GCSE MATHEMATICS

FOUNDATION TIER

COMPREHENSIVE LESSON NOTEBOOK

UNIT 2 | ALGEBRA

TEACH-FROM-SCRATCH • FREE WEBSITE EDITION

16 detailed chapters • original diagrams • worked examples • guided practice • answers

Student: _____ Target grade: _____

START HERE

STUDY ROUTINE

How to learn from this notebook

Meaning first. Method second. Practice third.

THE FIVE-PASS ROUTINE

1 Read the key idea without a calculator. 2 Cover each solution and reproduce it. 3 Complete the practice independently. 4 Mark in a different colour and repair errors. 5 Retest after 2–7 days.

What a complete mathematics answer contains

- A clear model or calculation, not only a calculator display.
- Enough working for another person to follow the reasoning.
- Exact values until approximation is requested.
- Units and sensible rounding in context.
- A final sentence when the result must be interpreted.

Error log

REPAIR, DO NOT MERELY CORRECT

Label each error: concept, operation, arithmetic, calculator entry, accuracy, unit or interpretation. Write the corrected step and one sentence explaining the change.

Foundation does not mean superficial

Foundation Tier rewards secure fluency and connected reasoning. Grade 4–5 questions often combine several familiar skills, hide the required operation inside a context, or ask whether an answer is reasonable. The notebook therefore explains why methods work as well as how to use them.

SPECIFICATION MAP

PEARSON EDEXCEL 1MA1

Unit 2 coverage map

Algebra content organised into a teachable sequence.

CH 01	A1, A2, A3	Algebraic notation, vocabulary and expressions
CH 02	A2, A5	Substitution and evaluating formulae
CH 03	A4	Expanding and factorising single brackets
CH 04	A17	Linear equations and unknowns on both sides
CH 05	A22	Inequalities and integer solution sets
CH 06	A23, A24, A25	Sequences and nth-term rules
CH 07	A8, A9, A10	Coordinates, gradients and straight-line graphs
CH 08	A11, A12, A14	Quadratic, cubic and reciprocal graph recognition
CH 09	A5	Rearranging formulae and changing the subject
CH 10	A6, A21	Algebraic modelling, proof and mixed problem solving
CH 11	A18	Quadratic equations by factorisation and graphs
CH 12	A19, A21	Simultaneous equations and modelling two unknowns
CH 13	A7	Functions, input-output rules and inverse processes
CH 14	A6	Identities, equivalence and algebraic arguments
CH 15	A4	Double brackets and quadratic expressions
CH 16	A4	Algebraic powers and index laws

IMPORTANT TIER NOTE

This notebook follows the Foundation-assessable content identified in the Pearson Edexcel GCSE Mathematics (1MA1) specification. Higher-only material is excluded from the core lesson sequence unless it is clearly labelled as optional enrichment.

REFERENCE

NUMBER FACTS AND FORMULAS

Fast-reference method bank

Understand each formula before memorising it.

Collecting like terms	add or subtract coefficients only
Expand a bracket	a(b+c)=ab+ac
Solve an equation	apply inverse operations to both sides
Gradient	change in y ÷ change in x
Straight line	y=mx+c
Arithmetic nth term	difference×n + adjustment
Quadratic roots	x-values where y=0
Midpoint	average x-values and average y-values
Rearranging	undo operations in reverse order
Verification	substitute into the original relationship

CHAPTER 01 • A1-A3

A1, A2, A3

Algebraic notation, vocabulary and expressions

Translate mathematical language before manipulating symbols.

SPECIFICATION FOCUS

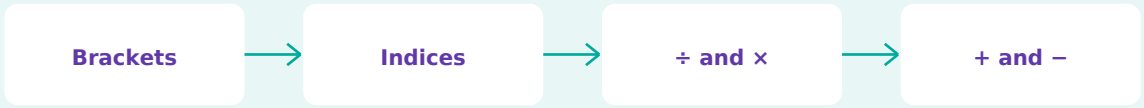
Pearson Edexcel content references A1, A2, A3. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Algebra uses letters to represent numbers whose values may vary or may not yet be known. An expression is a mathematical phrase with no equals sign. A term is separated by addition or subtraction; a coefficient multiplies a variable. Reading structure accurately is the first algebra skill.

KEY VOCABULARY

variable • constant • coefficient • term • expression • like terms • operation



Division/multiplication share a level; addition/subtraction share a level. Work left to right.

Why the method works

- 3x means 3 multiplied by x, not the two-digit number 3x.
- Like terms have exactly the same variable part, including powers.
- An expression can be simplified but not solved unless a value or equation is supplied.
- Operation order still applies when letters replace numbers.

CHECK BEFORE MOVING ON

Answer mentally: 1) State the coefficient of x in 9x−4. 2) How many terms are in 3a+2b−7? 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 01 • A1-A3 • METHODS

A1, A2, A3

Algebraic notation, vocabulary and expressions — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Identify terms and their signs.
- Rewrite repeated addition as multiplication.
- Collect coefficients of like terms only.
- Check by substituting a simple value.

WORKED EXAMPLE 1

Simplify $7x+3-2x+5$.

1. Group x-terms and constants.
2. $7x-2x=5x$ and $3+5=8$.

ANSWER: $5x+8$

WORKED EXAMPLE 2

Write an expression for three more than five times n.

1. Five times n is $5n$.
2. Three more means add 3.

ANSWER: $5n+3$

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Simplify $6x+4x$. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 01 • A1-A3 • APPLICATION

A1, A2, A3

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

A taxi charges £4 plus £1.80 per mile. For m miles, cost C=4+1.8m. The constant is the fixed charge and the coefficient is the rate per mile.

Common mistakes and how to repair them

MISTAKE 1

Combining 3x and 4 because both contain numbers. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Writing x+x as x^2. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Treating an expression as though it were an equation. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why 4x+3 cannot simplify to 7x. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 01 • A1-A3 • PRACTICE

A1, A2, A3

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **State the coefficient of x in 9x−4.**

2. **How many terms are in 3a+2b−7?**

3. **Simplify 6x+4x.**

4. **Simplify 8y−3+2y+5.**

5. **Write an expression for 7 less than 4n.**

6. **Write the perimeter of a rectangle with sides x and x+3.**

7. **Simplify 5a+2b−3a+b.**

8. **Explain why 4x+3 cannot simplify to 7x.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 02 • A2-A5

A2, A5

Substitution and evaluating formulae

Replace a variable with its value while preserving structure.

SPECIFICATION FOCUS

Pearson Edexcel content references A2, A5. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Substitution turns a general rule into a numerical calculation. Brackets protect negative values and multi-digit expressions. A formula describes a relationship between quantities; units and the meaning of each variable must be understood before calculation.

KEY VOCABULARY

substitute • evaluate • formula • input • output • variable • unit

Reverse the machine with inverse operations: -7, then divide by 3

Why the method works

- A substituted negative number must be enclosed in brackets.
- Powers apply to the substituted value: x^2 with $x=-3$ gives $(-3)^2=9$.
- A formula may require several substitutions before BIDMAS is applied.
- The final unit follows the quantity represented by the formula.

CHECK BEFORE MOVING ON

Answer mentally: 1) Evaluate $5x+7$ for $x=4$. 2) Evaluate $3a-2b$ for $a=-2, b=5$. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 02 • A2-A5 • METHODS

A2, A5

Substitution and evaluating formulae — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Write the formula unchanged.
- Replace every variable with a bracketed value.
- Apply BIDMAS carefully.
- Check sign, size and unit.

WORKED EXAMPLE 1

Evaluate $4x^2-3y$ for $x=-2$, $y=5$.

1. Substitute: $4(-2)^2-3(5)$.
2. Square first: $4\times4-15$.

ANSWER: 1

WORKED EXAMPLE 2

Use $A=\frac{1}{2}bh$ for $b=8.4$ cm and $h=5$ cm.

1. Substitute with units.
2. $A=\frac{1}{2}\times8.4\times5$.

ANSWER: 21 cm²

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Evaluate p^2+q for $p=-6, q=4$. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 02 • A2-A5 • APPLICATION

A2, A5

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

The stopping-distance model $d=0.06v^2+0.7v$ estimates metres from speed v in m/s. A model is useful only when its variables, units and assumptions are stated.

Common mistakes and how to repair them

MISTAKE 1

Omitting brackets around negative values. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Squaring only the digit and losing the sign structure. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Rounding before the final step. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why brackets matter when x is negative. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 02 • A2-A5 • PRACTICE

A2, A5

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Evaluate $5x+7$ for $x=4$.**

2. **Evaluate $3a-2b$ for $a=-2, b=5$.**

3. **Evaluate p^2+q for $p=-6, q=4$.**

4. **Use $C=2\pi r$ with $r=7$, leaving π.**

5. **Use $V=lwh$ for $3.2, 5, 8$.**

6. **Find $y=2x^2-1$ when $x=3$.**

7. **Use $s=ut+\frac{1}{2}at^2$ for $u=4, a=2, t=5$.**

8. **Explain why brackets matter when x is negative.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 03 • A4

A4

Expanding and factorising single brackets

See expansion and factorisation as inverse processes.

