Teaching guide: Standard form and order of magnitude calculations

Mathematics for GCSE Science

This resource helps you to deliver the mathematical requirements that students are required to demonstrate in the new GCSE Science specifications. It consists of a teaching guide and PowerPoint presentation.

1. Arithmetic and numerical computation

Science GCSE subject criteria Maths skill: 1a. Recognise and use expressions in decimal form

1. Brief explanation	Decimals are used when a greater degree of accuracy is required in a calculation or experiment. The term 'decimal' usually refers to the part of the number which is after the decimal point although 'decimal form' actually means any number in base 10.
2. Statement of coverage from: KS3 Mathematics programme of study (POS)	• Understand and use place value for decimals • Order positive and negative integers, decimals and fractions; use the symbols =, ≠, <, >, ≤, ≥ • Use the four operations, including formal written methods, applied to decimals • Work interchangeably with terminating decimals and their corresponding fractions (such as 3.5 and $\frac{7}{2}$ or 0.375 and $\frac{3}{8}$) • Round numbers and measures to an appropriate degree of accuracy [for example, to a number of decimal places or significant figures] • Use a calculator and other technologies to calculate results accurately and then interpret them appropriately
KS4 Mathematics programme of study (POS)	• Change recurring decimals into their corresponding fractions and vice versa
3. Maths introduction and development	Most students will be familiar with the use of decimals. It will be recapped at each key stage. • Understand and use place value (KS2) • Apply the four operations to decimals (KS2/KS3) • Understand and use place value when calculating with decimals (KS2/KS3)
4.Ref AQA All About Maths AQA All About Maths Basic decimals	NEW GCSE Maths (8300) > Foundation tier resources > Number > Basic decimals **Lesson 1** – Ordering positive and negative decimals. Addition and Subtraction of fractions. **Lesson 2** – Multiplication of decimals, converting between terminating decimals and fractions. **Lesson 3** – Division of decimals. **Lesson 4** – Review of decimals.

5. Misconceptions	• Longer is larger – the more decimal places the larger the number. These students need to be shown how the position of each digit in the number determines the size of the number (place value.) • Most misconceptions occur when converting between decimals and fractions or decimals and percentages e.g. A student might think that 0.12 = 1/12 or 0.5 = 5%
6. Some examples of where it is applied in science	**Biology** Microscopy Osmosis Rate of photosynthesis **Chemistry** Calculating rates of reactions Chromatography The Haber process **Physics** Changes in energy Efficiency Speed

1. Arithmetic and numerical computation

Science GCSE subject criteria Maths skill: 1b. Recognise and use expressions in standard form

1. Brief explanation	Standard form is a way of writing very large or very small numbers. It is also known as standard index form. It is based on using powers of 10 to express how big or small a number is. A number written in standard form is $A \times 10^n$. Where $1 \leq A < 10$ and n is the index, ie. the power of 10 required to multiply A to convert it back to the original.
2. Statement of coverage from: KS3 Mathematics programme of study (POS) KS4 Mathematics programme of study (POS) *This topic is new to the Foundation tier, having previously been assessed at the Higher tier only.*	• 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 • Calculate with numbers in standard form $A \times 10^n$ where $1 \leq A < 10$ and n is an integer.
3. Maths introduction and development	Objectives: be able to • write large numbers in standard form • convert standard form back into normal numbers • write small numbers in standard form • calculate with numbers in standard form
4.Ref AQA All About Maths AQA All About Maths Standard form	NEW GCSE Maths (8300) > Foundation tier resources > Number > Standard form The notation is a convention and so needs to be remembered. Converting to and from standard form relies also on understanding place value and being able to multiply and divide by powers of ten. The Basic Number unit also tackles these. Lesson plans 1-6 **Lesson 1** – This lesson revisits the prior learning required for the topic, specifically place value. **Lesson 2** – Standard form is introduced and the lesson focuses on switching between representing in standard form and as ordinary numbers. **Lesson 3** – This looks at the magnitude of numbers written in standard form.

	Lesson 4 – Starting to calculate with standard form, focusing on addition and subtraction. **Lesson 5** – Multiplying and dividing numbers in standard form without converting to ordinary numbers. **Lesson 6** – Applying knowledge and understanding of standard form from the whole unit to problems in context.
5. Misconceptions	Students typically find it difficult remembering whether positive powers of ten relate to large numbers or small numbers, as they recall a process without linking it to place value. The use of index notation within standard form makes routine problems look more difficult and students can be reluctant to attempt the questions, even though they know how to do them.
6. Some examples of where it is applied in science	**Biology** Eukaryotes and prokaryotes Microscopy **Chemistry** Size and mass of atoms Sizes of particles and their properties (chemistry only) Moles (HT only) **Physics** The structure of an atom Nuclear equations Different half-lives of radioactive isotopes

2. Handling data

Science GCSE subject criteria Maths skill: 2h. Make order of magnitude calculations

1. Brief explanation	Order of magnitude is an important skill, required when comparing or checking results. In Maths, students need to be able to identify scale factors and orders of magnitude which might be a decimal, fraction, percentage or integer value.
2. Statement of coverage from: KS3 Mathematics programme of study (POS) KS4 Mathematics programme of study (POS)	• use scale factors, scale diagrams and maps • compare lengths, areas and volumes using ratio notation and/or scale factors; make links to similarity (including trigonometric ratios) • interpret and use fractional {**and negative**} scale factors for enlargements
3. Maths introduction and development	Order of magnitude restricted to powers of 10 is covered during KS3. • Multiply and divide by powers of 10 • Multiplying by a power of 10 has an equivalent division calculation, eg ÷100 is the same as ×0.01 and ÷0.01 is the same as ×100 • Converting between metric measures and the meaning of the names, eg kilo means 1000, centi means 100th etc.
4.Ref AQA All About Maths	n/a
5. Misconceptions	These tend to occur with mixing up which way to do the conversions, eg a student might convert 2m to 2000km rather than 0.002km.
6. Some examples of where it is applied in science	**Biology** Eukaryotes and prokaryotes Microscopy Culturing microorganisms (Biology only) **Chemistry** Sizes of particles and their properties (Chemistry only) Strong and weak acids (HT only) Using the Earth's resources and sustainable development **Physics** Factors affecting braking distance