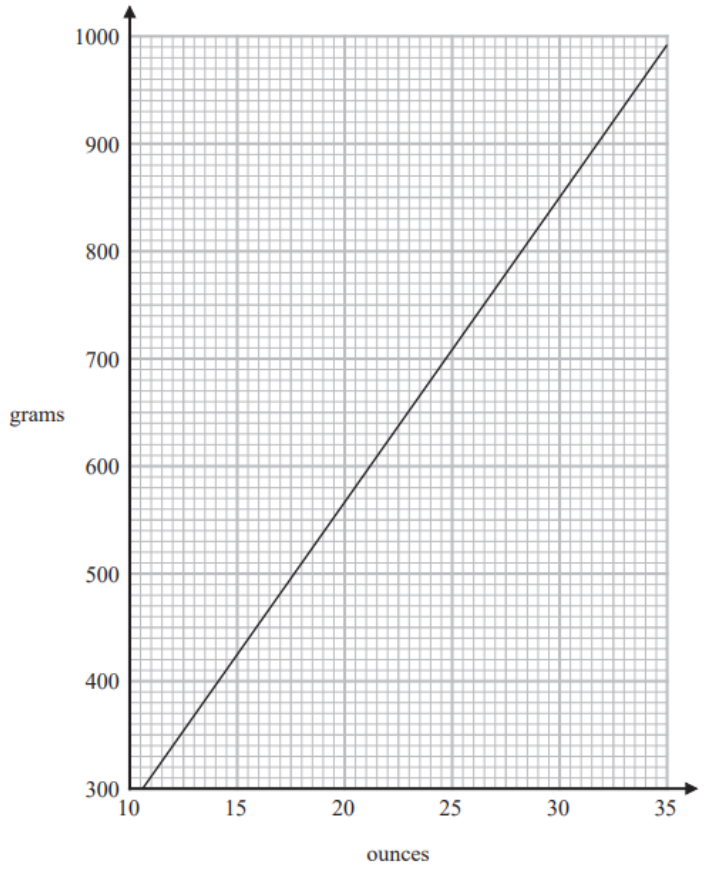
Includes Summer 2017 – Summer 2024 Exam Papers

(Unless otherwise stated)

Pearson

1 Simplify $5p - 3p + p$	6 Write 3758 correct to the nearest 1000
2 Write 56.78 correct to 1 significant figure	7 Work out $20 - 1 \times 10$
3 Change 365 cm into metres	8 Write down the first even multiple of 7
4 Solve $\frac{y}{4} = 10$	9 Work out the value of 3^4

14 You can use this graph to change between ounces and grams.



(a) Change 850 grams to ounces.

..... ounces

(1)

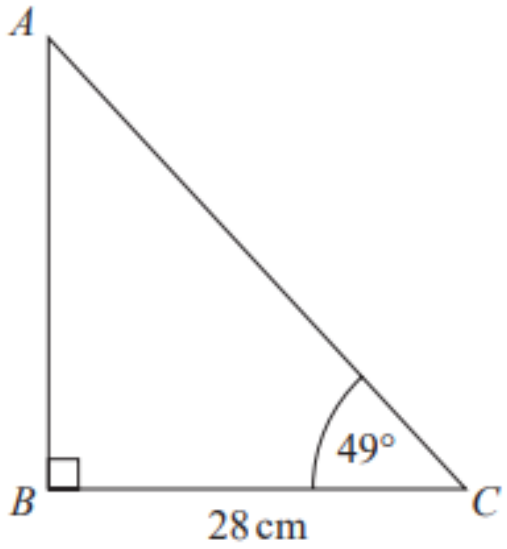
(b) Change 80 ounces to grams.

Science point: Candidates were able to complete the relevant calculations in the question, but found it challenging to provide the answer to the correct sf

Maths response: Generally part of a question (final part) after a calculation.

Can also be found as 1 mark foundation questions.

29 ABC is a right-angled triangle.



Calculate the length of AB.
Give your answer correct to 3 significant figures.

(a) Write 87 569 correct to 3 significant figures.

Science point: Working out simplest whole number ratios

Maths response: Very common on both foundation and higher tier in every sitting, quite often on multiple papers mostly in a context.

