

FIRE JUNGLE

CAPS-aligned mathematics for South African learners



GRADE 8

Mathematics

TEXTBOOK

Definitions • Worked Examples • Exercises • Full Answers



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by Joseph Matthew Mitchell

Fire Jungle Grade 8 Mathematics

A CAPS-aligned study textbook for the FET phase

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Publisher Fire Jungle — TsukaMath

Digital edition https://firejungle.com/math/TsukaMath_G8.php

Edition 2026

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How to use this book

Definitions. Each topic opens with the key terms you must know and be able to state in an exam.

Key formulas. The formulas and rules for the topic, gathered in one box for quick revision.

Worked examples. Fully solved problems. The right-hand notes explain the reason for every step.

Exercises. Practice questions. Try them before checking the back of the book.

Answers. Complete answers with working are collected in the Answers section at the end.

Digital edition. Scan the QR code on any page to open the interactive version of this textbook, with animated lessons, narration and unlimited generated practice.

Tip: work through the worked examples with a pen in hand, then attempt the exercises with the book closed. Use the digital edition for extra randomised practice on any topic you find hard.



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Contents

Real Numbers and Exponents 7

Rational and irrational numbers	7
Exponent laws: product	8
Exponent laws: quotient	9
Exponent laws: power of a power	10
Zero and negative exponents	11
Scientific notation	12

Integers, Fractions, Decimals 14

Operations with integers	14
Operations with fractions	15
Operations with decimals	16
Long Division (game)	17

Ratio, Proportion, Percentage 19

Direct and inverse proportion	19
Sharing in a ratio	20
Percent change (profit/loss)	21
Simple interest	22

Number Patterns 24

Linear number patterns	24
Find general term T_n	25
Quadratic patterns (intro)	26

Algebraic Expressions 28

Simplify by collecting like terms	28
Distributive property	29
Multiply algebraic terms	30
Divide algebraic terms	31
Substitute into expressions	32

Linear Equations 34

Solve linear equations	34
Equations with brackets	35



Equations: variable on both sides	36
Word problems → equations	37
Functions and Graphs	39
Cartesian plane	39
Linear function: $y = mx$	41
Linear function: $y = mx + c$	42
Find gradient	43
Find y-intercept	45
Lines and Angles	47
Parallel lines and transversals	47
Triangle angle sum	48
Exterior angle of triangle	50
Triangles, Quadrilaterals, Polygons	52
Congruent triangles	52
Similar triangles	53
Sum of interior angles of polygon	54
Each interior angle of regular polygon	55
3D Objects	57
Faces, edges, vertices	57
Nets of 3D shapes	58
Pythagoras	60
Pythagoras: find hypotenuse	60
Pythagoras: find leg	61
Verify right triangles	62
Mensuration	64
Perimeter of polygons	64
Area of triangle	66
Area of parallelogram	67
Area of trapezium	68
Volume of cylinder (use $\pi=3$)	69
Surface area of rectangular prism	71
Transformations	73





Translation	73
Reflection in x-axis	74
Reflection in y-axis	76
Rotation 180° about origin	77

Worked solutions to all exercises 79



CHAPTER 1

Real Numbers and Exponents

Rational Rational and irrational numbers

Exponent Product rule for exponents

Exponent Quotient rule for exponents

Exponent Power of a power

Zero Zero and negative exponents

Scientific Scientific notation

Rational and irrational numbers

DEFINITIONS

Rational number A number that can be written as a fraction a/b where a and b are whole numbers. Its decimal ends or repeats.

Irrational number A number that cannot be written as a simple fraction. Its decimal goes on forever without any pattern.

Perfect square A number that is a whole number squared: 1, 4, 9, 16, 25, 36...

KEY FORMULAS

- **Rational examples:** $1/2$, 3, 0.25, 0.333... (repeating), $\sqrt{9} = 3$
- **Irrational examples:** π , $\sqrt{2}$, $\sqrt{5}$, $\sqrt{7}$
- **Quick test:** if $\sqrt{n}$ is a whole number, it's rational; otherwise irrational

WORKED EXAMPLES

Example 1: Is $\sqrt{4}$ rational or irrational?

► Find $\sqrt{4}$.

What number times itself gives 4?

► $\sqrt{4} = 2$.

$2 \times 2 = 4$.

► $2 = 2/1$, a fraction.

Whole numbers are rational.

► $\sqrt{4}$ is rational.

Final answer.



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**Example 2: Is $\sqrt{5}$ rational or irrational?**

- Try whole numbers: $2^2 = 4$ (too small), $3^2 = 9$ (too big).

No whole number works.

- $\sqrt{5} \approx 2.2360679...$ never ends, never repeats.

Calculator confirms.

- **$\sqrt{5}$ is irrational.**

Cannot be a clean fraction.

EXERCISES (EASY → DIFFICULT)

1. Is $1/3$ rational or irrational?
2. Is π rational or irrational?
3. Is $\sqrt{5}$ rational or irrational?
4. Is $\sqrt{4}$ rational or irrational?

Exponent laws: product

Product rule for exponents

DEFINITIONS

Base	The number being raised to a power. In 2^5 , the base is 2.
Exponent	The small raised number that tells you how many times to multiply the base by itself. In 2^5 , the exponent is 5.
Like bases	Two powers with the same base. Only with like bases can you add or subtract exponents.

KEY FORMULAS

- **Product rule:** $a^m \times a^n = a^{m+n}$
- **In words:** same base, ADD the exponents
- **Why?** $2^3 \times 2^2 = (2 \times 2 \times 2) \times (2 \times 2) = 2^5$

WORKED EXAMPLES**Example 1: Simplify $2^3 \times 2^4$.**

- Same base (2) — use the product rule.

Add the exponents.

► $2^3 \times 2^4 = 2^{3+4} = 2^7$.

$3 + 4 = 7$.

Example 2: Simplify $5^2 \times 5^3$.

- Same base — add exponents.

Product rule.

► $5^2 \times 5^3 = 5^5$.

$2 + 3 = 5$.

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**EXERCISES (EASY → DIFFICULT)**

1. $5^2 \times 5^3 = 5^?$
2. $2^4 \times 2^3 = 2^?$
3. $4^4 \times 4^3 = 4^?$
4. $5^3 \times 5^2 = 5^?$
5. $2^2 \times 2^3 = 2^?$
6. $4^2 \times 4^4 = 4^?$
7. $4^2 \times 4^3 = 4^?$
8. $5^3 \times 5^3 = 5^?$
9. $3^2 \times 3^3 = 3^?$
10. $2^3 \times 2^3 = 2^?$

Exponent laws: quotient

Quotient rule for exponents

DEFINITIONS

Quotient	The result of a division — what you get when one number is divided by another.
Like bases	Two powers with the same base, like 5^7 and 5^2 .

KEY FORMULAS

- **Quotient rule:** $a^m \div a^n = a^{m-n}$
- **In words:** same base, SUBTRACT the exponents (top – bottom)
- **Why?** $2^5 \div 2^2 = (2 \times 2 \times 2 \times 2 \times 2) \div (2 \times 2) = 2^3$

WORKED EXAMPLES**Example 1: Simplify $5^6 \div 5^2$.**

- Same base — use quotient rule.

Subtract exponents.

- $5^6 \div 5^2 = 5^{6-2} = 5^4$.

$6 - 2 = 4$.

Example 2: Simplify $3^7 \div 3^3$.

- Subtract exponents: $7 - 3 = 4$.

Quotient rule.

- 3^4 .

Same base.