SPECIFICATION FOCUS

Pearson Edexcel content references A4. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

The distributive law states $a(b+c)=ab+ac$. Expanding removes brackets by multiplying every term inside. Factorising reverses this: identify a common factor and place the remaining expression inside brackets.

KEY VOCABULARY

expand • factorise • common factor • distributive law • term

$$3^4 = 3 \times 3 \times 3 \times 3 = 81$$

base = repeated factor index = number of factors

Why the method works

- The multiplier outside a bracket applies to every term inside.
- A negative multiplier changes every enclosed sign.
- The greatest common factor gives a fully factorised expression.
- Expansion can check a factorisation exactly.

CHECK BEFORE MOVING ON

Answer mentally: 1) Expand $4(x+3)$. 2) Expand $7(2x-5)$. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 03 • A4 • METHODS

A4

Expanding and factorising single brackets — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Multiply the outside term by each inside term.
- Write products with conventional coefficient order.
- Collect like terms after expansion.
- For factorising, divide every term by the chosen common factor.

WORKED EXAMPLE 1

Expand $5(3x-4)$.

1. $5\times 3x=15x$.
2. $5\times(-4)=-20$.

ANSWER: $15x-20$

WORKED EXAMPLE 2

Factorise $18x+24$.

1. $\text{HCF}(18,24)=6$.
2. Divide both terms by 6.

ANSWER: $6(3x+4)$

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Expand $-3(x-4)$. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 03 • A4 • APPLICATION

A4

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

A garden width is x and length is x+5. Its perimeter 2x+2(x+5) expands to 4x+10. Equivalent forms reveal different features of the same model.

Common mistakes and how to repair them

MISTAKE 1

Multiplying only the first term. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Losing the negative sign. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Factorising with a factor that does not divide every term. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Check 5(2x−3) by re-expanding. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 03 • A4 • PRACTICE

A4

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Expand 4(x+3).**

2. **Expand 7(2x−5).**

3. **Expand −3(x−4).**

4. **Expand 2(3a+5)+a.**

5. **Factorise 8x+20.**

6. **Factorise 15y−25.**

7. **Factorise 12a+18b.**

8. **Check 5(2x−3) by re-expanding.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 04 • A17

A17

Linear equations and unknowns on both sides

Maintain equality by performing the same operation to both sides.

SPECIFICATION FOCUS

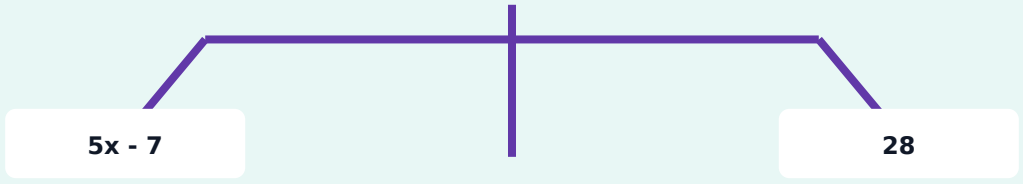
Pearson Edexcel content references A17. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

An equation states that two expressions have equal value. Solving finds every value that makes the statement true. Equality behaves like a balance: any operation applied to one side must also be applied to the other.

KEY VOCABULARY

equation • solution • inverse • balance • unknown • verify



Keep the balance: apply the same operation to both sides

Why the method works

- Inverse operations undo the construction of an expression.
- Collecting variable terms on one side creates a simpler equivalent equation.
- Clearing brackets must happen before collecting terms.
- Substitution into the original equation verifies a solution.

CHECK BEFORE MOVING ON

Answer mentally: 1) Solve x+9=23. 2) Solve 4x=36. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 04 • A17 • METHODS

A17

Linear equations and unknowns on both sides — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Expand brackets if present.
- Collect variable terms on one side.
- Collect constants on the other side.
- Divide by the coefficient and verify.

WORKED EXAMPLE 1

Solve $5x-7=28$.

1. Add 7 to both sides: $5x=35$.
2. Divide both sides by 5.

ANSWER: $x=7$

WORKED EXAMPLE 2

Solve $7x+4=3x+28$.

1. Subtract $3x$: $4x+4=28$.
2. Subtract 4, then divide by 4.

ANSWER: $x=6$

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Solve $3x-5=22$. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 04 • A17 • APPLICATION

A17

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

A gym charges £18 plus £4 per visit. Another charges £30 plus £2 per visit. The break-even equation $18+4v=30+2v$ finds when costs are equal.

Common mistakes and how to repair them

MISTAKE 1

Moving a term and changing sign without explaining the inverse operation. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Dividing only one term. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Checking in a rearranged equation instead of the original. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Verify $x=9$ in $6x+7=4x+25$. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 04 • A17 • PRACTICE

A17

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Solve $x+9=23$.**

2. **Solve $4x=36$.**

3. **Solve $3x-5=22$.**

4. **Solve $5-2x=17$.**

5. **Solve $6x+7=4x+25$.**

6. **Solve $3(x+4)=27$.**

7. **Solve $4(2x-1)=28$.**

8. **Verify $x=9$ in $6x+7=4x+25$.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 05 • A22

A22

Inequalities and integer solution sets

An inequality describes a region of values, not usually one number.

SPECIFICATION FOCUS

Pearson Edexcel content references A22. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

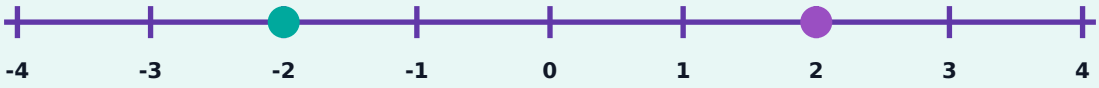
Understand the idea

Inequality symbols compare values. Solving follows equation methods, except multiplying or dividing by a negative reverses the order because the number line direction is reversed. Open and filled circles distinguish excluded and included endpoints.

KEY VOCABULARY

inequality • solution set • endpoint • strict • inclusive • integer

Position shows order: farther right means greater



Why the method works

- $x<4$ excludes 4; $x\leq 4$ includes it.
- Adding the same value preserves order.
- Multiplying by a negative reverses left and right, so the sign reverses.
- A listed integer solution set must respect any contextual restrictions.

CHECK BEFORE MOVING ON

Answer mentally: 1) Interpret $x>3$. 2) Solve $x-4\leq 9$. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 05 • A22 • METHODS

A22

Inequalities and integer solution sets — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Solve as an equation until a negative multiplication/division occurs.
- Reverse the inequality sign when required.
- Represent the result on a number line.
- Test one value from the solution region.

WORKED EXAMPLE 1

Solve $3x+2<20$.

1. Subtract 2: $3x<18$.
2. Divide by positive 3.

ANSWER: $x<6$

WORKED EXAMPLE 2

Solve $-2x\leq 10$.

1. Divide by -2.
2. Reverse $\leq$ to $\geq$.

ANSWER: $x\geq -5$

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Solve $5x<35$. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 05 • A22 • APPLICATION

A22

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

A lift allows total mass at most 630 kg. With 78 kg already loaded, $69n+78 \leq 630$ models the greatest whole number n of additional people.

Common mistakes and how to repair them

MISTAKE 1

Forgetting to reverse the sign after division by a negative. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Using a filled circle for a strict inequality. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Giving a non-integer person or object. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Find greatest integer n if $45n+20 \leq 250$. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 05 • A22 • PRACTICE

A22

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Interpret $x>3$.**

2. **Solve $x-4\leq 9$.**

3. **Solve $5x<35$.**

4. **Solve $-3x>12$.**

5. **Solve $2x+7\geq 19$.**

6. **List integers satisfying $-2<x\leq 3$.**

7. **Represent $x<-1$ on a number line.**

8. **Find greatest integer n if $45n+20\leq 250$.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 06 • A23-A25

A23, A24, A25

Sequences and nth-term rules

Describe position directly instead of continuing a pattern one step at a time.

SPECIFICATION FOCUS

Pearson Edexcel content references A23, A24, A25. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

A sequence is an ordered list generated by a rule. For an arithmetic sequence, the common difference becomes the coefficient of n. The adjustment is found by comparing the first term with the value of the multiple rule at n=1.

KEY VOCABULARY

sequence • term • position • common difference • nth term • arithmetic • geometric

+4 each time -> nth term 4n + 3

Why the method works

- The nth term maps a position n directly to its term.
- For arithmetic sequences, difference d gives dn plus an adjustment.
- Substitution checks a proposed rule against several positions.
- A value is in a sequence only if solving the nth-term equation gives a positive integer n.

CHECK BEFORE MOVING ON

Answer mentally: 1) Continue 4,9,14,19 for three terms. 2) Find nth term of 3,8,13,18. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 06 • A23-A25 • METHODS

A23, A24, A25

Sequences and nth-term rules — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Find the common difference.
- Begin with difference×n.
- Compare the generated first term with the actual first term.
- Substitute n=1,2,3 to check.