12 Amol, Gemma and Harry each have a number of sweets.

The number of sweets that Gemma has is 6 times the number of sweets that Amol has.
The number of sweets that Harry has is half the number of sweets that Gemma has.

Write down the ratio

the number of sweets that Amol has	:	the number of sweets that Gemma has	:	the number of sweets that Harry has

17 There are four boxes on a shelf, **A**, **B**, **C** and **D**.

The total weight of **A** and **B** is 3 times the total weight of **C** and **D**.

The weight of **A** is $\frac{2}{3}$ of the weight of **B**.

The weight of **C** is 75% of the weight of **D**.

Find the ratio

weight of **A** : weight of **B** : weight of **C** : weight of **D**

Science point: Unable to subtract figures in standard form

Maths response: Not particularly common in maths, when it does show up, not well answered in maths too. Particularly when in context!

Mostly multiply or divide on GCSE maths, rarely a subtract.

(c) Work out $(4 \times 10^{3}) \times (6 \times 10^{-5})$
Give your answer in standard form.

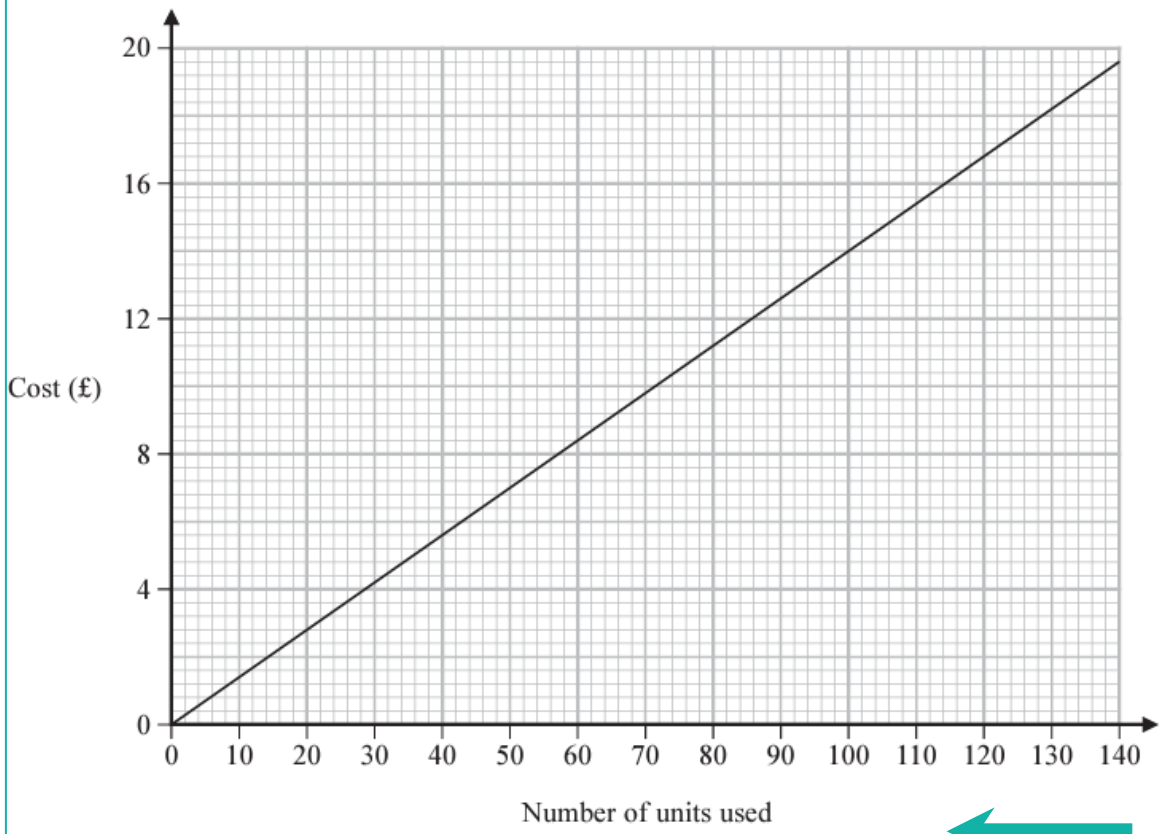
(b) Work out $\dfrac{2.56 \times 10^{6} \times 4.12 \times 10^{-3}}{1.6 \times 10^{-2}}$
Give your answer in standard form.

