ALGEBRA

A Complete Mathematics Worksheet Pack

Learn • Practise • Apply • Reason

CONCEPTS	SKILLS	APPLICATION
Variables and expressions	Simplify and substitute	Number patterns
Patterns and equations	Solve step by step	Real-life situations
Formulae and graphs	Recognise relationships	Reason and generalise

A flexible, non-grade-specific mathematics resource

Name: _____

Date: _____

Show your working, explain your reasoning and check your answers.

1. Understanding Variables and Expressions

A variable is a letter or symbol that represents a number. For example, if x = 4, then x + 3 = 7.

Example: x + 3 = 8

x	+	3	=	8	Take 3 away from both sides

1. If a = 6, find a + 5. 2. If b = 9, find b – 4. 3. If m = 3, find 4m.

4. Write an expression for 7 more than n. 5. Write an expression for 3 times p. 6. Write an expression for 5 less than k.

7. A notebook costs c units. Write an expression for the cost of 4 notebooks. 8. Explain what the variable represents in your expression.

Try it: Choose a variable for your age and write an expression for your age in 5 years.

2. Simplifying Algebraic Expressions

Like terms have the same variable part. Combine their coefficients: 3x + 2x = 5x.

Expression	Like terms grouped	Simplified
3x + 2x	3x and 2x	5x
4a + a	4a and 1a	5a
7p – 3p	7p and 3p	4p

Simplify:

1. 6x + 3x 2. 8a – 5a 3. 4m + 2m + m 4. 9p – 2p + p

5. 3x + 4 + 2x 6. 7a + 2 – 3a 7. 5m + 3n + 2m 8. 6p – 2q + p + 5q

9. Explain why 3x + 2y cannot be simplified to 5xy. 10. Create two different expressions that simplify to 7x.

3. Substitution: Finding the Value

Substitution means replacing a variable with its given value. If $x = 5$, then $2x + 1 = 2 \times 5 + 1 = 11$.

Find the value of each expression:

1. $x + 8$ when $x = 6$. 2. $3a$ when $a = 7$. 3. $2m + 4$ when $m = 5$. 4. $10 – p$ when $p = 3$.

5. $4x – 2$ when $x = 3$. 6. $a^2 + 1$ when $a = 4$. 7. $3b + 2c$ when $b = 2$ and $c = 5$.

8. $2(m + 3)$ when $m = 4$. 9. If $y = 3$, compare y^2 and $2y$. Which is greater?

10. Write your own expression involving two variables and evaluate it for chosen values.

4. Number Patterns and Sequences

Look for the rule that connects one term to the next.

Position (n)	1	2	3	4	5
Sequence A	3	6	9	12	15
Sequence B	2	5	8	11	14

1. Describe the rule for Sequence A. 2. Write the next two terms in Sequence B.

3. Find the 10th term of Sequence A. 4. Find the 8th term of Sequence B.

5. Complete: 5, 10, 15, __, __, __. 6. Complete: 30, 26, 22, __, __.

Matchstick pattern: each new square shares one side.



1 square(s) 2 square(s) 3 square(s) 4 square(s)

7. How many matchsticks are needed for 1, 2, 3 and 4 joined squares? 8. Describe a rule for n joined squares.

9. Create a sequence and explain its rule.

5. Solving One-Step Equations

An equation is like a balanced scale. Whatever operation you use on one side, use on the other side too.

An equation is like a balanced scale: do the same to both sides.



Example: x + 3 = 8. Subtract 3 from both sides: x = 5.

Solve:

1. x + 4 = 11 2. a – 6 = 9 3. 3m = 21 4. p ÷ 5 = 4

5. y + 8 = 15 6. b – 7 = 5 7. 6n = 42 8. q ÷ 3 = 6

9. Check your answer to Question 3 by substituting it into the original equation.

6. Solving Two-Step Equations

Undo operations in reverse order. For $2x + 3 = 13$, subtract 3, then divide by 2.