WORKED EXAMPLE 1

Find the nth term of 7,11,15,19,…

1. Difference is 4, so begin 4n.
2. 4n gives 4 at n=1; add 3.

ANSWER: 4n+3

WORKED EXAMPLE 2

Is 83 in the sequence 5n−2?

1. Solve 5n−2=83.
2. 5n=85, so n=17, a positive integer.

ANSWER: Yes, term 17

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Find nth term of 20,17,14,11. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 06 • A23-A25 • APPLICATION

A23, A24, A25

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Cinema rows contain 14 seats in row 1 and increase by 3 each row. Row n has 3n+11 seats, allowing capacity calculations without drawing every row.

Common mistakes and how to repair them

MISTAKE 1

Using the term value instead of its position. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Writing dn without the adjustment. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Accepting a negative or fractional term number. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why 40 is not in 6n+3. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 06 • A23-A25 • PRACTICE

A23, A24, A25

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Continue 4,9,14,19 for three terms.**

2. **Find nth term of 3,8,13,18.**

3. **Find nth term of 20,17,14,11.**

4. **Find term 25 of 4n+1.**

5. **Is 62 in 3n+2?**

6. **Find first term greater than 100 in 6n−1.**

7. **Write first four terms of n^2+1.**

8. **Explain why 40 is not in 6n+3.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 07 • A8-A10

A8, A9, A10

Coordinates, gradients and straight-line graphs

Connect an equation, a table and a geometric line.

SPECIFICATION FOCUS

Pearson Edexcel content references A8, A9, A10. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Coordinates locate points using horizontal x then vertical y movement. In y=mx+c, m is the constant rate of change (gradient) and c is the y-intercept. A straight line expresses a constant relationship between variables.

KEY VOCABULARY

coordinate • origin • quadrant • gradient • intercept • linear • parallel

Why the method works

- Gradient is change in y divided by change in x.
- The intercept is y when x=0.
- A positive gradient rises left to right; a negative gradient falls.
- Parallel lines have equal gradients.

CHECK BEFORE MOVING ON

Answer mentally: 1) Plot (−3,2) in words. 2) Find midpoint of (2,4) and (8,10). 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 07 • A8-A10 • METHODS

A8, A9, A10

Coordinates, gradients and straight-line graphs — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Create a value table if points are needed.
- Plot coordinates accurately using a consistent scale.
- For two points, calculate vertical change/horizontal change.
- Check the line crosses the y-axis at c.

WORKED EXAMPLE 1

Find gradient through (2,3) and (6,11).

1. Change in y=8.
2. Change in x=4.
3. Gradient=8/4.

ANSWER: 2

WORKED EXAMPLE 2

For y=−3x+5, state gradient and intercept.

1. Compare with y=mx+c.
2. m=−3 and c=5.

ANSWER: gradient −3; intercept 5

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Find gradient through (1,5),(4,14). First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 07 • A8-A10 • APPLICATION

A8, A9, A10

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

A water tank empties linearly: $V=600-25t$. The intercept 600 is starting volume and gradient -25 means 25 litres lost each minute.

Common mistakes and how to repair them

MISTAKE 1

Using x-change divided by y-change. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Reading the intercept from the x-axis. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Joining plotted points with an inconsistent scale. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Interpret gradient 12 when y is cost and x is tickets. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 07 • A8-A10 • PRACTICE

A8, A9, A10

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Plot (−3,2) in words.**

2. **Find midpoint of (2,4) and (8,10).**

3. **Find gradient through (1,5),(4,14).**

4. **State gradient of y=4x−7.**

5. **State y-intercept of y=−2x+9.**

6. **Find y when x=6 in y=3x−4.**

7. **Are y=5x+1 and y=5x−8 parallel?**

8. **Interpret gradient 12 when y is cost and x is tickets.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 08 • A11-A15

A11, A12, A14

Quadratic, cubic and reciprocal graph recognition

Use shape, symmetry and intercepts to interpret non-linear relationships.

SPECIFICATION FOCUS

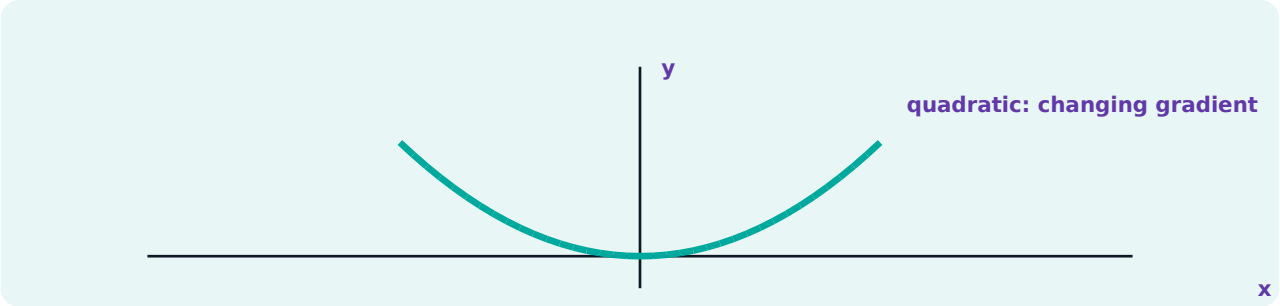
Pearson Edexcel content references A11, A12, A14. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Non-linear graphs do not have a constant gradient. Quadratic graphs form parabolas and may have zero, one or two roots. Cubic graphs may change direction twice. Reciprocal graphs have separate branches and approach axes without reaching them.

KEY VOCABULARY

quadratic • parabola • root • intercept • turning point • cubic • reciprocal



Why the method works

- A root is an x-value where y=0.
- The turning point is a maximum or minimum of a quadratic.
- Graph shape and symmetry reveal behaviour beyond plotted points.
- Solutions to f(x)=k are read where the graph meets horizontal line y=k.

CHECK BEFORE MOVING ON

Answer mentally: 1) State shape of $y=x^2$. 2) Find y for $x=-3$ in $y=x^2-1$. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 08 • A11-A15 • METHODS

A11, A12, A14

Quadratic, cubic and reciprocal graph recognition — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Build a table including negative and positive x-values.
- Plot accurately and join with a smooth curve.
- Read roots from x-axis crossings.
- Use the graph only to the accuracy supported by its scale.

WORKED EXAMPLE 1

Complete $y=x^2-4$ at $x=-2,-1,0,1,2$.

1. Square each x before subtracting 4.
2. Values are $0,-3,-4,-3,0$.

ANSWER: $0,-3,-4,-3,0$

WORKED EXAMPLE 2

Solve $x^2-4=0$ from the graph.

1. Roots occur where $y=0$.
2. The curve crosses at $x=-2$ and $x=2$.

ANSWER: $x=-2$ or 2

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

State roots of $y=(x-2)(x+4)$. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 08 • A11-A15 • APPLICATION

A11, A12, A14

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

A braking-distance model is curved because distance grows faster than speed. A quadratic model communicates that doubling speed can more than double distance.

Common mistakes and how to repair them

MISTAKE 1

Drawing a quadratic with straight segments. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Reading y-intercepts as roots. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Assuming a graph gives exact values beyond its scale. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why $y=x^2$ is not a straight line. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 08 • A11-A15 • PRACTICE

A11, A12, A14

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **State shape of $y=x^2$.**

2. **Find y for $x=-3$ in $y=x^2-1$.**

3. **State roots of $y=(x-2)(x+4)$.**

4. **State turning point of $y=x^2+3$.**

5. **How many roots if a parabola never meets x-axis?**

6. **Recognise $y=1/x$.**

7. **Solve $x^2=9$.**

8. **Explain why $y=x^2$ is not a straight line.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 09 • A5

A5

Rearranging formulae and changing the subject

Make a chosen variable the subject by undoing operations in reverse order.

SPECIFICATION FOCUS

Pearson Edexcel content references A5. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

The subject of a formula appears alone on one side. Rearranging does not change the relationship; it creates an equivalent form useful when a different quantity is unknown. Inverse operations should be applied to the complete side.

KEY VOCABULARY

subject • rearrange • inverse • formula • equivalent • isolate

Reverse the machine with inverse operations: -7, then divide by 3

Why the method works

- Undo addition/subtraction before multiplication/division when reversing a two-step formula.
- Operations applied to the subject must be undone on both sides.
- A fraction bar groups its entire numerator.
- Substitution can verify the rearranged form numerically.

CHECK BEFORE MOVING ON

Answer mentally: 1) Make x subject: y=x+5. 2) Make a subject: v=u+a. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 09 • A5 • METHODS

A5

Rearranging formulae and changing the subject — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Identify operations applied to the required subject.
- Undo them in reverse order on both sides.
- Simplify the new formula.
- Check by substituting consistent values.

WORKED EXAMPLE 1

Make x the subject of $y=3x+7$.

1. Subtract 7: $y-7=3x$.
2. Divide by 3.

ANSWER: $x=(y-7)/3$

WORKED EXAMPLE 2

Make r the subject of $C=2\pi r$.