EXERCISES (EASY → DIFFICULT)

1. $2^5 \div 2^3 = 2^?$
2. $3^5 \div 3^2 = 3^?$
3. $5^6 \div 5^3 = 5^?$
4. $4^6 \div 4^2 = 4^?$
5. $3^6 \div 3^3 = 3^?$
6. $4^6 \div 4^3 = 4^?$
7. $4^4 \div 4^3 = 4^?$

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8. $3^7 \div 3^2 = 3^?$
9. $5^7 \div 5^3 = 5^?$
10. $5^4 \div 5^3 = 5^?$

Exponent laws: power of a power

DEFINITIONS

Power of a power	When a power is itself raised to another power, like $(2^3)^4$.
Inner exponent	The exponent inside the bracket.
Outer exponent	The exponent outside the bracket.

KEY FORMULAS

- **Power of a power rule:** $(a^m)^n = a^{mn}$
- **In words:** MULTIPLY the two exponents
- **Why?** $(2^3)^4 = 2^3 \times 2^3 \times 2^3 \times 2^3 = 2^{12}$

WORKED EXAMPLES

Example 1: Simplify $(2^3)^4$.

- Use the rule: multiply the exponents.

Power of a power.

- $(2^3)^4 = 2^{3 \times 4} = 2^{12}$.

$3 \times 4 = 12$.

Example 2: Simplify $(5^2)^3$.

- Multiply: $2 \times 3 = 6$.

Power of a power.

- 5^6 .

Final answer.

EXERCISES (EASY → DIFFICULT)

1. $(5^4)^2 = 5^?$
2. $(3^3)^3 = 3^?$
3. $(5^3)^2 = 5^?$
4. $(4^2)^3 = 4^?$
5. $(5^3)^3 = 5^?$
6. $(4^4)^2 = 4^?$
7. $(3^3)^2 = 3^?$
8. $(3^2)^2 = 3^?$
9. $(4^3)^2 = 4^?$
10. $(3^4)^2 = 3^?$



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Zero and negative exponents

DEFINITIONS

Zero exponent Any non-zero number to the power 0 equals 1. Yes, even $100^0 = 1$!

Negative exponent A power below zero. Means take the reciprocal of the positive version.

KEY FORMULAS

- **Zero rule:** $a^0 = 1$ (for any $a \neq 0$)
- **Negative rule:** $a^{-n} = 1/a^n$
- **Why $a^0 = 1$?** Because $a^n \div a^n = a^{n-n} = a^0$, and $a^n \div a^n = 1$

WORKED EXAMPLES

Example 1: What is 7^0 ?

- Apply the zero rule.

Any non-zero number to power 0 is 1.

- $7^0 = 1$.

Direct rule.

Example 2: What is 3^{-1} ?

- Apply the negative rule: $a^{-1} = 1/a$.

Take the reciprocal.

- $3^{-1} = 1/3$.

Final answer.

EXERCISES (EASY → DIFFICULT)

1. $9^0 = ?$
2. $3^0 = ?$
3. $2^0 = ?$
4. $5^0 = ?$
5. $7^0 = ?$
6. $8^0 = ?$
7. $4^0 = ?$
8. $6^0 = ?$



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Scientific notation

DEFINITIONS

Scientific notation

A short way to write very big or very small numbers using powers of 10.
Form: $a \times 10^n$ where $1 \leq a < 10$.

Mantissa

The first part (a) of a scientific notation number — always between 1 and 10.

KEY FORMULAS

- **Standard form:** $a \times 10^n$ where $1 \leq a < 10$
- **Big numbers:** exponent is positive — move decimal RIGHT n places
- **Small numbers:** exponent is negative — move decimal LEFT n places
- **Examples:** $3 \times 10^4 = 30\,000$; $2 \times 10^{-2} = 0.02$

WORKED EXAMPLES

Example 1: Convert 3×10^4 to an ordinary number.

- Exponent is 4 (positive) — move decimal 4 places RIGHT.

Positive exponent = big number.

- Start with 3.0: $3 \rightarrow 30 \rightarrow 300 \rightarrow 3\,000 \rightarrow 30\,000$.

Add four zeros.

- $3 \times 10^4 = 30\,000$.

Thirty thousand.

Example 2: Convert 2.5×10^3 to ordinary.

- Move decimal 3 places right.

Exponent of 3.

- $2.5 \rightarrow 25 \rightarrow 250 \rightarrow 2\,500$.

Three moves right.

- $2.5 \times 10^3 = 2\,500$.

Done.

EXERCISES (EASY → DIFFICULT)

1. 3×10^4 as ordinary number:
2. 4×10^5 as ordinary number:
3. 2.5×10^3 as ordinary number:



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End of Chapter 1 — Mixed Exercise

Ten questions across the whole chapter, from easy to difficult.

1. Is $\frac{1}{3}$ rational or irrational?
2. $2^4 \times 2^3 = 2^?$
3. $5^6 \div 5^3 = 5^?$
4. $(4^2)^3 = 4^?$
5. $7^0 = ?$
6. 2.5×10^3 as ordinary number:
7. Is $\sqrt{4}$ rational or irrational?
8. $5^3 \times 5^3 = 5^?$
9. $5^7 \div 5^3 = 5^?$
10. $(3^4)^2 = 3^?$



CHAPTER 2

Integers, Fractions, Decimals

- Operations** Operations with integers
- Operations** Operations with fractions
- Operations** Operations with decimals
- Long** Long Division — interactive game

Operations with integers

DEFINITIONS

Integer A whole number — positive, negative, or zero. Examples: -5 , -1 , 0 , 3 , 100 .

Sign rule (multiply/divide) Same signs give POSITIVE. Different signs give NEGATIVE.

KEY FORMULAS

- **Adding same signs:** add and keep the sign. $(-3) + (-5) = -8$
- **Adding different signs:** subtract, sign of bigger. $(-3) + 7 = 4$
- **Multiplying:** $(+) \times (+) = +$, $(-) \times (-) = +$, $(+) \times (-) = -$
- **Dividing:** same sign rules as multiplication

WORKED EXAMPLES

Example 1: Calculate $(-4) \times (-5)$.

- Both numbers are negative.

Same signs.

- Same signs $\rightarrow$ answer is POSITIVE.

Sign rule.

- $4 \times 5 = 20$.

Multiply the size.

Example 2: Calculate $(-6) \times 3$.

- Different signs (one negative, one positive).

Sign rule.

- Different signs $\rightarrow$ answer is NEGATIVE.

Apply rule.

- $6 \times 3 = 18 \rightarrow -18$.

Multiply then attach negative sign.

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EXERCISES (EASY → DIFFICULT)

1. $(-2) \times (-2) = ?$
2. $(-9) \times (-7) = ?$
3. $(-6) \times (-5) = ?$
4. $(-3) \times (-8) = ?$
5. $(-9) \times (-3) = ?$
6. $(-2) \times (-4) = ?$
7. $(-9) \times (-8) = ?$
8. $(-5) \times (-8) = ?$
9. $(-3) \times (-6) = ?$
10. $(-3) \times (-4) = ?$

Operations with fractions

DEFINITIONS

Numerator	The TOP number of a fraction. In $\frac{3}{4}$, the numerator is 3.
Denominator	The BOTTOM number of a fraction. In $\frac{3}{4}$, the denominator is 4.
Common denominator	A denominator both fractions share — needed before adding or subtracting.

KEY FORMULAS

- **Add / subtract:** need a common denominator first, then add/subtract numerators
- **Multiply:** top $\times$ top, bottom $\times$ bottom — no common denominator needed
- **Divide:** flip the second fraction (reciprocal), then multiply

WORKED EXAMPLES

Example 1: Calculate $\frac{2}{3} + \frac{1}{4}$.

- Find a common denominator: LCM of 3 and 4 = 12.
Smallest number both go into.
- Rewrite: $\frac{2}{3} = \frac{8}{12}$ and $\frac{1}{4} = \frac{3}{12}$.
Multiply top and bottom equally.
- Add: $\frac{8}{12} + \frac{3}{12} = \frac{11}{12}$.
Same denominator now.
- $\frac{2}{3} + \frac{1}{4} = \frac{11}{12}$.
Final answer.

Example 2: Calculate $\frac{1}{2} \div \frac{1}{4}$.