Science point: Candidates unable to calculate the gradient of graph

Maths response: Poor in maths too, particularly at foundation. These seem to becoming more and more common in exams, and we feel students are getting better. Shared language idea … ***'rise over run'*** ?

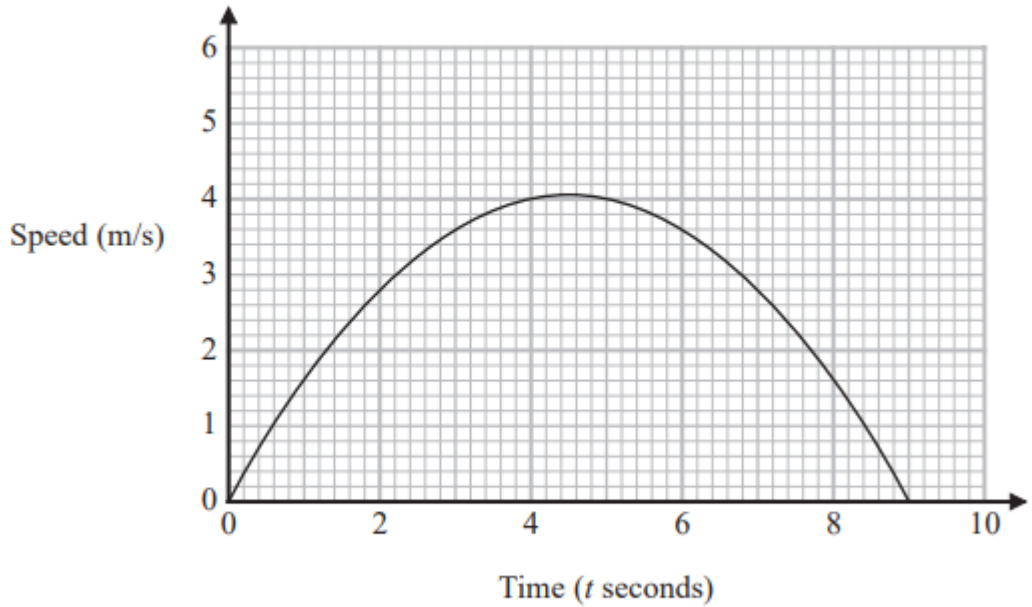
An electricity company charges the same fixed amount for each unit of electricity used.

David uses this graph to work out the total cost of the electricity he has used.



(b) What does the gradient of this line represent?

Here is a speed-time graph.



(a) Work out an estimate of the gradient of the graph at $t = 2$

Representation also quite common in GCSE maths

Use of ResultsPlus to help?

This cohort's top 5 **skills to celebrate** in relation to the Edexcel average **were:**

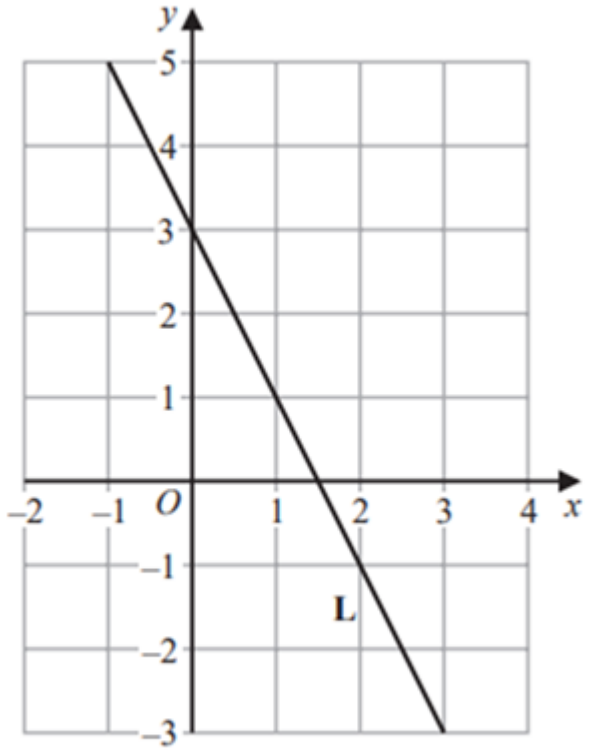
Skill Title	Score	Percentage	Edexcel Ave : ALL Edit	Variance
The nth term of a sequence	1.8/2	90%	0.91/2	+44.50 %
Growth and decay, compound interest	2.73/4	68%	1.22/4	+37.75 %
Graphs of quadra				
Graphs of linear f				
Compare lengths,				