1. Divide both sides by 2π.

ANSWER: $r=C/(2\pi)$

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Make t subject: $d=st$. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 09 • A5 • APPLICATION

A5

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

The temperature formula $F=1.8C+32$ becomes $C=(F-32)/1.8$ when Celsius is required from Fahrenheit. Both formulas describe the same relationship.

Common mistakes and how to repair them

MISTAKE 1

Changing sides without applying an operation. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Dividing only one term in a numerator. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Forgetting brackets around $y-7$. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why $(y-7)/3$ needs brackets. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 09 • A5 • PRACTICE

A5

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Make x subject: y=x+5.**

2. **Make a subject: v=u+a.**

3. **Make t subject: d=st.**

4. **Make w subject: P=2l+2w.**

5. **Make h subject: A=½bh.**

6. **Use C=(F−32)/1.8 for F=68.**

7. **Check x=(y−7)/3 when x=4.**

8. **Explain why (y−7)/3 needs brackets.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 10 • A6, A21

A6, A21

Algebraic modelling, proof and mixed problem solving

Turn a context into variables, relationships and a checked conclusion.

SPECIFICATION FOCUS

Pearson Edexcel content references A6, A21. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Algebraic modelling replaces repeated numerical reasoning with a general relationship. A proof uses a variable to show why a statement holds for every permitted value, not only selected examples. Mixed problems require translation, manipulation and contextual interpretation.

KEY VOCABULARY

model • assumption • equation • constraint • proof • counterexample • verify

A reliable solution is a chain of decisions, not only a calculator display.

Why the method works

- Define every variable before writing an equation.
- Units and constraints determine which algebraic solutions are valid.
- A proof ends by connecting the final algebraic form to the claim.
- One counterexample is enough to disprove an “always” statement.

CHECK BEFORE MOVING ON

Answer mentally: 1) Form equation: number x increased by 8 is 21. 2) Solve perimeter problem: sides x and x+5, perimeter 34. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 10 • A6, A21 • METHODS

A6, A21

Algebraic modelling, proof and mixed problem solving — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Define the unknown.
- Translate each sentence into an expression or equation.
- Solve or simplify with justified steps.
- Check against the context and communicate the conclusion.

WORKED EXAMPLE 1

Three consecutive integers total 72. Find them.

1. Let integers be n,n+1,n+2.
2. 3n+3=72, so n=23.

ANSWER: 23,24,25

WORKED EXAMPLE 2

Show the sum of two consecutive integers is odd.

1. Let them be n and n+1.
2. Sum=2n+1, the form of an odd integer.

ANSWER: proved

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Three consecutive integers total 45. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 10 • A6, A21 • APPLICATION

A6, A21

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

A rectangle has width x and length x+4 with perimeter 36. Equation 2x+2(x+4)=36 gives x=7 and length 11; the positive contextual solution is then checked in the perimeter.

Common mistakes and how to repair them

MISTAKE 1

Using an undefined letter. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Proving with examples only. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Keeping an algebraic solution that violates a length or counting constraint. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

State one assumption in a linear cost model. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 10 • A6, A21 • PRACTICE

A6, A21

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Form equation: number x increased by 8 is 21.**

2. **Solve perimeter problem: sides x and x+5, perimeter 34.**

3. **Three consecutive integers total 45.**

4. **Show even+even is even.**

5. **Disprove “$x^2>x$ for all x”.**

6. **Adult ticket £a, child £c: write cost of 3 adults and 2 children.**

7. **Solve $4n+3=51$ in a sequence context.**

8. **State one assumption in a linear cost model.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 11 • A18

Quadratic equations by factorisation and graphs

Connect factors, roots and x-axis intersections.

SPECIFICATION FOCUS

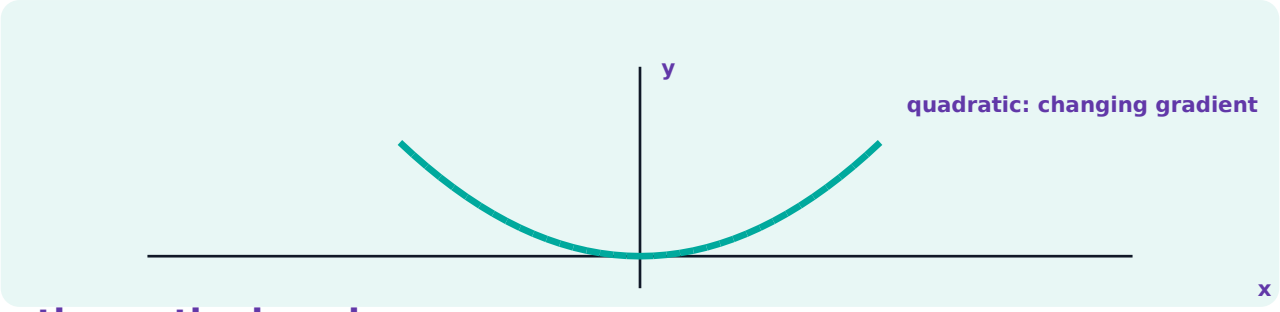
Pearson Edexcel content references A18. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

A quadratic equation contains a squared variable. At Foundation Tier, many quadratics are solved by factorising into two linear factors and using the zero-product rule: if ab=0, then a=0 or b=0. A graph gives approximate roots where the curve crosses the x-axis.

KEY VOCABULARY

quadratic • factorise • root • solution • zero-product rule • parabola



Why the method works

- Expanding checks that the factors reproduce the original quadratic.
- A product is zero when at least one factor is zero.
- A quadratic can have two, one or no real x-axis intersections.
- Graphical roots are approximate unless the scale and intersections give exact values.

CHECK BEFORE MOVING ON

Answer mentally: 1) Solve $x^2+5x+6=0$. 2) Solve $x^2-9=0$. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 11 • A18 • METHODS

A18

Quadratic equations by factorisation and graphs — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Rearrange so one side equals zero.
- Factorise the quadratic.
- Set each factor equal to zero.
- Check both solutions in the original equation.

WORKED EXAMPLE 1

Solve $x^2+7x+12=0$.

1. Factorise: $(x+3)(x+4)=0$.
2. $x+3=0$ or $x+4=0$.

ANSWER: $x=-3$ or $x=-4$

WORKED EXAMPLE 2

Solve $x^2-5x=0$.

1. Factorise common x: $x(x-5)=0$.
2. Set each factor to zero.

ANSWER: $x=0$ or $x=5$

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Solve $x^2-4x=0$. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 11 • A18 • APPLICATION

A18

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

The height of a thrown object can be modelled by a quadratic. Solving height=0 estimates when the object is at ground level; contextual time restrictions may reject a negative root.

Common mistakes and how to repair them

MISTAKE 1

Forgetting to make the equation equal zero. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Finding only one root. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Factorising without checking by expansion. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain the zero-product rule. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 11 • A18 • PRACTICE

A18

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Solve $x^2+5x+6=0$.**

2. **Solve $x^2-9=0$.**

3. **Solve $x^2-4x=0$.**

4. **Solve $x^2+2x-15=0$.**

5. **State roots of $y=(x-6)(x+1)$.**

6. **How many roots if graph only touches x-axis?**

7. **Check roots of $x^2-7x+12$.**

8. **Explain the zero-product rule.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 12 • A19, A21

A19, A21

Simultaneous equations and modelling two unknowns

Use two independent relationships to determine two unknown quantities.

SPECIFICATION FOCUS

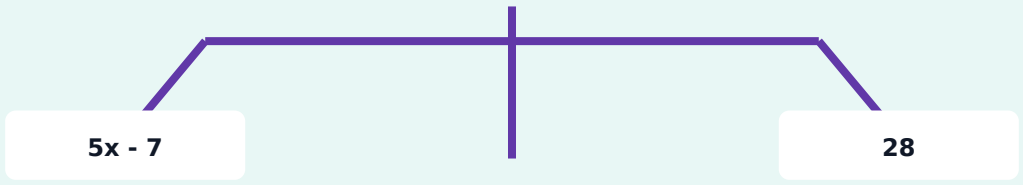
Pearson Edexcel content references A19, A21. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Simultaneous equations describe the same two unknowns under two conditions. Elimination combines equations so one variable cancels; substitution replaces one variable using an equivalent expression. The solution is an ordered pair satisfying both original equations and often represents two prices or quantities.

KEY VOCABULARY

simultaneous • eliminate • substitute • ordered pair • coefficient • model



Keep the balance: apply the same operation to both sides

Why the method works

- One equation alone usually represents infinitely many pairs.
- Equal coefficients allow subtraction to eliminate a variable.
- Multiplying a complete equation preserves its solution set.
- Checking in both originals detects arithmetic errors.

CHECK BEFORE MOVING ON

Answer mentally: 1) Solve $x+y=9, x-y=1$. 2) Solve $2x+y=11, x+y=7$. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 12 • A19, A21 • METHODS

A19, A21

Simultaneous equations and modelling two unknowns — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Align like variables and constants.
- Multiply one or both equations if needed.
- Add or subtract to eliminate one variable.
- Back-substitute and verify both values.