- To divide, flip the second fraction and multiply.
Reciprocal rule.
- $\frac{1}{2} \div \frac{1}{4} = \frac{1}{2} \times \frac{4}{1}$.
Flip $\frac{1}{4}$ to $\frac{4}{1}$.
- $= \frac{4}{2} = 2$.
Multiply and simplify.



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**EXERCISES (EASY → DIFFICULT)**

1. $1/2 \div 1/4 = ?$
2. $5/6 - 1/3 = ?$
3. $2/3 \times 3/5 = ?$
4. $2/3 + 1/4 = ?$

Operations with decimals

DEFINITIONS

Decimal	A number written with a decimal point, separating whole and fractional parts. E.g. 3.5 means 3 wholes and 5 tenths.
Decimal place	A digit's position after the decimal point — tenths, hundredths, etc.

KEY FORMULAS

- **Adding/subtracting decimals:** line up the decimal points, then add or subtract as normal
- **Multiplying decimals:** ignore the points, multiply as whole numbers, then put the point back
- **Decimal places in product:** sum of decimal places in the two original numbers

WORKED EXAMPLES**Example 1: Calculate 2.5×3.0 .**

- ▶ Multiply as whole numbers: $25 \times 30 = 750$.
Ignore the decimal points first.
- ▶ Count decimal places: 2.5 has 1, 3.0 has 1 → total 2 places.
Sum of decimal places.
- ▶ Place decimal: 7.50.
Move 2 places from the right.
- ▶ **$2.5 \times 3.0 = 7.5$.**
Final answer.

Example 2: Calculate 4.2×2.0 .

- ▶ $42 \times 20 = 840$.
Multiply as integers.
- ▶ $1 + 1 = 2$ decimal places.
Count points.
- ▶ **$8.40 = 8.4$.**
Place decimal point.

EXERCISES (EASY → DIFFICULT)

1. $6.0 \times 4.5 = ?$
2. $6.6 \times 5.1 = ?$
3. $7.2 \times 3.0 = ?$
4. $6.6 \times 5.2 = ?$
5. $2.4 \times 3.3 = ?$
6. $5.8 \times 8.4 = ?$
7. $7.2 \times 6.5 = ?$

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8. $8.7 \times 5.2 = ?$

9. $5.7 \times 6.1 = ?$

10. $2.9 \times 5.4 = ?$

Long Division (game)

Long Division — interactive game

DEFINITIONS

Long division	A step-by-step way to divide big numbers: divide, multiply, subtract, bring down.
Dividend	The number being divided (goes under the bracket).
Divisor	The number you divide by.
Quotient	The answer that sits on top.
Remainder	What is left over when it does not divide evenly.

KEY FORMULAS

- **Divide → Multiply → Subtract → Bring down**, then repeat
- **$\text{dividend} \div \text{divisor} = \text{quotient (remainder r)}$**

WORKED EXAMPLES

Example 1: This opens the Division Quest game, where Tsuka guides you through every step with apple groups and 3-choice answers.

- Divide: how many times does the divisor fit?

Step 1.

- Multiply that digit by the divisor.

Step 2.

- Subtract, then bring down the next digit.

Step 3, then repeat.

EXERCISES (EASY → DIFFICULT)

1. Open the Long Division game to practise step by step.

End of Chapter 2 — Mixed Exercise

Ten questions across the whole chapter, from easy to difficult.



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1. $(-2) \times (-2) = ?$
2. $5/6 - 1/3 = ?$
3. $7.2 \times 3.0 = ?$
4. Open the Long Division game to practise step by step.
5. $(-9) \times (-3) = ?$
6. $2/3 + 1/4 = ?$
7. $7.2 \times 6.5 = ?$
8. Open the Long Division game to practise step by step.
9. $(-3) \times (-6) = ?$
10. $1/2 \div 1/4 = ?$

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CHAPTER 3

Ratio, Proportion, Percentage

- Direct** Direct proportion
Sharing Sharing in a ratio
Percent Percent change — profit and loss
Simple Simple interest

Direct and inverse proportion

Direct proportion

DEFINITIONS

Direct proportion	When one quantity doubles, the other also doubles. Both go up (or down) together.
Inverse proportion	When one quantity doubles, the other halves. One goes up, the other goes down.
Unit rate	How much of something costs per ONE unit. E.g. R10 per kg.

KEY FORMULAS

- **Direct proportion strategy:** find the rate per ONE unit, then multiply
- **Example:** if 3 kg costs R60, then 1 kg costs R20, and 5 kg costs R100
- **Inverse proportion:** if 2 workers take 6 hours, then 4 workers take 3 hours (half)

WORKED EXAMPLES

Example 1: 3 kg of apples costs R60. How much does 5 kg cost?

- Find cost per 1 kg: $R60 \div 3 = R20$.

Unit rate.

- Multiply: $R20 \times 5 = R100$.

Apply to 5 kg.

- **5 kg costs R100.**

Direct proportion.

Example 2: 4 kg of rice costs R80. Cost of 7 kg?

- Per 1 kg: $R80 \div 4 = R20$.

Unit rate.

- 7 kg: $R20 \times 7 = \mathbf{R140}$.

Multiply.



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**EXERCISES (EASY → DIFFICULT)**

1. 3 kg costs R51. 8 kg costs?
2. 4 kg costs R100. 2 kg costs?
3. 2 kg costs R26. 4 kg costs?
4. 2 kg costs R38. 5 kg costs?
5. 3 kg costs R72. 4 kg costs?
6. 3 kg costs R33. 5 kg costs?
7. 2 kg costs R22. 6 kg costs?
8. 4 kg costs R48. 2 kg costs?
9. 2 kg costs R28. 2 kg costs?
10. 4 kg costs R84. 4 kg costs?

Sharing in a ratio

DEFINITIONS

Ratio	A comparison of two amounts, written as a:b. E.g. 3:5 means 3 parts to 5 parts.
Total parts	The sum of all numbers in the ratio. For 3:5, total parts = $3 + 5 = 8$.

KEY FORMULAS

- **Sharing strategy:** Step 1 — add ratio parts. Step 2 — divide total amount by parts to get value-per-part. Step 3 — multiply each ratio number.
- **Quick formula:** each person's share = (their ratio) / (total parts) × total amount

WORKED EXAMPLES**Example 1: Share R80 in the ratio 3:5. What's the larger share?**

- Add the parts: $3 + 5 = 8$.

Total ratio parts.

- Value per part: $R80 \div 8 = R10$.

Each part is worth R10.

- Larger share has 5 parts: $5 \times R10 = R50$.

Multiply.

- **Larger share = R50.**

Done.

Example 2: Share R120 in ratio 1:2:3. Largest share?

- Parts: $1 + 2 + 3 = 6$.

Total parts.

- Per part: $R120 \div 6 = R20$.

Value per part.

- Largest (3 parts): $3 \times R20 = \mathbf{R60}$.

Multiply.

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**EXERCISES (EASY → DIFFICULT)**

1. Share R80 in ratio 3:5. Larger share?
2. Share R120 in ratio 3:5. Larger share?
3. Share R100 in ratio 3:5. Larger share?
4. Share R60 in ratio 3:5. Larger share?

Percent change (profit/loss)

Percent change — profit and loss

DEFINITIONS

Profit	When selling price is HIGHER than cost price. Profit = selling – cost.
Loss	When selling price is LOWER than cost price. Loss = cost – selling.
Percent profit/loss	The profit or loss expressed as a percentage of the COST price.

KEY FORMULAS

- **Profit:** selling price – cost price
- **% profit:** $(\text{profit} \div \text{cost price}) \times 100$
- **% loss:** $(\text{loss} \div \text{cost price}) \times 100$
- **Important:** always divide by COST price, not selling price

WORKED EXAMPLES**Example 1: An item cost R100 and sold for R125. What's the % profit?**

► Profit = selling – cost = R125 – R100 = R25.