This cohort's top 5 **skills to improve** in relation to the Edexcel average **were:**

Skill Title	Score	Percentage	Edexcel Ave : ALL Edit	Variance
Factorise expressions	0.65/2	33%	0.82/2	-8.50 %
Conventional geometrical terms and notation	0.82/2	41%	0.92/2	-5.00 %
Graphs and equations of lines	0.16/4	4%	0.27/4	-2.75 %
Solve linear inequalities	0.08/3	3%	0.16/3	-2.67 %
Simplify and manipulate algebraic expressions and fractions	0.73/1	73%	0.75/1	-2.00 %

ResultsPlus – very helpful if a crossover skill/question too

28 The line **L** is shown on the grid.



Find an equation for **L**.

Foundation

Q25a	0.16/3	0.24/3	-2.67 %
Q25b	0.00/1	0.04/1	-4.00 %

Higher

Q06a	1.62/3	2.1/3	-16.00 %
Q06b	0.19/1	0.6/1	-41.00 %

Calculators

What calculator do they use?

Same in maths as science as in exams?

- Different from the maths classroom ‘standard’ such as Casio Classwiz fx-82EX

- There is also the very popular Casio FX-85GTCW version which is the main one sold by schools and supermarkets

Popular ‘cheaper’ alternatives

Additional points …

- Do their rulers have cm and mm (are they transparent?). 30cm or 15cm?

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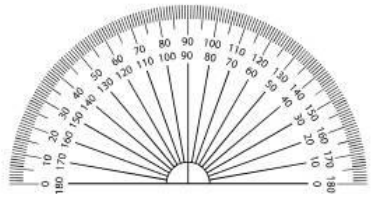
- What type of protractor do they prefer/use in class/exams… half or full circle?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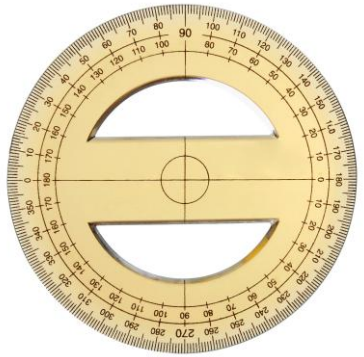
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Can they use these?

Some go-tos – the power of video!

Video title	Video link	Notes
Johnny Ball estimates the number of black cabs in London – Bang Goes the Theory – BBC	https://www.youtube.com/watch?v=tyX79mPm2xY	
Powers of Ten™ (1977) – Eames Office	https://www.youtube.com/watch?v=0fKBhvDjuy0	Key for maths and science (a little old now though!)
Circumference is pi times diameter song	https://www.youtube.com/watch?v=Opi5EaucFik	A catchy song to help you remember the area and circumference of circles.
Area of a Trapezium – Pop Goes The Weasel	https://www.youtube.com/watch?v=qIxawNewXiY	

