GCSE ONLINE TUTORING

NUMBER / TOPIC GUIDE 06

06

Standard form

Shared GCSE core

Standard form makes very large and very small numbers easier to read, compare and calculate with. The power of ten records the scale, while a coefficient between 1 and 10 records the significant digits. This guide keeps meaning and size visible throughout.

$$4.8 \times 10^6 = 4{,}800{,}000$$

Coefficient 4.8 • scale 10^6

UNDERSTAND THE IDEA. EXPLAIN THE METHOD.

Detailed teaching • Worked examples • Discussion • Original practice • Full solutions

Name: _____

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Before you begin

Understand decimal place value, powers of ten and ordinary arithmetic.

Your route through this notebook

1. Writing and interpreting standard form
2. Comparing and calculating products and quotients
3. Addition, subtraction and contextual answers

How to use it

Read a lesson, cover the worked solutions and try the examples yourself. Complete its practice page before checking the answers at the back. Finish with the mixed review, then return to any method you could not explain.

YOUR PROGRESS

After each lesson, ask: Can I explain the idea? Can I choose a method? Can I check my result? Record any questions you want to revisit.

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LESSON 1 / UNDERSTAND

Writing and interpreting standard form

A positive number in standard form is written $A \times 10^n$, where $1 \leq A < 10$ and n is an integer. The coefficient A records the significant digits and the power of ten restores the size. For example, 5.4×10^6 means 5.4 multiplied by one million. For a negative number, a minus sign is placed in front of the standard-form representation of its size.

A negative power of ten means a small scale: $10^{-3} = 1/1{,}000$. It does not make the number negative. Standard form is a particular representation; 54×10^5 has the same value as 5.4×10^6 but is not in standard form because 54 is too large to be the coefficient.

A reliable method

1. Choose a coefficient with one non-zero digit before the decimal point.
2. Count the power of ten needed to rebuild the original number.
3. Check both conditions: coefficient in range and integer exponent.

Worked example 1

Write 72,000,000 in standard form.

STEP-BY-STEP SOLUTION

The coefficient is 7.2. Since $7.2 \times 10^7 = 72{,}000{,}000$, the answer is 7.2×10^7.

Worked example 2

Write 0.000084 in standard form.

STEP-BY-STEP SOLUTION

Use coefficient 8.4. To return to the original small number, multiply by 10^{-5}: 8.4×10^{-5}.

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LESSON 1 / DISCUSS & PRACTISE

Explain it, then try it

DISCUSSION • TEST THE IDEA

A coefficient of exactly 10 is outside the allowed range. Rewrite 10×10^4 as 1×10^5. When converting back to ordinary notation, use the exponent as a scale instruction rather than guessing how many zeros to write.

Say it in your own words

Explain the key idea to someone else. Use a small example to support your explanation. If you disagree with a claim, show why it fails.

1.1 Write 3,450,000 in standard form.

1.2 Write 0.0062 in standard form.

1.3 Write 4.08×10^4 as an ordinary number.

1.4 Rewrite 0.73×10^8 in standard form.

Check before turning to the answers: is the size sensible, is the notation clear, and have you included any required units?

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LESSON 2 / UNDERSTAND

Comparing and calculating products and quotients

For positive numbers already in standard form, the exponent usually decides which is larger. If exponents match, compare coefficients. This works because coefficients are restricted to the same interval. For multiplication, multiply coefficients and add powers of ten. For division, divide coefficients and subtract powers. Afterwards, normalise the result so its coefficient is in range.

Keep the numerical calculation separate from the power-of-ten calculation until the final step. This reduces sign errors with negative exponents. On many calculators, an EXP or $\times 10^{x}$ key enters the scale directly. Learn your own calculator's display and check the size of the result before copying it.

A reliable method

1. Multiply: $(A \times 10^{m})(B \times 10^{n}) = AB \times 10^{m+n}$.

2. Divide: $(A \times 10^{m})/(B \times 10^{n}) = (A/B) \times 10^{m-n}$.

3. Renormalise if the coefficient is below 1 or at least 10.

Worked example 1

Calculate $(6 \times 10^{5})(4 \times 10^{-3})$.

STEP-BY-STEP SOLUTION

Coefficients: $6 \times 4 = 24$. Powers: $10^{5-3} = 10^{2}$. Thus $24 \times 10^{2} = 2.4 \times 10^{3}$.