Find profit.

► % profit = profit / cost $\times 100$.

Apply formula.

► $= 25/100 \times 100 = 25\%$.

Calculate.

Example 2: Cost R200, sold for R240. % profit?

► Profit = 240 – 200 = R40.

Subtract.

► % = $40/200 \times 100 = 20\%$.

Apply formula.

EXERCISES (EASY → DIFFICULT)

1. Cost R100, sold R125. % profit?
2. Cost R100, sold R120. % profit?
3. Cost R100, sold R110. % profit?

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Simple interest

DEFINITIONS

Principal (P)	The amount of money invested or borrowed.
Interest rate (r)	The percentage charged or earned per year.
Time (t)	How long the money is invested or borrowed, in years.
Simple interest	Interest calculated only on the original principal — does not earn interest on interest.

KEY FORMULAS

- **Simple interest:** $I = P \times r \times t \div 100$
- **P** = principal in rand
- **r** = annual rate as a percentage
- **t** = time in years

WORKED EXAMPLES

Example 1: P = R2 000, r = 8%, t = 3 years. Find the interest.

- ▶ Apply $I = Prt/100$.
Simple interest formula.
- ▶ $I = (2000 \times 8 \times 3) / 100$.
Substitute.
- ▶ $= 48\,000 / 100 = \mathbf{R480}$.
Calculate.

Example 2: P = R5 000, r = 10%, t = 2 years.

- ▶ $I = (5000 \times 10 \times 2) / 100$.
Apply formula.
- ▶ $= 100\,000 / 100 = \mathbf{R1\,000}$.
Calculate.

EXERCISES (EASY → DIFFICULT)

1. P=R1623, r=8%, t=3 yr. Interest?
2. P=R4858, r=5%, t=5 yr. Interest?
3. P=R3574, r=8%, t=5 yr. Interest?
4. P=R4543, r=8%, t=5 yr. Interest?
5. P=R3439, r=5%, t=3 yr. Interest?
6. P=R3558, r=5%, t=4 yr. Interest?
7. P=R3227, r=5%, t=5 yr. Interest?
8. P=R3546, r=5%, t=5 yr. Interest?
9. P=R2637, r=10%, t=3 yr. Interest?
10. P=R1501, r=8%, t=4 yr. Interest?



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End of Chapter 3 — Mixed Exercise

Ten questions across the whole chapter, from easy to difficult.

1. 3 kg costs R51. 8 kg costs?
2. Share R120 in ratio 3:5. Larger share?
3. Cost R100, sold R110. % profit?
4. $P=R4543$, $r=8\%$, $t=5$ yr. Interest?
5. 3 kg costs R72. 4 kg costs?
6. Share R60 in ratio 3:5. Larger share?
7. Cost R100, sold R125. % profit?
8. $P=R3546$, $r=5\%$, $t=5$ yr. Interest?
9. 2 kg costs R28. 2 kg costs?
10. Share R80 in ratio 3:5. Larger share?



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CHAPTER 4

Number Patterns

Linear Linear number patterns

Find Finding the general term

Quadratic Quadratic patterns

Linear number patterns

DEFINITIONS

Term (T_n)	A single number in a sequence. T_1 is the first term, T_2 is the second, etc.
General term	A formula that gives ANY term T_n when you put in the position number n .
Linear pattern	A pattern that adds the same number each step (constant difference).

KEY FORMULAS

- **General term:** $T_n = (\text{step}) \times n + (\text{constant})$
- **To find T_5 :** substitute $n = 5$
- **To find T_{100} :** substitute $n = 100$

WORKED EXAMPLES

Example 1: $T_n = 3n + 2$. Find T_5 .

- Substitute $n = 5$.

Replace n with 5.

► $T_5 = 3 \times 5 + 2$.

Apply the formula.

► $= 15 + 2 = 17$.

Calculate.

Example 2: $T_n = 4n + 1$. Find T_6 .

► $T_6 = 4 \times 6 + 1$.

Substitute $n = 6$.

► $= 24 + 1 = 25$.

Calculate.



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**EXERCISES (EASY → DIFFICULT)**

1. $T_n = 6n + 2$. Find T_5 :
2. $T_n = 5n + 2$. Find T_5 :
3. $T_n = 3n + 5$. Find T_5 :
4. $T_n = 6n + 6$. Find T_5 :
5. $T_n = 6n + 3$. Find T_5 :
6. $T_n = 4n + 6$. Find T_5 :
7. $T_n = 4n + 9$. Find T_5 :
8. $T_n = 2n + 6$. Find T_5 :
9. $T_n = 7n + 4$. Find T_5 :
10. $T_n = 3n + 3$. Find T_5 :

Find general term T_n

Finding the general term

DEFINITIONS**Common difference**

The constant amount added each step to get the next term. Find it by subtracting consecutive terms.

General term formula

$T_n = (\text{common difference}) \times n + (T_1 - \text{common difference})$.

KEY FORMULAS

- **Step 1:** find the common difference (subtract consecutive terms)
- **Step 2:** the coefficient of n IS the common difference
- **Step 3:** find the constant by checking T_1 — work back from the first term

WORKED EXAMPLES**Example 1: Pattern: 5, 8, 11, 14... Find T_n .**

- Common difference: $8 - 5 = 3$.

Each step adds 3.

- So T_n starts as $3n + ?$

Coefficient of n is 3.

- Test T_1 : $3(1) + ? = 5$, so $? = 2$.

Find the constant.

- **$T_n = 3n + 2$.**

Verify: $T_2 = 3(2) + 2 = 8$.

Example 2: Pattern: 7, 11, 15, 19... Find T_n .

- Common difference: $11 - 7 = 4$.

Step is 4.

- $T_n = 4n + ?$

Start.

- T_1 : $4 + ? = 7$, so $? = 3$.

Find constant.

- **$T_n = 4n + 3$.**

Done.

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**EXERCISES (EASY → DIFFICULT)**

1. Pattern: 13, 20, 27. T_n ?
2. Pattern: 9, 12, 15. T_n ?
3. Pattern: 6, 9, 12. T_n ?
4. Pattern: 11, 13, 15. T_n ?
5. Pattern: 10, 15, 20. T_n ?
6. Pattern: 9, 13, 17. T_n ?
7. Pattern: 7, 10, 13. T_n ?
8. Pattern: 8, 14, 20. T_n ?
9. Pattern: 4, 6, 8. T_n ?
10. Pattern: 6, 8, 10. T_n ?

Quadratic patterns (intro)**DEFINITIONS****Quadratic pattern**

A pattern where the SECOND difference (difference of differences) is constant, not the first.

Perfect squares

The numbers 1, 4, 9, 16, 25, 36... These are $1^2, 2^2, 3^2, 4^2, 5^2, 6^2$.

KEY FORMULAS

- **Squares pattern:** 1, 4, 9, 16, 25... $\rightarrow T_n = n^2$
- **Test for quadratic:** if first differences are NOT constant but second differences are, it's quadratic
- **Example:** 1, 4, 9, 16 $\rightarrow$ first diffs: 3, 5, 7; second diffs: 2, 2 (constant!)

WORKED EXAMPLES**Example 1: Pattern: 1, 4, 9, 16. What's next?**

- Recognise the pattern: $1^2, 2^2, 3^2, 4^2$.

These are perfect squares.

- Next term: 5^2 .

Continue squaring.

- $5^2 = 25$.

Final answer.

Example 2: Pattern: 4, 9, 16, 25. Next?

- Recognise: $2^2, 3^2, 4^2, 5^2$.

Squares shifted up.

- Next: $6^2 = 36$.

Continue.

EXERCISES (EASY → DIFFICULT)

1. Pattern 1, 4, 9, 16. Next?

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End of Chapter 4 — Mixed Exercise

Ten questions across the whole chapter, from easy to difficult.