WORKED EXAMPLE 1

Solve x+y=11 and x−y=3.

1. Add equations: 2x=14, so x=7.
2. Then y=4.

ANSWER: x=7,y=4

WORKED EXAMPLE 2

2 pens and 3 books cost £13; 2 pens and 1 book cost £7. Find prices.

1. Subtract equations: 2 books cost £6.
2. Book £3; then 2 pens=£4.

ANSWER: pen £2, book £3

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Solve 3x+y=14,x−y=2. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 12 • A19, A21 • APPLICATION

A19, A21

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Ticket and product-price problems often supply totals from two different purchases. Define variables with units before forming equations.

Common mistakes and how to repair them

MISTAKE 1

Subtracting unmatched equations carelessly. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Changing only one term when multiplying an equation. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Reporting x and y without contextual labels. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why two independent equations are needed. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 12 • A19, A21 • PRACTICE

A19, A21

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Solve $x+y=9, x-y=1$.**

2. **Solve $2x+y=11, x+y=7$.**

3. **Solve $3x+y=14, x-y=2$.**

4. **Solve $x+2y=12, 3x-2y=4$.**

5. **Check $(4,3)$ in $x+y=7, 2x+y=11$.**

6. **Form equations: 2 adult+1 child £17; 1 adult+2 child £13.**

7. **Solve previous prices.**

8. **Explain why two independent equations are needed.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 13 • A7

A7

Functions, input-output rules and inverse processes

Treat a function as a rule mapping each permitted input to one output.

SPECIFICATION FOCUS

Pearson Edexcel content references A7. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

A function transforms an input using a stated rule. Function machines make operation order visible. An inverse process reverses each operation in reverse order and is used to recover an input. At Foundation Tier, clear input-output interpretation matters more than formal notation.

KEY VOCABULARY

function • input • output • mapping • inverse • operation • domain

Reverse the machine with inverse operations: -7, then divide by 3

Why the method works

- A function assigns one output to each permitted input.
- Successive operations are carried out in the stated order.
- An inverse reverses both the operation and the order.
- A table of values is generated by applying the same rule consistently.

CHECK BEFORE MOVING ON

Answer mentally: 1) Rule $3x+2$: output for $x=5$. 2) Rule x^2-1: output for $x=-4$. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 13 • A7 • METHODS

A7

Functions, input-output rules and inverse processes — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Write the function rule as an expression.
- Substitute the input with brackets.
- Apply operations in order.
- For an inverse, undo the final operation first.

WORKED EXAMPLE 1

Rule multiply by 4 then subtract 3. Find output for 6.

1. 4×6−3.

ANSWER: 21

WORKED EXAMPLE 2

Output is 29 from rule multiply by 5 then add 4. Find input.

1. Subtract 4:25.
2. Divide by 5.

ANSWER: 5

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Find input if 2x+7=25. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 13 • A7 • APPLICATION

A7

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Conversion formulas are functions: temperature input maps to an output. The inverse formula reverses the conversion.

Common mistakes and how to repair them

MISTAKE 1

Undoing operations in the original order. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Confusing input with output. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Applying different rules to different table rows. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why inverse order reverses. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 13 • A7 • PRACTICE

A7

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Rule 3x+2: output for x=5.**

2. **Rule x^2-1: output for x=−4.**

3. **Find input if 2x+7=25.**

4. **Inverse steps of ×6 then −5.**

5. **Complete y=4x−1 for x=0,2,5.**

6. **Does rule $y=x^2$ give same output for 3 and −3?**

7. **Write rule “halve then add 8”.**

8. **Explain why inverse order reverses.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 14 • A6

A6

Identities, equivalence and algebraic arguments

Use algebra to establish a statement for every permitted value.

SPECIFICATION FOCUS

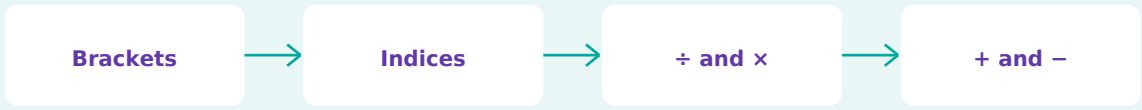
Pearson Edexcel content references A6. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

An equation is true for particular solution values; an identity is true for every permitted value because both sides are equivalent expressions. Algebraic proof begins with a general integer representation and transforms it into a form that guarantees the claimed property. Numerical examples can suggest a pattern but cannot prove it universally.

KEY VOCABULARY

identity • equation • equivalent • proof • general integer • counterexample



Division/multiplication share a level; addition/subtraction share a level. Work left to right.

Why the method works

- The symbol ≡ indicates an identity.
- Expansion and collection can demonstrate two expressions are equivalent.
- Even integers have form 2n; odd integers have form 2n+1.
- One valid counterexample disproves an “always” statement.

CHECK BEFORE MOVING ON

Answer mentally: 1) Expand to show 2(x+5)+3x≡5x+10. 2) Show even+odd is odd. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 14 • A6 • METHODS

A6

Identities, equivalence and algebraic arguments — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Start with one side or a general representation.
- Apply valid algebraic transformations.
- Reach the required form or the other side.
- State explicitly why the final form proves the claim.

WORKED EXAMPLE 1

Show $3(x+2)+2x \equiv 5x+6$.

1. Expand left:$3x+6+2x$.
2. Collect to $5x+6$.

ANSWER: identity shown

WORKED EXAMPLE 2

Show sum of two odd integers is even.

1. Let them be $2m+1$ and $2n+1$.
2. Sum$=2m+2n+2=2(m+n+1)$.

ANSWER: even

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Show three consecutive integers sum to multiple of 3. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 14 • A6 • APPLICATION

A6

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Proof communicates why a pattern continues beyond tested cases. A counterexample is more efficient when a universal claim is false.

Common mistakes and how to repair them

MISTAKE 1

Writing several examples as a proof. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Using the same variable for unrelated integers without justification. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Ending without connecting algebraic form to the claim. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain difference between equation and identity. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 14 • A6 • PRACTICE

A6

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Expand to show $2(x+5)+3x \equiv 5x+10$.**

2. **Show even+odd is odd.**

3. **Show three consecutive integers sum to multiple of 3.**

4. **Disprove $x^2 > x$ for every positive x.**

5. **Is $4(x+1)=4x+4$ equation or identity?**

6. **Solve equation $4(x+1)=20$.**

7. **Write general multiple of 5.**

8. **Explain difference between equation and identity.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 15 • A4

A4

Double brackets and quadratic expressions

Use an organised multiplication structure so every term is included once.

SPECIFICATION FOCUS

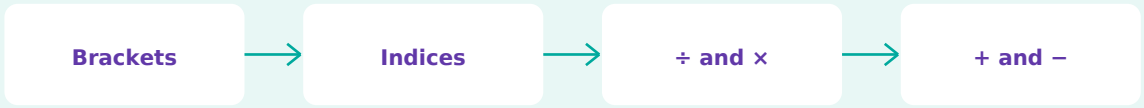
Pearson Edexcel content references A4. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Expanding two binomials applies the distributive law twice. Each term in the first bracket multiplies every term in the second. The four products are then collected. Simple monic quadratics can be factorised by finding two numbers with the required product and sum. Difference of two squares uses $a^2-b^2=(a-b)(a+b)$.

KEY VOCABULARY

binomial • quadratic • expand • factorise • product • sum • difference of squares



Division/multiplication share a level; addition/subtraction share a level. Work left to right.

Why the method works

- A grid or systematic arrows produce all four products.
- The x^2 term comes from multiplying the two x terms.
- For x^2+bx+c, factor numbers multiply to c and add to b.
- Conjugate brackets cancel middle terms in a difference of squares.

CHECK BEFORE MOVING ON

Answer mentally: 1) Expand $(x+2)(x+7)$. 2) Expand $(x-3)(x+5)$. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 15 • A4 • METHODS

A4

Double brackets and quadratic expressions — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Multiply first terms, outer terms, inner terms and last terms.
- Collect like x terms.
- For factorisation, test factor pairs of the constant.
- Re-expand to verify.

WORKED EXAMPLE 1

Expand (x+3)(x+5).

1. Products x^2,5x,3x,15.
2. Collect middle terms.

ANSWER: $x^2+8x+15$

WORKED EXAMPLE 2

Factorise x^2-16.

1. Recognise x^2-4^2.

ANSWER: $(x-4)(x+4)$

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Expand (2x+1)(x+4). First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 15 • A4 • APPLICATION

A4

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Area models turn bracket multiplication into rectangle partitions, making all four products visible.