Pearson Edexcel

Maths in Science resources

MiS Skills Worksheet

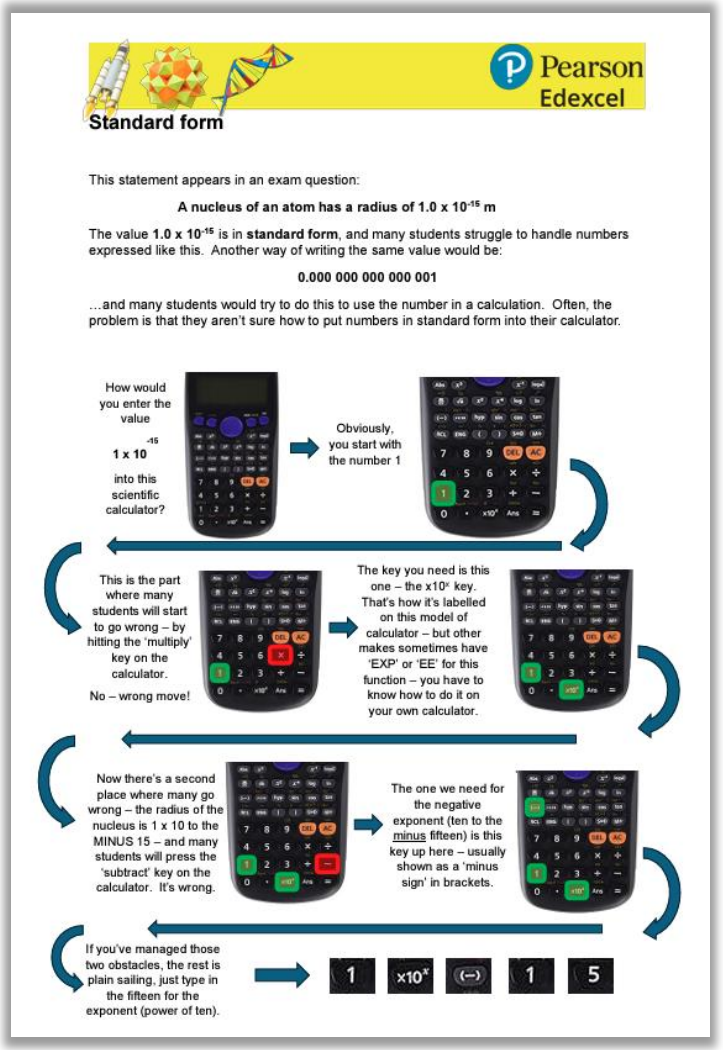
Pearson Edexcel provide a ‘Maths in Science Skills Sheets' that can be downloaded from the Teaching and Learning Materials section, under Maths and Practical support on the Edexcel GCSE Science website.

MiS Skills Worksheet – Standard Form

MiS Skills Worksheet - Standard Form NEW
| PDF 291.2 KB | 29 November 2024

MiS Skills Worksheet - Tables, Charts and Graphs
| PDF 607.5 KB | 29 November 2024

MiS Skills Worksheet - Decimals and Significant Figures
| PDF 561.6 KB | 29 November 2024



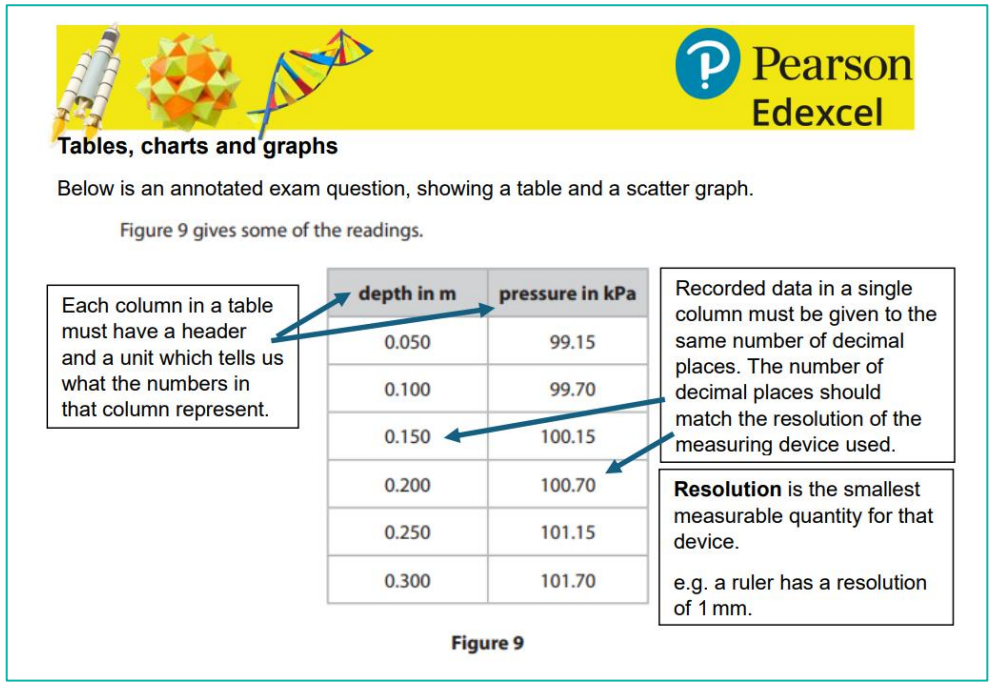
Mathematics in Science – Skills Worksheets – Standard Form

MiS Skills Worksheet

[Mathematics in Science – Skills Worksheets – Standard Form]

You can use this how-to-guides to help students and teachers understand how different areas are approached in maths. Each guide also includes a range of past paper questions and answers.