1. $2x + 5 = 17$ 2. $3a – 4 = 14$ 3. $5m + 2 = 27$ 4. $4p – 7 = 9$

5. $2y – 6 = 10$ 6. $7b + 1 = 22$ 7. $3n + 8 = 20$ 8. $6q – 5 = 31$

9. Explain why you undo addition or subtraction before multiplication or division in these examples.

10. Write a two-step equation whose solution is $x = 4$.

7. Inequalities and Number Lines

An inequality compares values. The symbols are: < less than, > greater than, ≤ less than or equal to, ≥ greater than or equal to.

Symbol	Meaning	Example
<	less than	x < 5
>	greater than	x > 2
≤	less than or equal to	x ≤ 7
≥	greater than or equal to	x ≥ 3

1. Write a symbol: 4 __ 9. 2. Write a symbol: 12 __ 7. 3. List three whole numbers satisfying x < 4.

4. Give two values satisfying n ≥ 6. 5. Is 5 a solution of x ≤ 5? 6. Is 8 a solution of x < 8?

7. Draw a number line and mark all whole-number values of x where 2 ≤ x ≤ 6.

8. Write an inequality for: a number t is greater than 10.

8. Formulae and Using Rules

A formula is a rule written using symbols. Example: perimeter of a rectangle P = 2l + 2w.

Length (l)	Width (w)	Perimeter P = 2l + 2w
5 cm	3 cm	16 cm
8 cm	2 cm	20 cm
4 cm	4 cm	16 cm

1. Find P when l = 7 cm and w = 4 cm. 2. Find P when l = 10 m and w = 6 m.

3. Use C = 2πr to find circumference when r = 3 cm. Use π = 3.14. 4. If d = 5t, find d when t = 8.

5. A taxi fare is F = 4 + 2k, where k is kilometres. Find F for 6 km.

6. Explain what each letter represents in one formula of your choice.

9. Algebraic Identities and Operations

Use the rules below to simplify, expand and factorise algebraic expressions. Work one step at a time.

A. Useful algebra rules

Rule	Identity / property	Example
Distributive property	$\mathbf{a(b + c) = ab + ac}$	$3(x + 2) = 3x + 6$
Square of a sum	$\mathbf{(a + b)^2 = a^2 + 2ab + b^2}$	$(x + 2)^2 = x^2 + 4x + 4$
Square of a difference	$\mathbf{(a - b)^2 = a^2 - 2ab + b^2}$	$(x - 3)^2 = x^2 - 6x + 9$
Difference of two squares	$\mathbf{(a + b)(a - b) = a^2 - b^2}$	$(x + 4)(x - 4) = x^2 - 16$

B. Worked examples

1. Expand: $4(x + 3) = 4x + 12$	**2. Simplify:** $5x + 3x - 2 = 8x - 2$
3. Use an identity: $(x + 5)^2 = x^2 + 10x + 25$	**4. Factorise:** $6x + 12 = 6(x + 2)$

C. Practise

1. Simplify: $7x + 4x - 3x$.
2. Simplify: $5a + 3b + 2a - b$.
3. Expand: $3(x + 4)$.
4. Expand and simplify: $2(3x + 5) + 4x$.
5. Expand: $(x + 3)^2$.
6. Expand: $(y - 4)^2$.
7. Use the difference of two squares to expand: $(m + 6)(m - 6)$.
8. Factorise: $8x + 20$.
9. Factorise: $x^2 - 25$.
10. A rectangle has length $(x + 5)$ cm and width $(x + 2)$ cm. Write and simplify an expression for its perimeter.
11. Challenge: Simplify $2(x + 3) + 3(x - 1)$, then find its value when $x = 4$.

Remember: Only like terms can be combined. Keep the signs with their terms, and check your expansion by multiplying each term inside the bracket.

10. Algebra in Everyday Life

Translate each situation into an algebraic expression or equation, then solve where possible.