Common mistakes and how to repair them

MISTAKE 1

Omitting an inner or outer product. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Adding constants instead of multiplying them. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Choosing factors with the wrong signed sum. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why four products appear. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 15 • A4 • PRACTICE

A4

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Expand (x+2)(x+7).**

2. **Expand (x−3)(x+5).**

3. **Expand (2x+1)(x+4).**

4. **Factorise $x^2+9x+20$.**

5. **Factorise $x^2-2x-15$.**

6. **Factorise x^2-25.**

7. **Check (x+6)(x−1).**

8. **Explain why four products appear.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

CHAPTER 16 • A4

A4

Algebraic powers and index laws

Count repeated factors and apply a law only when bases match.

SPECIFICATION FOCUS

Pearson Edexcel content references A4. This lesson develops representation, accurate calculation and interpretation within Foundation Tier problem solving.

Understand the idea

Index laws compact repeated algebraic multiplication. For the same non-zero base, multiplication adds indices, division subtracts indices, and a power raised to a power multiplies indices. Coefficients are calculated separately from variable powers. A zero index gives 1 and a negative index gives a reciprocal.

KEY VOCABULARY

base • index • power • coefficient • zero index • negative index • reciprocal

$$3^4 = 3 \times 3 \times 3 \times 3 = 81$$

base = repeated factor index = number of factors

Why the method works

- $x^m x^n = x^{m+n}$ for the same base.
- $x^m \div x^n = x^{m-n}$ for non-zero x.
- $(x^m)^n = x^{mn}$.
- $x^0 = 1$ and $x^{-n} = 1/x^n$ for non-zero x.

CHECK BEFORE MOVING ON

Answer mentally: 1) Simplify $x^3 \times x^5$. 2) Simplify $y^9 \div y^4$. 3) State one definition or rule from this page in your own words.

EXPLAIN IT

Complete this sentence: “The method works because …” Use the key vocabulary above and refer to the representation in the diagram.

CHAPTER 16 • A4 • METHODS

A4

Algebraic powers and index laws — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Separate numerical coefficients and variable factors.
- Check bases match before using an index law.
- Apply the correct operation to indices.
- Rewrite negative indices as reciprocals when required.

WORKED EXAMPLE 1

Simplify $3x^4 \times 5x^2$.

1. Coefficients $3 \times 5 = 15$.
2. Add x indices $4+2$.

ANSWER: $15x^6$

WORKED EXAMPLE 2

Simplify $12a^7 \div 3a^3$.

1. Coefficients $12 \div 3 = 4$.
2. Subtract indices $7-3$.

ANSWER: $4a^4$

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes it easier to repair errors.

GUIDED TRY

Simplify $(a^3)^2$. First predict the form or approximate size of the answer; then show a complete method.

CHAPTER 16 • A4 • APPLICATION

A4

Apply and reason

Connect the method to a context and communicate the conclusion.

Real-world model

CONTEXT

Scientific formulas use powers to express scaling. Index laws keep these formulas manageable without expanding every repeated factor.

Common mistakes and how to repair them

MISTAKE 1

Adding unlike bases. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 2

Multiplying indices during ordinary multiplication. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

MISTAKE 3

Assuming $x^0=0$. Repair: return to the definition, write one complete mathematical line, then check the size or sign of the result.

Exam communication

- Write the operation or equation before the answer.
- Preserve exact values unless the question asks for rounding.
- Attach units and interpret the final value in the context.

REASONING PROMPT

Explain why bases must match. Write one sentence explaining why your calculation or conclusion is valid.

CHAPTER 16 • A4 • PRACTICE

A4

Independent practice

Complete without notes, then use the answer section to diagnose errors.

1. **Simplify $x^3 \times x^5$.**

2. **Simplify $y^9 \div y^4$.**

3. **Simplify $(a^3)^2$.**

4. **Simplify $4m^2 \times 3m^5$.**

5. **Simplify $18p^6 \div 6p^2$.**

6. **Evaluate 7^0.**

7. **Write x^{-3} with positive index.**

8. **Explain why bases must match.**

REFLECTION

Circle one: secure / almost / reteach. Write the question number of your most useful error and the rule that repairs it.

PRACTICE ANSWERS

CHAPTER 01

Practice answers and repair notes

Algebraic notation, vocabulary and expressions

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. State the coefficient of x in 9x−4. **ANSWER: 9**

Method cue: Identify terms and their signs. Then check the sign, size, accuracy and units of the result.

2. How many terms are in 3a+2b−7? **ANSWER: 3**

Method cue: Rewrite repeated addition as multiplication. Then check the sign, size, accuracy and units of the result.

3. Simplify 6x+4x. **ANSWER: 10x**

Method cue: Collect coefficients of like terms only. Then check the sign, size, accuracy and units of the result.

4. Simplify 8y−3+2y+5. **ANSWER: 10y+2**

Method cue: Check by substituting a simple value. Then check the sign, size, accuracy and units of the result.

5. Write an expression for 7 less than 4n. **ANSWER: 4n−7**

Method cue: Identify terms and their signs. Then check the sign, size, accuracy and units of the result.

6. Write the perimeter of a rectangle with sides x and x+3. **ANSWER: 4x+6**

Method cue: Rewrite repeated addition as multiplication. Then check the sign, size, accuracy and units of the result.

7. Simplify 5a+2b−3a+b. **ANSWER: 2a+3b**

Method cue: Collect coefficients of like terms only. Then check the sign, size, accuracy and units of the result.

8. Explain why 4x+3 cannot simplify to 7x. **ANSWER: terms are unlike**

Method cue: Check by substituting a simple value. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 02

Practice answers and repair notes

Substitution and evaluating formulae

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Evaluate $5x+7$ for $x=4$. **ANSWER: 27**

Method cue: Write the formula unchanged. Then check the sign, size, accuracy and units of the result.

2. Evaluate $3a-2b$ for $a=-2, b=5$. **ANSWER: −16**

Method cue: Replace every variable with a bracketed value. Then check the sign, size, accuracy and units of the result.

3. Evaluate p^2+q for $p=-6, q=4$. **ANSWER: 40**

Method cue: Apply BIDMAS carefully. Then check the sign, size, accuracy and units of the result.

4. Use $C=2\pi r$ with $r=7$, leaving π. **ANSWER: 14π**

Method cue: Check sign, size and unit. Then check the sign, size, accuracy and units of the result.

5. Use $V=lwh$ for 3.2,5,8. **ANSWER: 128**

Method cue: Write the formula unchanged. Then check the sign, size, accuracy and units of the result.

6. Find $y=2x^2-1$ when $x=3$. **ANSWER: 17**

Method cue: Replace every variable with a bracketed value. Then check the sign, size, accuracy and units of the result.

7. Use $s=ut+\frac{1}{2}at^2$ for $u=4, a=2, t=5$. **ANSWER: 45**

Method cue: Apply BIDMAS carefully. Then check the sign, size, accuracy and units of the result.

8. Explain why brackets matter when x is negative. **ANSWER: they preserve the sign**

Method cue: Check sign, size and unit. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 03

Practice answers and repair notes

Expanding and factorising single brackets

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Expand 4(x+3). **ANSWER: 4x+12**

Method cue: Multiply the outside term by each inside term. Then check the sign, size, accuracy and units of the result.

2. Expand 7(2x−5). **ANSWER: 14x−35**

Method cue: Write products with conventional coefficient order. Then check the sign, size, accuracy and units of the result.

3. Expand −3(x−4). **ANSWER: −3x+12**

Method cue: Collect like terms after expansion. Then check the sign, size, accuracy and units of the result.

4. Expand 2(3a+5)+a. **ANSWER: 7a+10**

Method cue: For factorising, divide every term by the chosen common factor. Then check the sign, size, accuracy and units of the result.

5. Factorise 8x+20. **ANSWER: 4(2x+5)**

Method cue: Multiply the outside term by each inside term. Then check the sign, size, accuracy and units of the result.

6. Factorise 15y−25. **ANSWER: 5(3y−5)**

Method cue: Write products with conventional coefficient order. Then check the sign, size, accuracy and units of the result.

7. Factorise 12a+18b. **ANSWER: 6(2a+3b)**

Method cue: Collect like terms after expansion. Then check the sign, size, accuracy and units of the result.

8. Check 5(2x−3) by re-expanding. **ANSWER: 10x−15**

Method cue: For factorising, divide every term by the chosen common factor. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 04

Practice answers and repair notes

Linear equations and unknowns on both sides

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Solve $x+9=23$. **ANSWER: 14**

Method cue: Expand brackets if present. Then check the sign, size, accuracy and units of the result.

2. Solve $4x=36$. **ANSWER: 9**

Method cue: Collect variable terms on one side. Then check the sign, size, accuracy and units of the result.

3. Solve $3x-5=22$. **ANSWER: 9**

Method cue: Collect constants on the other side. Then check the sign, size, accuracy and units of the result.

4. Solve $5-2x=17$. **ANSWER: -6**

Method cue: Divide by the coefficient and verify. Then check the sign, size, accuracy and units of the result.

5. Solve $6x+7=4x+25$. **ANSWER: 9**

Method cue: Expand brackets if present. Then check the sign, size, accuracy and units of the result.