These guides could be used as resources during lessons, for homework or for revision purposes for students.



Coming Soon….

MiS Skills Videos

- Complement each worksheet
- Designed to be for student use
- Worked examples of how each mathematical skill is applied to different scientific contexts
- Range of past paper questions with MS

Specification Mapping Document

- This maps our science specification with maths and statistics
- Allows teachers across maths and science teams to show where skills are taught and opportunities for cross curricular teaching

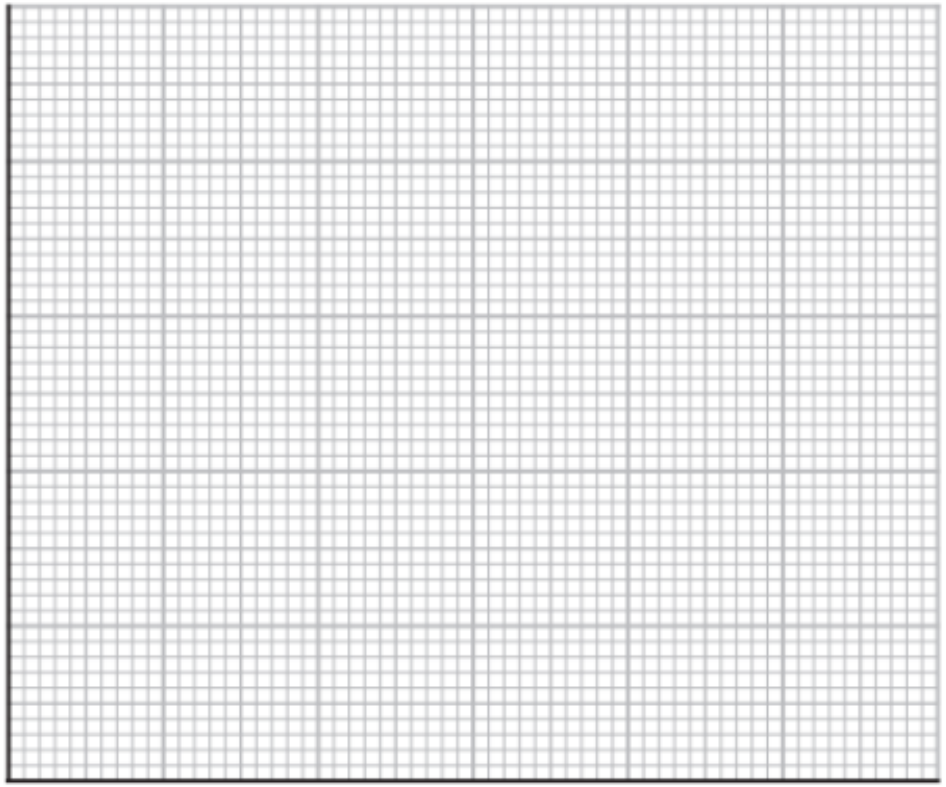
Collaborative Approach

Classroom Tips

- Maths for Science learning mat
- Practical investigations that require students to collect and analyse data https://qualifications.pearson.com/content/dam/pdf/GCSE/Science/2016/teaching-and-learning-materials/GCSE-9-1-Sciences-core-practical-guide.pdf
- MiS Skills sheets and videos https://qualifications.pearson.com/en/qualifications/edexcel-gcses/sciences-2016.coursematerials.html#%2FfilterQuery=category:Pearson-UK:Category%2FTeaching-and-learning-materials
- Pupil Audit of Maths skills
- Never operate under the assumption that students have the knowledge
- Maths Quizzes – baseline testing
- Maths Roulette such as GCSE Mathematics in Science Questions available here https://qualifications.pearson.com/content/dam/secure/silver/all-uk-and-international/gcse/science/2016/teaching-and-learning-materials/mqis-f-qp-lb.pdf?30415470673615 1