1. $T_n = 6n + 2$. Find T_5 :
2. Pattern: 9, 12, 15. T_n ?
3. Pattern 1, 4, 9, 16. Next?
4. $T_n = 6n + 6$. Find T_5 :
5. Pattern: 10, 15, 20. T_n ?
6. Pattern 1, 4, 9, 16. Next?
7. $T_n = 4n + 9$. Find T_5 :
8. Pattern: 8, 14, 20. T_n ?
9. Pattern 1, 4, 9, 16. Next?
10. $T_n = 3n + 3$. Find T_5 :





CHAPTER 5

Algebraic Expressions

- Simplify** Collecting like terms
- Distributive** Distributive property
- Multiply** Multiplying algebraic terms
- Divide** Dividing algebraic terms
- Substitute** Substituting values

Simplify by collecting like terms

DEFINITIONS

Term	A single number, variable, or product, separated from others by + or – signs.
Like terms	Terms with the same variable raised to the same power. $4x$ and $7x$ are like terms; $4x$ and $7y$ are NOT.
Coefficient	The number in front of a variable. In $5x$, the coefficient is 5.

KEY FORMULAS

- **Rule:** add or subtract the coefficients of like terms, keep the variable
- **Example:** $3x + 5x = 8x$ (not $8x^2$)
- **Unlike terms stay apart:** $3x + 5y$ stays as $3x + 5y$

WORKED EXAMPLES

Example 1: Simplify $5x + 3y + 2x$.

- Identify like terms: $5x$ and $2x$ have the same variable x .
 $3y$ is a separate term.
- Combine x -terms: $5x + 2x = 7x$.
Add coefficients.
- $3y$ stays separate.
Cannot combine with x -terms.
- **Answer:** $7x + 3y$.
Final simplified form.

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**Example 2: Simplify $8a + 4b - 3a + 2b$.**

► a-terms: $8a - 3a = 5a$.

Combine a-terms.

► b-terms: $4b + 2b = 6b$.

Combine b-terms.

► **$5a + 6b$.**

Done.

EXERCISES (EASY → DIFFICULT)

1. $4x + 4y + 3x = ?$
2. $6x + 4y + 5x = ?$
3. $6x + 5y + 3x = ?$
4. $8x + 3y + 5x = ?$
5. $3x + 3y + 5x = ?$
6. $5x + 4y + 5x = ?$
7. $5x + 3y + 5x = ?$
8. $9x + 5y + 4x = ?$
9. $6x + 2y + 4x = ?$
10. $4x + 5y + 2x = ?$

Distributive property**DEFINITIONS****Distributive property**

Multiplying a number outside brackets by EACH term inside. $a(b + c) = ab + ac$.

Expand

Remove brackets by applying the distributive property.

KEY FORMULAS

- **Distributive rule:** $a(b + c) = a \cdot b + a \cdot c$
- **With subtraction:** $a(b - c) = a \cdot b - a \cdot c$
- **Watch the sign:** careful when the number outside or inside is negative

WORKED EXAMPLES**Example 1: Expand $3(x - 4)$.**

► Multiply 3 by EACH term inside.

Distributive property.

► $3 \times x = 3x$.

First term.

► $3 \times 4 = 12$, keep the minus.

Second term.

► **$3(x - 4) = 3x - 12$.**

Done.

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**Example 2: Expand $5(x + 2)$.**

► $5 \times x = 5x$.

First term.

► $5 \times 2 = 10$.

Second term.

► **$5x + 10$.**

Done.

EXERCISES (EASY → DIFFICULT)

1. $2(x - 3) = ?$
2. $3(x - 2) = ?$
3. $4(x - 1) = ?$
4. $4(x - 5) = ?$
5. $5(x - 2) = ?$
6. $5(x - 3) = ?$
7. $4(x - 3) = ?$
8. $5(x - 5) = ?$
9. $2(x - 4) = ?$
10. $3(x - 1) = ?$

Multiply algebraic terms

Multiplying algebraic terms

DEFINITIONS**Variable**

A letter that stands for an unknown number, like x or y .

Power of a variable

When a variable is multiplied by itself. $x \cdot x = x^2$; $x \cdot x \cdot x = x^3$.

KEY FORMULAS

- **Multiply terms:** multiply numbers, ADD the exponents of the variables
- **Example:** $3x \cdot 4x = 12x^2$ (because $3 \times 4 = 12$ and $x^1 \cdot x^1 = x^2$)
- **Different variables:** just write them together: $2x \cdot 3y = 6xy$

WORKED EXAMPLES**Example 1: Simplify $3x \times 4x$.**

► Multiply the numbers: $3 \times 4 = 12$.

Coefficients.

► Add the x -exponents: $x^1 \times x^1 = x^2$.

Same base, add exponents.

► **$3x \times 4x = 12x^2$.**

Combine.

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**Example 2: Simplify $2x \times 5x$.**

► $2 \times 5 = 10$.

Coefficients.

► $x \times x = x^2$.

Add exponents.

► $10x^2$.

Done.

EXERCISES (EASY → DIFFICULT)

1. $2x \times 3x = ?$
2. $4x \times 2x = ?$
3. $3x \times 5x = ?$
4. $4x \times 3x = ?$
5. $2x \times 4x = ?$
6. $3x \times 4x = ?$
7. $5x \times 5x = ?$
8. $4x \times 5x = ?$
9. $5x \times 3x = ?$
10. $3x \times 2x = ?$

Divide algebraic terms

Dividing algebraic terms

DEFINITIONS

Quotient rule When dividing same-base powers, SUBTRACT the exponents.

KEY FORMULAS

- **Divide terms:** divide the numbers, SUBTRACT the exponents of like variables
- **Example:** $12x^5 \div 4x^2 = 3x^3$ (because $12 \div 4 = 3$ and $5 - 2 = 3$)
- **Watch:** $x^0 = 1$, so $6x^2 \div 6x^2 = 1$, not zero

WORKED EXAMPLES**Example 1: Simplify $6x^3 \div 2x$.**

► Divide the numbers: $6 \div 2 = 3$.

Coefficients.

► Subtract the x-exponents: $x^{3-1} = x^2$.

Quotient rule.

► $6x^3 \div 2x = 3x^2$.

Combine.

Example 2: Simplify $10x^4 \div 5x$.

► $10 \div 5 = 2$.

Coefficients.

► $x^{4-1} = x^3$.

Subtract exponents.

► $2x^3$.

Done.

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**EXERCISES (EASY → DIFFICULT)**

1. $9x^3 \div 3x = ?$
2. $6x^3 \div 2x = ?$
3. $20x^3 \div 5x = ?$
4. $10x^3 \div 5x = ?$
5. $8x^3 \div 2x = ?$
6. $12x^3 \div 3x = ?$
7. $4x^3 \div 2x = ?$
8. $6x^3 \div 3x = ?$
9. $16x^3 \div 4x = ?$
10. $12x^3 \div 4x = ?$

Substitute into expressions

Substituting values

DEFINITIONS

Substitute	Replace a letter (variable) with a given number, then calculate.
BODMAS	Order of operations: Brackets, Orders (powers), Division, Multiplication, Addition, Subtraction.

KEY FORMULAS

- **Steps:** (1) replace each variable with its value, (2) apply BODMAS, (3) calculate
- **Tip:** use brackets around substituted values, especially for negatives
- **Watch:** x^2 means x times x , NOT 2 times x

WORKED EXAMPLES**Example 1: If $x = 4$, find $x^2 + 3x$.**

- Substitute $x = 4$ into both terms.

Replace x with 4.

- $x^2 = 4^2 = 16$.

Square first.

- $3x = 3 \times 4 = 12$.

Multiply.

- Sum: $16 + 12 = 28$.

Add.

Example 2: If $x = 5$, find $x^2 + 2x$.

- $x^2 = 25$.

Square first.

- $2x = 10$.

Multiply.

- $25 + 10 = 35$.

Add.