1. A number increased by 9 is 21. Find the number.
2. Three identical notebooks cost 18 units altogether. Let c be the cost of one notebook. Write and solve an equation.
3. A taxi charges a fixed fee of 5 units plus 3 units per kilometre. Write a formula for a journey of k kilometres.
4. Sam is 4 years older than Lee. If Lee is a years old, write an expression for Sam's age.
5. A rectangle has width w and length 3 cm more than its width. Write an expression for its perimeter.
6. You have x coins and receive 7 more. Write an expression for the new total.
7. A phone plan costs 10 units plus 2 units per gigabyte. Find the cost for 6 GB.

11. Algebra Detective Challenge

Use patterns, equations and reasoning to solve each puzzle.

1. I think of a number, multiply it by 4 and add 3. The answer is 27. What was my number?

2. A pattern begins 4, 7, 10, 13, ... Write an expression for its nth term.

3. If $5x - 2 = 3x + 8$, find x.

4. A rectangle's length is twice its width. Its perimeter is 36 cm. Find its dimensions.

5. Find two different values of a and b for which $a + b = 12$.

6. A number is less than 20 and is a multiple of 3. Write all possible positive whole-number values.

7. Create a real-life situation represented by $4x + 6 = 30$ and solve it.

8. Explain why checking a solution by substitution is useful.

Teacher Answer Key

Suggested answers. Accept equivalent expressions and clear alternative reasoning where appropriate.

Worksheet 1 — 1. 11. 2. 5. 3. 12. 4. n+7. 5. 3p. 6. k–5. 7. 4c. 8. c is the cost of one notebook.

Worksheet 2 — 1. 9x. 2. 3a. 3. 7m. 4. 8p. 5. 5x+4. 6. 4a+2. 7. 7m+3n. 8. 7p+3q. 9. x and y are unlike terms. 10. Answers vary.

Worksheet 3 — 1. 14. 2. 21. 3. 14. 4. 7. 5. 10. 6. 17. 7. 16. 8. 14. 9. $y^2=9$ and $2y=6$; y^2 is greater. 10. Answers vary.

Worksheet 4 — 1. Add 3 each time. 2. 17, 20. 3. 30. 4. 23. 5. 20, 25, 30. 6. 18, 14. 7. 4, 7, 10, 13 matchsticks. 8. 3n+1 matchsticks for n joined squares. 9. Answers vary.

Worksheet 5 — 1. 7. 2. 15. 3. 7. 4. 20. 5. 7. 6. 12. 7. 7. 8. 18. 9. m=7; 3×7=21.

Worksheet 6 — 1. 6. 2. 6. 3. 5. 4. 4. 5. 8. 6. 3. 7. 4. 8. 6. 9. Reverse operations isolate the variable. 10. e.g. 2x+1=9.

Worksheet 7 — 1. <. 2. >. 3. 0,1,2,3 (any three). 4. Any two values 6 or greater. 5. Yes. 6. No. 7. 2,3,4,5,6. 8. t>10.

Worksheet 8 — 1. 22 cm. 2. 32 m. 3. 18.84 cm. 4. 40. 5. 16 units. 6. Answers vary.

Worksheet 9 — 1. 8x. 2. 7a+2b. 3. 3x+12. 4. 10x+10. 5. x^2+6x+9. 6. $y^2–8y+16$. 7. $m^2–36$. 8. 4(2x+5). 9. (x+5)(x–5). 10. 4x+14 cm. 11. 5x+3; when x=4, 23.

Worksheet 10 — 1. 12. 2. 3c=18, c=6. 3. F=5+3k. 4. a+4. 5. P=2w+2(w+3)=4w+6. 6. x+7. 7. 22 units.

Worksheet 11 — 1. 6. 2. 3n+1. 3. x=5. 4. Width 6 cm, length 12 cm. 5. Any pairs summing to 12, e.g. 5 and 7; 8 and 4. 6. 3,6,9,12,15,18. 7. Example: four items at x each plus a fee of 6 cost 30; x=6. 8. It confirms the value satisfies the original equation.