Cross-Departmental Tips

- Similar approach to Maths department
- Video bank
- Linked lessons
- Maths teachers using Science starters
- Common stationery



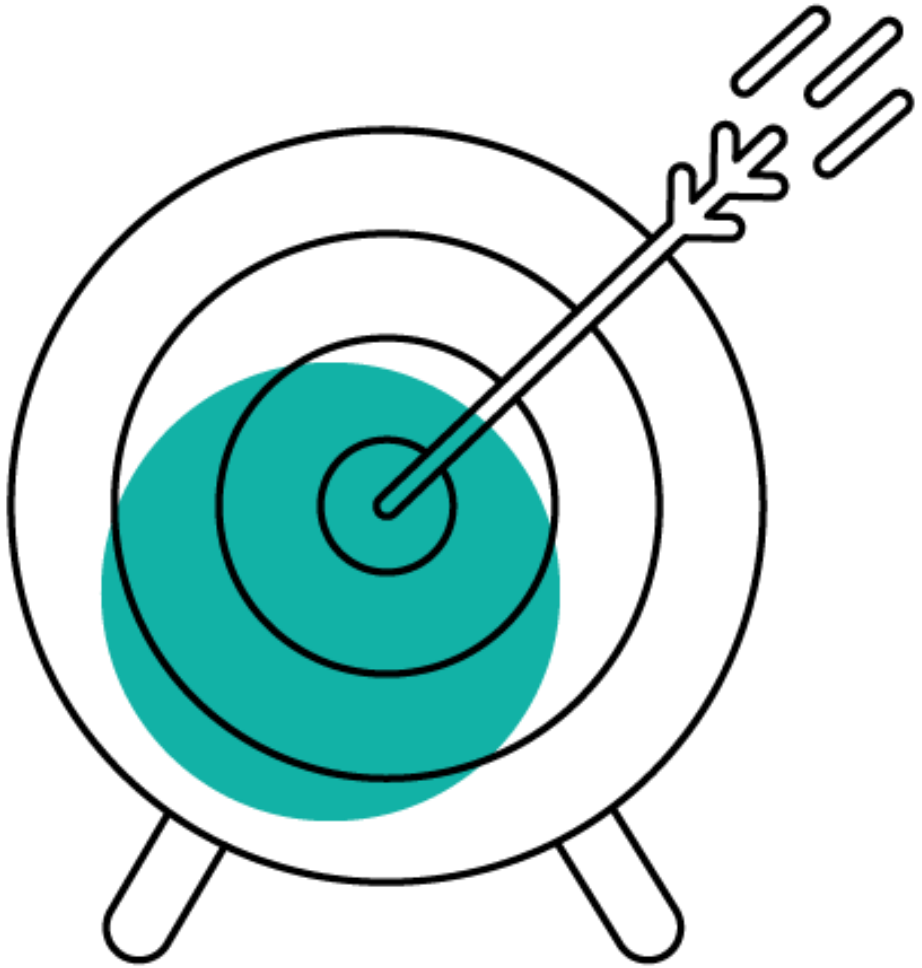
Supporting Learners with Dyscalculia in Science

- Use of visual aids: Charts, graphs and diagrams.
- Chunking: Break down complex problems into smaller, more manageable steps.
- Consistent practice and review via variety of exercises and regularly review of topics.
- Real-life applications: relate mathematical concepts to real-life situations to make them more relevant and understandable.
- Technology and software: use educational software and apps designed to support students.
- Extra time: allow extra time for students to process information and complete tasks.
- Use of mnemonics and memory aids: create catchy phrases or acronyms to aid memory.

Summary

In this session we looked at:

- maths requirements in GCSE Science
- examiner feedback summer 2024
- mathematical misconceptions – strategies for improvement
- Maths in Science resources
- collaborative approaches.



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Your Feedback Matters

Following this event, you will receive an invitation to share your thoughts about the session. Your feedback is invaluable to us, as it helps us tailor our professional development materials to better meet your needs. Please don’t hesitate to let us know what you’d like to see more of and what areas you think could be improved.

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