6. Solve $3(x+4)=27$. **ANSWER: 5**

Method cue: Collect variable terms on one side. Then check the sign, size, accuracy and units of the result.

7. Solve $4(2x-1)=28$. **ANSWER: 4**

Method cue: Collect constants on the other side. Then check the sign, size, accuracy and units of the result.

8. Verify $x=9$ in $6x+7=4x+25$. **ANSWER: both sides 61**

Method cue: Divide by the coefficient and verify. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 05

Practice answers and repair notes

Inequalities and integer solution sets

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Interpret $x>3$. **ANSWER: greater than 3**

Method cue: Solve as an equation until a negative multiplication/division occurs. Then check the sign, size, accuracy and units of the result.

2. Solve $x-4\leq 9$. **ANSWER: $x\leq 13$**

Method cue: Reverse the inequality sign when required. Then check the sign, size, accuracy and units of the result.

3. Solve $5x<35$. **ANSWER: $x<7$**

Method cue: Represent the result on a number line. Then check the sign, size, accuracy and units of the result.

4. Solve $-3x>12$. **ANSWER: $x<-4$**

Method cue: Test one value from the solution region. Then check the sign, size, accuracy and units of the result.

5. Solve $2x+7\geq 19$. **ANSWER: $x\geq 6$**

Method cue: Solve as an equation until a negative multiplication/division occurs. Then check the sign, size, accuracy and units of the result.

6. List integers satisfying $-2<x\leq 3$. **ANSWER: $-1,0,1,2,3$**

Method cue: Reverse the inequality sign when required. Then check the sign, size, accuracy and units of the result.

7. Represent $x<-1$ on a number line. **ANSWER: open circle at -1, shade left**

Method cue: Represent the result on a number line. Then check the sign, size, accuracy and units of the result.

8. Find greatest integer n if $45n+20\leq 250$. **ANSWER: 5**

Method cue: Test one value from the solution region. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 06

Practice answers and repair notes

Sequences and nth-term rules

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Continue 4,9,14,19 for three terms. **ANSWER: 24,29,34**

Method cue: Find the common difference. Then check the sign, size, accuracy and units of the result.

2. Find nth term of 3,8,13,18. **ANSWER: 5n−2**

Method cue: Begin with difference×n. Then check the sign, size, accuracy and units of the result.

3. Find nth term of 20,17,14,11. **ANSWER: 23−3n**

Method cue: Compare the generated first term with the actual first term. Then check the sign, size, accuracy and units of the result.

4. Find term 25 of 4n+1. **ANSWER: 101**

Method cue: Substitute n=1,2,3 to check. Then check the sign, size, accuracy and units of the result.

5. Is 62 in 3n+2? **ANSWER: Yes, n=20**

Method cue: Find the common difference. Then check the sign, size, accuracy and units of the result.

6. Find first term greater than 100 in 6n−1. **ANSWER: 101 at n=17**

Method cue: Begin with difference×n. Then check the sign, size, accuracy and units of the result.

7. Write first four terms of n^2+1. **ANSWER: 2,5,10,17**

Method cue: Compare the generated first term with the actual first term. Then check the sign, size, accuracy and units of the result.

8. Explain why 40 is not in 6n+3. **ANSWER: n=37/6 not integer**

Method cue: Substitute n=1,2,3 to check. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 07

Practice answers and repair notes

Coordinates, gradients and straight-line graphs

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Plot (−3,2) in words. **ANSWER: 3 left,2 up**

Method cue: Create a value table if points are needed. Then check the sign, size, accuracy and units of the result.

2. Find midpoint of (2,4) and (8,10). **ANSWER: (5,7)**

Method cue: Plot coordinates accurately using a consistent scale. Then check the sign, size, accuracy and units of the result.

3. Find gradient through (1,5),(4,14). **ANSWER: 3**

Method cue: For two points, calculate vertical change/horizontal change. Then check the sign, size, accuracy and units of the result.

4. State gradient of y=4x−7. **ANSWER: 4**

Method cue: Check the line crosses the y-axis at c. Then check the sign, size, accuracy and units of the result.

5. State y-intercept of y=−2x+9. **ANSWER: 9**

Method cue: Create a value table if points are needed. Then check the sign, size, accuracy and units of the result.

6. Find y when x=6 in y=3x−4. **ANSWER: 14**

Method cue: Plot coordinates accurately using a consistent scale. Then check the sign, size, accuracy and units of the result.

7. Are y=5x+1 and y=5x−8 parallel? **ANSWER: Yes**

Method cue: For two points, calculate vertical change/horizontal change. Then check the sign, size, accuracy and units of the result.

8. Interpret gradient 12 when y is cost and x is tickets. **ANSWER: £12 per ticket**

Method cue: Check the line crosses the y-axis at c. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 08

Practice answers and repair notes

Quadratic, cubic and reciprocal graph recognition

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. State shape of $y=x^2$. **ANSWER: parabola**

Method cue: Build a table including negative and positive x-values. Then check the sign, size, accuracy and units of the result.

2. Find y for $x=-3$ in $y=x^2-1$. **ANSWER: 8**

Method cue: Plot accurately and join with a smooth curve. Then check the sign, size, accuracy and units of the result.

3. State roots of $y=(x-2)(x+4)$. **ANSWER: 2 and −4**

Method cue: Read roots from x-axis crossings. Then check the sign, size, accuracy and units of the result.

4. State turning point of $y=x^2+3$. **ANSWER: (0,3)**

Method cue: Use the graph only to the accuracy supported by its scale. Then check the sign, size, accuracy and units of the result.

5. How many roots if a parabola never meets x-axis? **ANSWER: 0**

Method cue: Build a table including negative and positive x-values. Then check the sign, size, accuracy and units of the result.

6. Recognise $y=1/x$. **ANSWER: reciprocal graph**

Method cue: Plot accurately and join with a smooth curve. Then check the sign, size, accuracy and units of the result.

7. Solve $x^2=9$. **ANSWER: $x=-3$ or 3**

Method cue: Read roots from x-axis crossings. Then check the sign, size, accuracy and units of the result.

8. Explain why $y=x^2$ is not a straight line. **ANSWER: gradient changes**

Method cue: Use the graph only to the accuracy supported by its scale. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 09

Practice answers and repair notes

Rearranging formulae and changing the subject

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Make x subject: y=x+5. **ANSWER: x=y−5**

Method cue: Identify operations applied to the required subject. Then check the sign, size, accuracy and units of the result.

2. Make a subject: v=u+a. **ANSWER: a=v−u**

Method cue: Undo them in reverse order on both sides. Then check the sign, size, accuracy and units of the result.

3. Make t subject: d=st. **ANSWER: t=d/s**

Method cue: Simplify the new formula. Then check the sign, size, accuracy and units of the result.

4. Make w subject: P=2l+2w. **ANSWER: w=(P−2l)/2**

Method cue: Check by substituting consistent values. Then check the sign, size, accuracy and units of the result.

5. Make h subject: A=½bh. **ANSWER: h=2A/b**

Method cue: Identify operations applied to the required subject. Then check the sign, size, accuracy and units of the result.

6. Use C=(F−32)/1.8 for F=68. **ANSWER: 20°C**

Method cue: Undo them in reverse order on both sides. Then check the sign, size, accuracy and units of the result.

7. Check x=(y−7)/3 when x=4. **ANSWER: y=19 gives x=4**

Method cue: Simplify the new formula. Then check the sign, size, accuracy and units of the result.

8. Explain why (y−7)/3 needs brackets. **ANSWER: whole difference divided by 3**

Method cue: Check by substituting consistent values. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 10

Practice answers and repair notes

Algebraic modelling, proof and mixed problem solving

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Form equation: number x increased by 8 is 21. **ANSWER: x+8=21**

Method cue: Define the unknown. Then check the sign, size, accuracy and units of the result.

2. Solve perimeter problem: sides x and x+5, perimeter 34. **ANSWER: x=6, other side 11**

Method cue: Translate each sentence into an expression or equation. Then check the sign, size, accuracy and units of the result.

3. Three consecutive integers total 45. **ANSWER: 14,15,16**

Method cue: Solve or simplify with justified steps. Then check the sign, size, accuracy and units of the result.

4. Show even+even is even. **ANSWER: 2m+2n=2(m+n)**

Method cue: Check against the context and communicate the conclusion. Then check the sign, size, accuracy and units of the result.

5. Disprove “$x^2>x$ for all x”. **ANSWER: x=0 gives equality**

Method cue: Define the unknown. Then check the sign, size, accuracy and units of the result.

6. Adult ticket £a, child £c: write cost of 3 adults and 2 children. **ANSWER: 3a+2c**

Method cue: Translate each sentence into an expression or equation. Then check the sign, size, accuracy and units of the result.

7. Solve 4n+3=51 in a sequence context. **ANSWER: n=12**

Method cue: Solve or simplify with justified steps. Then check the sign, size, accuracy and units of the result.