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**EXERCISES (EASY → DIFFICULT)**

1. If $x=8$, value of $x^2 + 3x$:
2. If $x=2$, value of $x^2 + 3x$:
3. If $x=5$, value of $x^2 + 3x$:
4. If $x=6$, value of $x^2 + 3x$:
5. If $x=4$, value of $x^2 + 3x$:
6. If $x=3$, value of $x^2 + 3x$:
7. If $x=7$, value of $x^2 + 3x$:

End of Chapter 5 — Mixed Exercise

Ten questions across the whole chapter, from easy to difficult.

1. $4x + 4y + 3x = ?$
2. $3(x - 2) = ?$
3. $3x \times 5x = ?$
4. $10x^3 \div 5x = ?$
5. If $x=4$, value of $x^2 + 3x$:
6. $5x + 4y + 5x = ?$
7. $4(x - 3) = ?$
8. $4x \times 5x = ?$
9. $16x^3 \div 4x = ?$
10. If $x=7$, value of $x^2 + 3x$:

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CHAPTER 6

Linear Equations

Solve Solving linear equations

Equations Equations with brackets

Equations: Equations with variable on both sides

Word Word problems with equations

Solve linear equations

Solving linear equations

DEFINITIONS

Equation	A maths sentence with an equals sign. Both sides must always balance.
Solve	Find the value of the unknown letter that makes the equation true.
Inverse operation	The opposite operation. $+/ -$ are inverses; $\times / \div$ are inverses.

KEY FORMULAS

- **Golden rule:** whatever you do to one side, do to the other
- **Strategy:** isolate x using inverse operations
- **Order:** undo $+$ or $-$ first, then $\times$ or $\div$

WORKED EXAMPLES

Example 1: Solve $3x + 4 = 19$.

- Subtract 4 from both sides: $3x = 15$.

Inverse of $+4$.

- Divide both sides by 3: $x = 5$.

Inverse of $\times 3$.

- **$x = 5$.**

Check: $3(5) + 4 = 19$.



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**Example 2: Solve $2x + 7 = 13$.**

► Subtract 7: $2x = 6$.

Undo +7.

► Divide by 2: $x = 3$.

Undo $\times 2$.

► **$x = 3$.**

Check: $2(3) + 7 = 13$.

EXERCISES (EASY → DIFFICULT)

1. Solve $2x + 1 = 15$:
2. Solve $2x + 2 = 10$:
3. Solve $3x + 2 = 32$:
4. Solve $2x + 8 = 12$:
5. Solve $3x + 2 = 26$:
6. Solve $3x + 5 = 38$:
7. Solve $3x + 7 = 43$:
8. Solve $2x + 3 = 13$:
9. Solve $3x + 4 = 13$:
10. Solve $4x + 9 = 25$:

Equations with brackets

DEFINITIONS**Expand**

Remove brackets using the distributive property.

KEY FORMULAS

- **Step 1:** expand brackets — multiply outside number by each term inside
- **Step 2:** simplify each side
- **Step 3:** solve as a normal linear equation

WORKED EXAMPLES**Example 1: Solve $3(x + 2) = 18$.**

► Expand: $3x + 6 = 18$.

Distribute the 3.

► Subtract 6: $3x = 12$.

Inverse of +6.

► Divide by 3: $x = 4$.

Inverse of $\times 3$.

► **$x = 4$.**

Check: $3(4+2) = 18$.

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**Example 2: Solve $2(x + 5) = 16$.**

► Expand: $2x + 10 = 16$.

Distribute.

► $2x = 6$.

Subtract 10.

► $x = 3$.

Divide by 2.

EXERCISES (EASY → DIFFICULT)

1. Solve $3(x + 4) = 30$:
2. Solve $3(x + 5) = 21$:
3. Solve $4(x + 5) = 44$:
4. Solve $3(x + 5) = 33$:
5. Solve $3(x + 4) = 33$:
6. Solve $2(x + 5) = 22$:
7. Solve $3(x + 4) = 21$:
8. Solve $3(x + 1) = 12$:
9. Solve $4(x + 3) = 36$:
10. Solve $2(x + 4) = 22$:

Equations: variable on both sides

Equations with variable on both sides

DEFINITIONS**Variable on both sides**

When the unknown (x) appears on both the left and right of the equals sign.

KEY FORMULAS

- **Strategy:** move all x -terms to ONE side (usually subtract the smaller from both sides)
- **Then:** move all numbers to the OTHER side
- **Finally:** divide to find x

WORKED EXAMPLES**Example 1: Solve $5x = 2x + 15$.**

► Subtract $2x$ from both sides.

Move x -terms to the left.

► $5x - 2x = 15 \rightarrow 3x = 15$.

Combine.

► Divide by 3: $x = 5$.

Check: $5(5) = 25 = 2(5) + 15$.

Example 2: Solve $4x = x + 12$.

► Subtract x from both sides: $3x = 12$.

Move x -terms.

► $x = 4$.

Divide by 3.

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**EXERCISES (EASY → DIFFICULT)**

1. Solve $5x = 4x + 3$:
2. Solve $5x = 3x + 6$:
3. Solve $5x = 2x + 12$:
4. Solve $4x = 1x + 21$:
5. Solve $5x = 1x + 8$:
6. Solve $4x = 4x + 0$:
7. Solve $4x = 3x + 4$:
8. Solve $5x = 4x + 4$:
9. Solve $6x = 3x + 15$:
10. Solve $4x = 1x + 12$:

Word problems → equations

Word problems with equations

DEFINITIONS**Translate**

Turn words into a maths equation. "Twice a number" → $2n$; "plus 3" → $+3$.

Let n be...

A common way to start: define what your variable means.

KEY FORMULAS

- **Translation hints:**
- **Sum / total / plus:** $+$ (addition)
- **Difference / less than:** $-$ (subtraction)
- **Twice / double:** $\times 2$
- **Of (with fractions or %):** $\times$ (multiplication)

WORKED EXAMPLES**Example 1: Twice a number plus 3 equals 17. Find the number.**

- Let n = the number.

Define variable.

- Translate: $2n + 3 = 17$.

Twice n plus 3.

- Subtract 3: $2n = 14$.

Solve.

- Divide by 2: **$n = 7$** .

Check: $2(7) + 3 = 17$.

Example 2: Three times a number minus 4 equals 11. Find n .

- $3n - 4 = 11$.

Translate.

- $3n = 15$.

Add 4.

- **$n = 5$** .

Divide by 3.

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**EXERCISES (EASY → DIFFICULT)**

1. Twice a number plus 3 = 25. Find it.
2. Twice a number plus 3 = 17. Find it.
3. Twice a number plus 3 = 15. Find it.
4. Twice a number plus 3 = 19. Find it.
5. Twice a number plus 3 = 27. Find it.
6. Twice a number plus 3 = 21. Find it.
7. Twice a number plus 3 = 29. Find it.
8. Twice a number plus 3 = 33. Find it.
9. Twice a number plus 3 = 31. Find it.
10. Twice a number plus 3 = 23. Find it.

End of Chapter 6 — Mixed Exercise

Ten questions across the whole chapter, from easy to difficult.