Worked example 2

Calculate $(3.6 \times 10^{-4}) \div (9 \times 10^{2})$.

STEP-BY-STEP SOLUTION

Coefficients: $3.6 \div 9 = 0.4$. Exponent: $-4 - 2 = -6$. Rewrite 0.4×10^{-6} as 4×10^{-7}.

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LESSON 2 / DISCUSS & PRACTISE

Explain it, then try it

DISCUSSION • TEST THE IDEA

When dividing by 10^{-3}, subtracting the exponent means subtracting -3, which adds 3. Also, 8×10^{-4} is smaller than 2×10^{-3}: the larger coefficient does not outweigh the different scale.

Say it in your own words

Explain the key idea to someone else. Use a small example to support your explanation. If you disagree with a claim, show why it fails.

2.1 Which is greater, 7.9×10^5 or 1.2×10^6?

2.2 Calculate $(3 \times 10^4)(5 \times 10^3)$.

2.3 Calculate $(8.4 \times 10^7) \div (2.1 \times 10^2)$.

2.4 Calculate $(2 \times 10^{-3})^2$.

Check before turning to the answers: is the size sensible, is the notation clear, and have you included any required units?

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LESSON 3 / UNDERSTAND

Addition, subtraction and contextual answers

You cannot add powers of ten in the same way as you combine them in multiplication. Addition requires a common scale, just as fraction addition requires a common denominator. Rewrite both numbers using the same power, add or subtract the coefficients, then put the result back into standard form. Alternatively, use ordinary notation when the numbers are manageable.

In applications, keep units attached. A result in metres must be converted before reporting it in kilometres. If a question asks for a stated number of significant figures, round only the final coefficient. Intermediate rounding can distort a small difference or a quotient. The original quantities may be measurements, so avoid claiming more accuracy than is justified.

A reliable method

1. Rewrite numbers with a shared exponent before adding or subtracting.

2. Keep units consistent before forming a calculation.

3. Round once at the end if requested, and include units in the final answer.

Worked example 1

Calculate $4.2 \times 10^6 + 7 \times 10^5$.

STEP-BY-STEP SOLUTION

Rewrite 7×10^5 as 0.7×10^6. Add coefficients: $(4.2 + 0.7) \times 10^6 = 4.9 \times 10^6$.

Worked example 2

A signal travels 1.5×10^8 m at 3×10^8 m/s. Find its travel time.

STEP-BY-STEP SOLUTION

Time = distance ÷ speed = $(1.5/3) \times 10^0 = 0.5$ seconds. The metres cancel, leaving seconds.

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LESSON 3 / DISCUSS & PRACTISE

Explain it, then try it

DISCUSSION • TEST THE IDEA

The expression $3 \times 10^4 + 2 \times 10^4$ equals 5×10^4, not 5×10^8. Adding exponents is a multiplication rule. Identify the operation before choosing an index law.

Say it in your own words

Explain the key idea to someone else. Use a small example to support your explanation. If you disagree with a claim, show why it fails.

3.1 Calculate $2.5 \times 10^5 + 3.2 \times 10^5$.

3.2 Calculate $8 \times 10^6 - 4 \times 10^5$.

3.3 A cell has mass 2.4×10^{-9} g. Find the mass of 5×10^6 cells.

3.4 A distance is 6.8×10^7 m. Express it in kilometres in standard form.

Check before turning to the answers: is the size sensible, is the notation clear, and have you included any required units?

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MIXED REVIEW / ORIGINAL EXAM-STYLE PRACTICE

Apply your learning • 1

These questions are independently authored, not taken or adapted from past papers. Marks are suggested for self-assessment. Show your method and explain decisions. Use a calculator only where the arithmetic requires it.

R1. Write 0.00000309 in standard form. [2 marks]

R2. Order 6×10^{-5}, 8×10^{-6} and 1.2×10^{-4}, smallest first. [2 marks]

R3. Calculate $(7 \times 10^{3})(4 \times 10^{5})$, giving standard form. [3 marks]

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MIXED REVIEW / ORIGINAL EXAM-STYLE PRACTICE

Apply your learning • 2

These questions are independently authored, not taken or adapted from past papers. Marks are suggested for self-assessment. Show your method and explain decisions. Use a calculator only where the arithmetic requires it.