8. State one assumption in a linear cost model. **ANSWER: constant rate/fixed charge**

Method cue: Check against the context and communicate the conclusion. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 11

Practice answers and repair notes

Quadratic equations by factorisation and graphs

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Solve $x^2+5x+6=0$. **ANSWER: $-2,-3$**

Method cue: Rearrange so one side equals zero. Then check the sign, size, accuracy and units of the result.

2. Solve $x^2-9=0$. **ANSWER: $-3,3$**

Method cue: Factorise the quadratic. Then check the sign, size, accuracy and units of the result.

3. Solve $x^2-4x=0$. **ANSWER: 0,4**

Method cue: Set each factor equal to zero. Then check the sign, size, accuracy and units of the result.

4. Solve $x^2+2x-15=0$. **ANSWER: $3,-5$**

Method cue: Check both solutions in the original equation. Then check the sign, size, accuracy and units of the result.

5. State roots of $y=(x-6)(x+1)$. **ANSWER: $6,-1$**

Method cue: Rearrange so one side equals zero. Then check the sign, size, accuracy and units of the result.

6. How many roots if graph only touches x-axis? **ANSWER: one repeated root**

Method cue: Factorise the quadratic. Then check the sign, size, accuracy and units of the result.

7. Check roots of $x^2-7x+12$. **ANSWER: 3 and 4**

Method cue: Set each factor equal to zero. Then check the sign, size, accuracy and units of the result.

8. Explain the zero-product rule. **ANSWER: a product zero has a zero factor**

Method cue: Check both solutions in the original equation. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 12

Practice answers and repair notes

Simultaneous equations and modelling two unknowns

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Solve $x+y=9, x-y=1$. **ANSWER: $x=5, y=4$**

Method cue: Align like variables and constants. Then check the sign, size, accuracy and units of the result.

2. Solve $2x+y=11, x+y=7$. **ANSWER: $x=4, y=3$**

Method cue: Multiply one or both equations if needed. Then check the sign, size, accuracy and units of the result.

3. Solve $3x+y=14, x-y=2$. **ANSWER: $x=4, y=2$**

Method cue: Add or subtract to eliminate one variable. Then check the sign, size, accuracy and units of the result.

4. Solve $x+2y=12, 3x-2y=4$. **ANSWER: $x=4, y=4$**

Method cue: Back-substitute and verify both values. Then check the sign, size, accuracy and units of the result.

5. Check $(4,3)$ in $x+y=7, 2x+y=11$. **ANSWER: satisfies both**

Method cue: Align like variables and constants. Then check the sign, size, accuracy and units of the result.

6. Form equations: 2 adult+1 child £17; 1 adult+2 child £13. **ANSWER: $2a+c=17, a+2c=13$**

Method cue: Multiply one or both equations if needed. Then check the sign, size, accuracy and units of the result.

7. Solve previous prices. **ANSWER: adult £7, child £3**

Method cue: Add or subtract to eliminate one variable. Then check the sign, size, accuracy and units of the result.

8. Explain why two independent equations are needed. **ANSWER: one equation has many pairs**

Method cue: Back-substitute and verify both values. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 13

Practice answers and repair notes

Functions, input-output rules and inverse processes

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Rule 3x+2: output for x=5. **ANSWER: 17**

Method cue: Write the function rule as an expression. Then check the sign, size, accuracy and units of the result.

2. Rule x^2-1: output for x=−4. **ANSWER: 15**

Method cue: Substitute the input with brackets. Then check the sign, size, accuracy and units of the result.

3. Find input if 2x+7=25. **ANSWER: 9**

Method cue: Apply operations in order. Then check the sign, size, accuracy and units of the result.

4. Inverse steps of ×6 then −5. **ANSWER: +5 then ÷6**

Method cue: For an inverse, undo the final operation first. Then check the sign, size, accuracy and units of the result.

5. Complete y=4x−1 for x=0,2,5. **ANSWER: −1,7,19**

Method cue: Write the function rule as an expression. Then check the sign, size, accuracy and units of the result.

6. Does rule $y=x^2$ give same output for 3 and −3? **ANSWER: yes**

Method cue: Substitute the input with brackets. Then check the sign, size, accuracy and units of the result.

7. Write rule “halve then add 8”. **ANSWER: x/2+8**

Method cue: Apply operations in order. Then check the sign, size, accuracy and units of the result.

8. Explain why inverse order reverses. **ANSWER: undo latest operation first**

Method cue: For an inverse, undo the final operation first. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 14

Practice answers and repair notes

Identities, equivalence and algebraic arguments

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Expand to show $2(x+5)+3x \equiv 5x+10$. **ANSWER: shown by expansion**

Method cue: Start with one side or a general representation. Then check the sign, size, accuracy and units of the result.

2. Show even+odd is odd. **ANSWER: $2m+(2n+1)=2(m+n)+1$**

Method cue: Apply valid algebraic transformations. Then check the sign, size, accuracy and units of the result.

3. Show three consecutive integers sum to multiple of 3. **ANSWER: $n+n+1+n+2=3(n+1)$**

Method cue: Reach the required form or the other side. Then check the sign, size, accuracy and units of the result.

4. Disprove $x^2>x$ for every positive x. **ANSWER: x=1 gives equality**

Method cue: State explicitly why the final form proves the claim. Then check the sign, size, accuracy and units of the result.

5. Is $4(x+1)=4x+4$ equation or identity? **ANSWER: identity**

Method cue: Start with one side or a general representation. Then check the sign, size, accuracy and units of the result.

6. Solve equation $4(x+1)=20$. **ANSWER: x=4**

Method cue: Apply valid algebraic transformations. Then check the sign, size, accuracy and units of the result.

7. Write general multiple of 5. **ANSWER: 5n**

Method cue: Reach the required form or the other side. Then check the sign, size, accuracy and units of the result.

8. Explain difference between equation and identity. **ANSWER: equation true for solutions; identity for all values**

Method cue: State explicitly why the final form proves the claim. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 15

Practice answers and repair notes

Double brackets and quadratic expressions

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Expand (x+2)(x+7). **ANSWER: $x^2+9x+14$**

Method cue: Multiply first terms, outer terms, inner terms and last terms. Then check the sign, size, accuracy and units of the result.

2. Expand (x−3)(x+5). **ANSWER: $x^2+2x-15$**

Method cue: Collect like x terms. Then check the sign, size, accuracy and units of the result.

3. Expand (2x+1)(x+4). **ANSWER: $2x^2+9x+4$**

Method cue: For factorisation, test factor pairs of the constant. Then check the sign, size, accuracy and units of the result.

4. Factorise $x^2+9x+20$. **ANSWER: (x+4)(x+5)**

Method cue: Re-expand to verify. Then check the sign, size, accuracy and units of the result.

5. Factorise $x^2-2x-15$. **ANSWER: (x−5)(x+3)**

Method cue: Multiply first terms, outer terms, inner terms and last terms. Then check the sign, size, accuracy and units of the result.

6. Factorise x^2-25. **ANSWER: (x−5)(x+5)**

Method cue: Collect like x terms. Then check the sign, size, accuracy and units of the result.

7. Check (x+6)(x−1). **ANSWER: x^2+5x-6**

Method cue: For factorisation, test factor pairs of the constant. Then check the sign, size, accuracy and units of the result.

8. Explain why four products appear. **ANSWER: each term multiplies both terms**

Method cue: Re-expand to verify. Then check the sign, size, accuracy and units of the result.

PRACTICE ANSWERS

CHAPTER 16

Practice answers and repair notes

Algebraic powers and index laws

Use these only after making a genuine attempt. Rework any incorrect question from a blank line rather than copying the final value.

1. Simplify $x^3 \times x^5$. **ANSWER: x^8**

Method cue: Separate numerical coefficients and variable factors. Then check the sign, size, accuracy and units of the result.

2. Simplify $y^9 \div y^4$. **ANSWER: y^5**

Method cue: Check bases match before using an index law. Then check the sign, size, accuracy and units of the result.

3. Simplify $(a^3)^2$. **ANSWER: a^6**

Method cue: Apply the correct operation to indices. Then check the sign, size, accuracy and units of the result.

4. Simplify $4m^2 \times 3m^5$. **ANSWER: $12m^7$**

Method cue: Rewrite negative indices as reciprocals when required. Then check the sign, size, accuracy and units of the result.

5. Simplify $18p^6 \div 6p^2$. **ANSWER: $3p^4$**

Method cue: Separate numerical coefficients and variable factors. Then check the sign, size, accuracy and units of the result.

6. Evaluate 7^0. **ANSWER: 1**

Method cue: Check bases match before using an index law. Then check the sign, size, accuracy and units of the result.

7. Write x^{-3} with positive index. **ANSWER: $1/x^3$**

Method cue: Apply the correct operation to indices. Then check the sign, size, accuracy and units of the result.

8. Explain why bases must match. **ANSWER: laws count repeated copies of same factor**

Method cue: Rewrite negative indices as reciprocals when required. Then check the sign, size, accuracy and units of the result.

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PUBLICATION EDITION

Independent authorship and release check

Unit 2: Algebra • Foundation Tier

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