1. Solve $2x + 1 = 15$:
2. Solve $3(x + 5) = 21$:
3. Solve $5x = 2x + 12$:
4. Twice a number plus 3 = 19. Find it.
5. Solve $3x + 2 = 26$:
6. Solve $2(x + 5) = 22$:
7. Solve $4x = 3x + 4$:
8. Twice a number plus 3 = 33. Find it.
9. Solve $3x + 4 = 13$:
10. Solve $2(x + 4) = 22$:

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CHAPTER 7

Functions and Graphs

Cartesian The Cartesian plane

Linear Direct proportion: $y = mx$

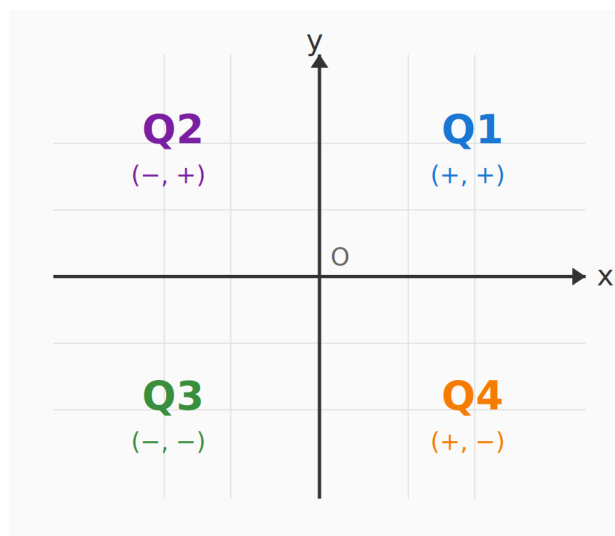
Linear Linear function: $y = mx + c$

Find Finding the gradient

Find Finding the y-intercept

Cartesian plane

The Cartesian plane



DEFINITIONS

Cartesian plane A flat surface with an x-axis (horizontal) and y-axis (vertical), used to plot points.

Quadrant One of four regions of the plane, divided by the axes. Numbered 1-4 anticlockwise from top-right.

Ordered pair (x, y) Two numbers showing a point's position: x first (horizontal), y second (vertical).



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KEY FORMULAS

- **Quadrant 1:** x positive (+), y positive (+) — top right
- **Quadrant 2:** x negative (–), y positive (+) — top left
- **Quadrant 3:** x negative (–), y negative (–) — bottom left
- **Quadrant 4:** x positive (+), y negative (–) — bottom right

WORKED EXAMPLES

Example 1: Which quadrant is (3, 4) in?

- ▶ Check signs: $x = +3$ (positive), $y = +4$ (positive).

Both positive.

- ▶ Both positive → Quadrant 1.

Top right.

- ▶ **Quadrant 1.**

Done.

Example 2: Which quadrant is (–2, 3) in?

- ▶ $x = -2$ (negative), $y = +3$ (positive).

Check signs.

- ▶ Negative x, positive y → Quadrant 2.

Top left.

- ▶ **Quadrant 2.**

Done.

EXERCISES (EASY → DIFFICULT)

1. $(-2, -3)$ is in quadrant:
2. $(4, -1)$ is in quadrant:
3. $(3, -1)$ is in quadrant:
4. $(1, -1)$ is in quadrant:
5. $(-3, 2)$ is in quadrant:
6. $(-1, 1)$ is in quadrant:
7. $(5, 1)$ is in quadrant:
8. $(5, -4)$ is in quadrant:
9. $(2, 3)$ is in quadrant:
10. $(-3, -1)$ is in quadrant:



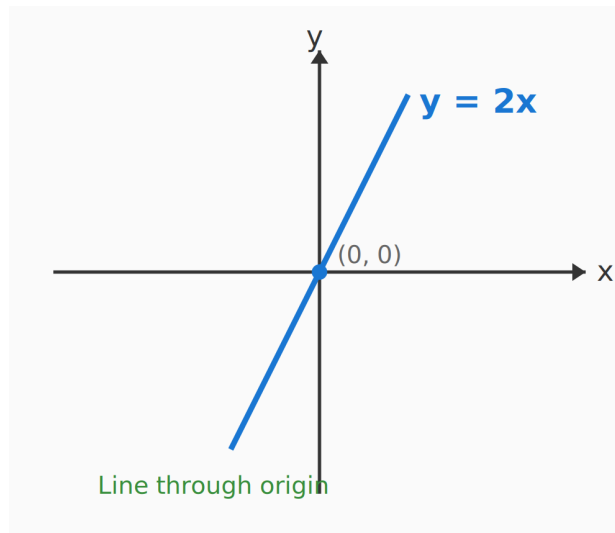
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Linear function: $y = mx$

Direct proportion: $y = mx$



DEFINITIONS

Direct proportion

When y is directly proportional to x . The graph passes through the origin $(0, 0)$.

Constant of proportionality (m)

The fixed number m in $y = mx$. Tells you how fast y grows with x .

KEY FORMULAS

- **Direct proportion:** $y = mx$
- **Always passes through origin:** when $x = 0$, $y = 0$
- **To find y :** substitute the x -value and multiply by m

WORKED EXAMPLES

Example 1: $y = 3x$. Find y when $x = 4$.

► Substitute $x = 4$.

Replace x .

► $y = 3 \times 4 = 12$.

Multiply.

Example 2: $y = 5x$. Find y when $x = 3$.

► $y = 5 \times 3$.

Substitute.

► $y = 15$.

Multiply.

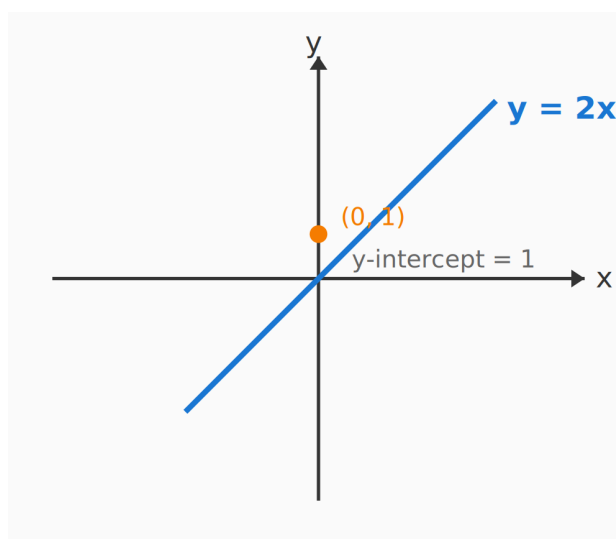
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EXERCISES (EASY → DIFFICULT)

1. $y = 4x$. y when $x = 2$:
2. $y = 3x$. y when $x = 5$:
3. $y = 2x$. y when $x = 2$:
4. $y = 4x$. y when $x = 3$:
5. $y = 5x$. y when $x = 5$:
6. $y = 4x$. y when $x = 1$:
7. $y = 5x$. y when $x = 3$:
8. $y = 4x$. y when $x = 5$:
9. $y = 3x$. y when $x = 2$:
10. $y = 5x$. y when $x = 2$:

Linear function: $y = mx + c$



DEFINITIONS

- | | |
|------------------------|---|
| Linear function | A function whose graph is a straight line. Form: $y = mx + c$. |
| Gradient (m) | How steep the line is — the change in y for every 1 increase in x . |
| Y-intercept (c) | The y -value where the line crosses the y -axis (when $x = 0$). |

KEY FORMULAS

- **Standard form:** $y = mx + c$
- **To find y :** substitute the value of x , multiply by m , then add c
- **When $x = 0$:** $y = c$ (the y -intercept)

WORKED EXAMPLES



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**Example 1: $y = 3x + 2$. Find y when $x = 4$.**

► Substitute $x = 4$.

Replace x .

► $y = 3(4) + 2 = 12 + 2$.

Multiply first, then add.

► **$y = 14$.**

Done.

Example 2: $y = 2x - 5$. Find y when $x = 3$.

► $y = 2(3) - 5 = 6 - 5$.

Substitute.

► **$y = 1$.**

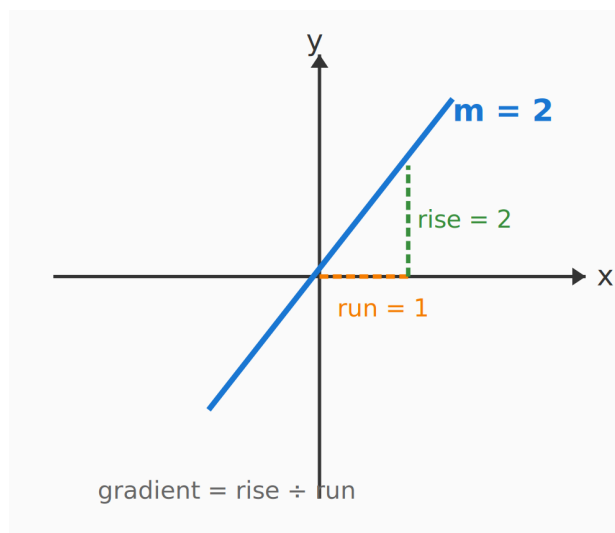
Calculate.