R4. Calculate $(1.8 \times 10^{-3}) \div (6 \times 10^{4})$. [3 marks]

R5. Calculate $3.4 \times 10^{7} + 8.5 \times 10^{6}$. [3 marks]

R6. A storage device holds 2.4×10^{11} bytes. Each file uses 6×10^{6} bytes. Find the maximum number of complete files, assuming no other storage use. [3 marks]

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SOLUTIONS / LESSON PRACTICE

Check the reasoning

Your layout may differ. Compare the mathematical reasoning as well as the final answer. Correct any error, then reattempt the question without looking.

Lesson 1 • Writing and interpreting standard form

1.1 Write 3,450,000 in standard form.

3.45×10^{6}.

1.2 Write 0.0062 in standard form.

6.2×10^{-3}.

1.3 Write 4.08×10^{4} as an ordinary number.

40,800.

1.4 Rewrite 0.73×10^{8} in standard form.

Multiply the coefficient by 10 and reduce the exponent by 1: 7.3×10^{7}.

Lesson 2 • Comparing and calculating products and quotients

2.1 Which is greater, 7.9×10^{5} or 1.2×10^{6}?

1.2×10^{6} is greater. In ordinary form the comparison is 790,000 versus 1,200,000.

2.2 Calculate $(3 \times 10^{4})(5 \times 10^{3})$.

$15 \times 10^{7} = 1.5 \times 10^{8}$.

2.3 Calculate $(8.4 \times 10^{7}) \div (2.1 \times 10^{2})$.

4×10^{5}.

2.4 Calculate $(2 \times 10^{-3})^{2}$.

Square the coefficient and the scale: 4×10^{-6}.

Lesson 3 • Addition, subtraction and contextual answers

3.1 Calculate $2.5 \times 10^{5} + 3.2 \times 10^{5}$.

$(2.5 + 3.2) \times 10^{5} = 5.7 \times 10^{5}$.

3.2 Calculate $8 \times 10^{6} - 4 \times 10^{5}$.

$8 \times 10^{6} - 0.4 \times 10^{6} = 7.6 \times 10^{6}$.

3.3 A cell has mass 2.4×10^{-9} g. Find the mass of 5×10^{6} cells.

$(2.4 \times 5) \times 10^{-9+6} = 12 \times 10^{-3} = 1.2 \times 10^{-2}$ g.

3.4 A distance is 6.8×10^{7} m. Express it in kilometres in standard form.

Divide by 1,000 = 10^{3}: 6.8×10^{4} km.

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SOLUTIONS / MIXED REVIEW

Answers and marking guidance

Award the suggested method marks for valid working, even where a later arithmetic slip occurs. Do not count the same step twice. These are independent teaching allocations, not official exam-board mark schemes.

R1. Write 0.00000309 in standard form. [2 marks]

3.09×10^{-6}. [1 for coefficient; 1 for exponent.]

R2. Order 6×10^{-5}, 8×10^{-6} and 1.2×10^{-4}, smallest first. [2 marks]

$8 \times 10^{-6} < 6 \times 10^{-5} < 1.2 \times 10^{-4}$. [1 for consistent comparison; 1 for full order.]

R3. Calculate $(7 \times 10^{3})(4 \times 10^{5})$, giving standard form. [3 marks]

$28 \times 10^{8} = 2.8 \times 10^{9}$. [1 for 28; 1 for exponent 8; 1 for normalisation.]

R4. Calculate $(1.8 \times 10^{-3}) \div (6 \times 10^{4})$. [3 marks]

$0.3 \times 10^{-7} = 3 \times 10^{-8}$. [1 for coefficient; 1 for exponent; 1 for normalisation.]

R5. Calculate $3.4 \times 10^{7} + 8.5 \times 10^{6}$. [3 marks]

$3.4 \times 10^{7} + 0.85 \times 10^{7} = 4.25 \times 10^{7}$. [1 for shared scale; 1 for coefficient addition; 1 for answer.]

R6. A storage device holds 2.4×10^{11} bytes. Each file uses 6×10^{6} bytes. Find the maximum number of complete files, assuming no other storage use. [3 marks]

$(2.4 \times 10^{11})/(6 \times 10^{6}) = 0.4 \times 10^{5} = 40{,}000$ files. [1 for division model; 1 for powers/coefficient; 1 for number of files.]

Reflect, repair and revisit

Record one secure method, one mistake you corrected and one question to retry. Reattempt the questions you missed in a few days. Explain why your new method works before you compare your answer.

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