GCSE ONLINE TUTORING

ALGEBRA & GRAPHS / TOPIC GUIDE 11

11

Algebra basics and operations with terms

Shared GCSE foundations

Letters let us describe many numbers at once. Learn the language of algebra, combine terms correctly and distinguish expressions from equations. The aim is to explain every change, not just memorise rules.

3x + 5x = 8x

Like terms combine; products follow a different rule.

UNDERSTAND THE IDEA. EXPLAIN THE METHOD.

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

Name: _____

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Your learning guide

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Independent educational resource

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Before you begin

Work confidently with signed numbers, multiplication, division and powers.

Your route through this notebook

1. Reading algebra and identifying terms
2. Collecting like terms
3. Multiplying and dividing algebraic terms

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

Reading algebra and identifying terms

A variable represents a number that may vary or be unknown. In 5x + 3, the coefficient 5 multiplies x and the constant 3 is added. A term is a part of an expression separated by addition or subtraction at the outermost level. Thus 4x − 7y + 2 has terms 4x, −7y and 2; the minus belongs to the term.

Algebra normally omits the multiplication sign: 3ab means 3 × a × b. A power is different: a^2 means a × a, whereas 2a means a + a. An expression has no assertion of equality; an equation states that two expressions are equal for particular values. An identity is true for every permitted value of its variables.

A reliable method

1. Read adjacent letters and numbers as multiplication.

2. Identify terms together with their signs.

3. Decide whether you are simplifying an expression or solving an equation.

Worked example 1

Identify the terms and coefficients in 6p − 3q + 8.

STEP-BY-STEP SOLUTION

The terms are 6p, −3q and 8. The coefficients of p and q are 6 and −3. The constant is 8.

Worked example 2

Write a number n increased by 7, and seven times n.

STEP-BY-STEP SOLUTION

Increased by 7 is n + 7. Seven times n is 7n. These describe different operations.

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LESSON 1 / DISCUSS & PRACTISE

Explain it, then try it

DISCUSSION • TEST THE IDEA

A letter is a number, not an object label. If a is the number of apples, 3a counts three times that number. Two different letters can have the same value; different symbols do not guarantee different numbers.

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 List the terms of $2x - 5y - 9$.

1.2 Write $4 \times a \times b$ without multiplication signs.

1.3 Explain the difference between x^2 and $2x$.

1.4 Classify $3x + 2$ and $3x + 2 = 14$.

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

Collecting like terms

Like terms have exactly the same variable part, including powers. Because 3x and 5x count the same kind of quantity, their coefficients can be added: 3x + 5x = 8x. The terms x and x^2 are unlike; they represent different expressions. Constants can be collected with constants.

Subtraction is addition of a negative term, so carry every sign while rearranging. Commutativity allows terms in a sum to be regrouped, but changing a sign changes the value. A simplified expression should have each type of term collected and no unnecessary multiplication signs. You are not finding a numerical answer unless the variables have specified values.

A reliable method

1. Group terms with matching letters and matching powers.

2. Add their signed coefficients.

3. Keep unlike terms separate and combine constants.

Worked example 1

Simplify $7x - 3 + 2x + 8$.

STEP-BY-STEP SOLUTION

The x terms give $7x + 2x = 9x$. Constants give $-3 + 8 = 5$. Result: $9x + 5$.

Worked example 2

Simplify $4a^2 + 3a - a^2 - 5a$.

STEP-BY-STEP SOLUTION

Square terms give $3a^2$; linear terms give $-2a$. Result: $3a^2 - 2a$.

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LESSON 2 / DISCUSS & PRACTISE

Explain it, then try it

DISCUSSION • TEST THE IDEA

3x + 4y cannot generally become 7xy. Test x = 1 and y = 2: the sum is 11 but 7xy is 14. A single counterexample disproves the suggested rule.

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 Simplify $8x - 3x + x$.

2.2 Simplify $5a + 2b - a + 7b$.

2.3 Simplify $6p^2 - p + 2p^2 + 4p$.

2.4 Simplify $9 - 4y - 12 + y$.

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

Multiplying and dividing algebraic terms

A product combines factors rather than adding coefficients. Multiply numerical coefficients and then combine the variable factors. For example, $(3x)(4x) = 12x^2$ because $x \times x = x^2$. Different letters remain as separate factors: $x \times y = xy$. Sign rules are the same as for ordinary numbers.

Division can be written as a fraction and simplified by cancelling common non-zero factors. A cancelled variable cannot be zero in the original denominator. When dividing powers with the same base, subtract their indices. Do not cancel across addition: $(x + 3)/x$ is not 3 because x is not a factor of the whole numerator.

A reliable method

1. Multiply or divide coefficients with their signs.
2. Combine matching variable factors using index laws.
3. State restrictions caused by any original denominator.

Worked example 1

Simplify $(-3a)(2a^2b)$.

STEP-BY-STEP SOLUTION

The coefficients give -6; $a \times a^2 = a^3$. Therefore $-6a^3b$.

Worked example 2

Simplify $18x^3y \div 6xy$, where x and y are non-zero.

STEP-BY-STEP SOLUTION

Divide coefficients: $18/6 = 3$. Cancel y and one x, leaving x^2. Result: $3x^2$.

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LESSON 3 / DISCUSS & PRACTISE

Explain it, then try it

DISCUSSION • TEST THE IDEA

Addition and multiplication follow different rules: $3x + 4x = 7x$, but $(3x)(4x) = 12x^2$. Identify the operation before changing coefficients or powers.

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 Simplify $(5x)(-2y)$.

3.2 Simplify $(3a^2)(4a^3)$.

3.3 Simplify $20m^3n^2 \div 5mn$, for non-zero m,n.

3.4 A rectangle has sides 3x cm and 5x cm. Express its perimeter and area.

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. Simplify $9x - 4y - 3x + y$. [2 marks]

R2. Simplify $5a^2 + 2a - 3a^2 + 7a$. [2 marks]

R3. Simplify $(-4p^2)(3pq)$. [2 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. Simplify $24x^4y^2 \div 8x^2y$, with non-zero x,y. [2 marks]

R5. Explain why $2x + 3x^2$ is not $5x^3$. [2 marks]

R6. A rectangle has sides 2a and 7a. Find expressions for area and perimeter. [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 • Reading algebra and identifying terms

1.1 List the terms of $2x - 5y - 9$.

$2x$, $-5y$ and -9.

1.2 Write $4 \times a \times b$ without multiplication signs.

$4ab$.

1.3 Explain the difference between x^2 and $2x$.

x^2 is x multiplied by x; $2x$ is x added to itself. For $x = 3$ they give 9 and 6.

1.4 Classify $3x + 2$ and $3x + 2 = 14$.

$3x + 2$ is an expression. $3x + 2 = 14$ is an equation.

Lesson 2 • Collecting like terms

2.1 Simplify $8x - 3x + x$.

$(8 - 3 + 1)x = 6x$.

2.2 Simplify $5a + 2b - a + 7b$.

$4a + 9b$.

2.3 Simplify $6p^2 - p + 2p^2 + 4p$.

$8p^2 + 3p$.

2.4 Simplify $9 - 4y - 12 + y$.

$-3y - 3$, or $-3 - 3y$.

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SOLUTIONS / LESSON PRACTICE

Check the reasoning • continued

Lesson 3 • Multiplying and dividing algebraic terms

3.1 Simplify $(5x)(-2y)$.

$-10xy$.

3.2 Simplify $(3a^2)(4a^3)$.

$12a^5$.

3.3 Simplify $20m^3n^2 \div 5mn$, for non-zero m,n.

$4m^2n$.

3.4 A rectangle has sides 3x cm and 5x cm. Express its perimeter and area.

Perimeter = $2(3x + 5x) = 16x$ cm. Area = $(3x)(5x) = 15x^2$ cm². For lengths, $x > 0$.

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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. Simplify $9x - 4y - 3x + y$. [2 marks]

$6x - 3y$. [1 for each collected variable.]

R2. Simplify $5a^2 + 2a - 3a^2 + 7a$. [2 marks]

$2a^2 + 9a$. [1 for each term type.]

R3. Simplify $(-4p^2)(3pq)$. [2 marks]

$-12p^3q$. [1 for coefficient; 1 for variables.]

R4. Simplify $24x^4y^2 \div 8x^2y$, with non-zero x,y. [2 marks]

$3x^2y$. [1 for coefficient; 1 for cancelled powers.]

R5. Explain why $2x + 3x^2$ is not $5x^3$. [2 marks]

The terms have different powers and cannot be collected. For $x = 2$ the original is 16, while $5x^3 = 40$. [1 for unlike terms; 1 for valid illustration.]

R6. A rectangle has sides 2a and 7a. Find expressions for area and perimeter. [3 marks]

Area $= 14a^2$; perimeter $= 2(2a + 7a) = 18a$. [1 for each formula; 1 for correct simplification.]

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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