EXERCISES (EASY → DIFFICULT)

1. $y = 2x + 2$. y when $x = 5$:
2. $y = 4x + 1$. y when $x = 4$:
3. $y = 4x + 3$. y when $x = 1$:
4. $y = 3x + 1$. y when $x = 5$:
5. $y = 2x + 5$. y when $x = 2$:
6. $y = 2x + 8$. y when $x = 2$:
7. $y = 3x + 2$. y when $x = 2$:
8. $y = 3x + 4$. y when $x = 3$:
9. $y = 2x + 5$. y when $x = 1$:
10. $y = 4x + 1$. y when $x = 5$:

Find gradient

Finding the gradient

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DEFINITIONS

Gradient

The slope of a line. Positive = uphill, negative = downhill, zero = flat.

KEY FORMULAS

- From $y = mx + c$: the coefficient of x is the gradient
- In $y = 3x + 5$: gradient = 3
- In $y = -2x + 7$: gradient = -2 (downhill line)

WORKED EXAMPLES

Example 1: Find the gradient of $y = 4x + 7$.

- Compare with $y = mx + c$.

Match the form.

- The number in front of x is the gradient.

Gradient = m .

- **Gradient = 4.**

Direct read.

Example 2: Gradient of $y = -3x + 2$?

- Coefficient of x : -3 .

Read directly.

- **Gradient = -3 .**

Negative — downhill.

EXERCISES (EASY → DIFFICULT)

1. Gradient of $y = 2x + 3$:
2. Gradient of $y = 4x + 3$:
3. Gradient of $y = 5x + 3$:
4. Gradient of $y = 3x + 3$:



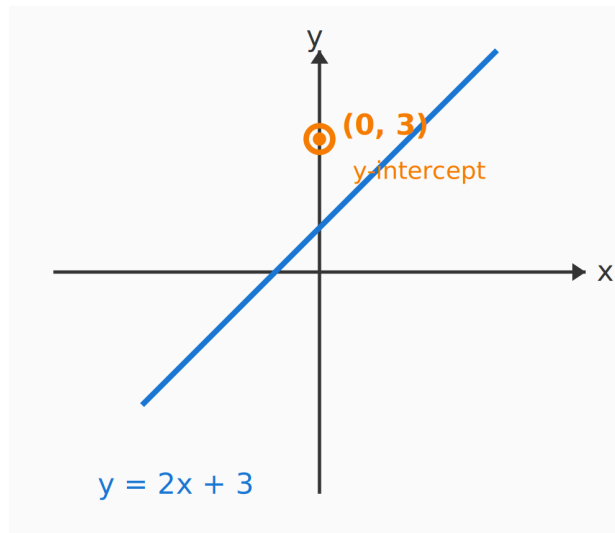
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Find y-intercept

Finding the y-intercept



DEFINITIONS

Y-intercept The y-value where the line crosses the y-axis (when $x = 0$).

KEY FORMULAS

- From $y = mx + c$: the constant term c IS the y-intercept
- In $y = 3x + 5$: y-intercept = 5 (line crosses y-axis at $(0, 5)$)
- To verify: substitute $x = 0$ and you get $y = c$

WORKED EXAMPLES

Example 1: Find the y-intercept of $y = 4x + 7$.

- Compare with $y = mx + c$.

Match.

- The constant term is the y-intercept.

Y-intercept = c .

- **Y-intercept = 7.**

Read off.

Example 2: Y-intercept of $y = 2x - 5$?

- Constant term: -5 .

Read directly.

- **Y-intercept = -5 .**

Line crosses y-axis at $(0, -5)$.

EXERCISES (EASY → DIFFICULT)

1. y-intercept of $y = 2x + 3$:
2. y-intercept of $y = 3x + 4$:
3. y-intercept of $y = 4x + 9$:
4. y-intercept of $y = 2x + 9$:
5. y-intercept of $y = 5x + 7$:



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6. y-intercept of $y = 2x + 1$:
7. y-intercept of $y = 5x + 9$:
8. y-intercept of $y = 3x + 7$:
9. y-intercept of $y = 4x + 2$:
10. y-intercept of $y = 5x + 2$:

End of Chapter 7 — Mixed Exercise

Ten questions across the whole chapter, from easy to difficult.

1. $(-2, -3)$ is in quadrant:
2. $y = 3x$. y when $x = 5$:
3. $y = 4x + 3$. y when $x = 1$:
4. Gradient of $y = 3x + 3$:
5. y-intercept of $y = 5x + 7$:
6. $(-1, 1)$ is in quadrant:
7. $y = 5x$. y when $x = 3$:
8. $y = 3x + 4$. y when $x = 3$:
9. Gradient of $y = 2x + 3$:
10. y-intercept of $y = 5x + 2$:



CHAPTER 8

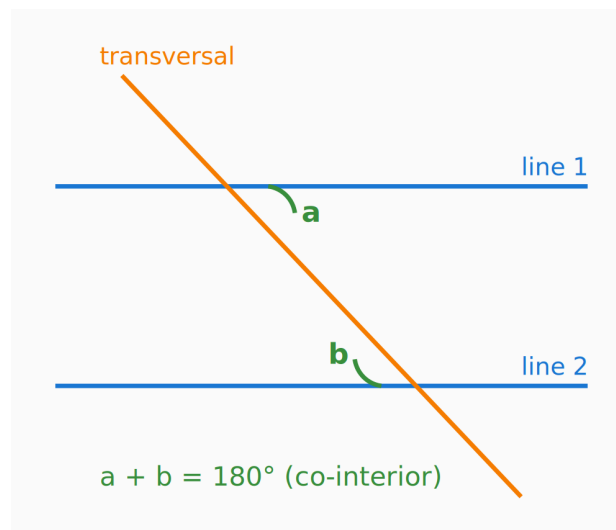
Lines and Angles

Parallel Parallel lines and transversals

Triangle Triangle angle sum

Exterior Exterior angle of a triangle

Parallel lines and transversals



DEFINITIONS

Parallel lines	Two lines that never meet — they stay the same distance apart.
Transversal	A line that crosses two parallel lines.
Co-interior angles	Angles on the SAME SIDE of the transversal, BETWEEN the parallel lines. They add to 180°.
Corresponding angles	Angles in matching positions where the transversal meets each parallel line. They are EQUAL.

KEY FORMULAS

- **Co-interior angles add to 180°** (same side of transversal, between lines)
- **Corresponding angles are equal** (same position at each crossing)
- **Alternate angles are equal** (Z-shape between lines)
- **Vertically opposite angles are equal** (across an X)



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WORKED EXAMPLES

Example 1: One co-interior angle is 70° . Find the other.

- Co-interior angles add to 180° .

Property of parallel lines.

- Other = $180^\circ - 70^\circ$.

Subtract.

- = **110°** .

Done.

Example 2: A co-interior angle is 135° . Find the other.

- $180^\circ - 135^\circ = 45^\circ$.

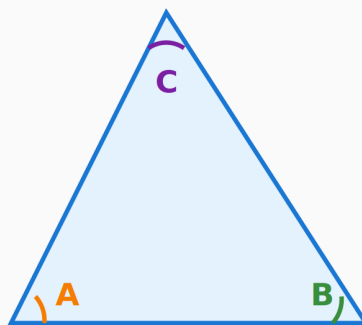
Co-interior sum.

- **45°** .

Done.

EXERCISES (EASY → DIFFICULT)

1. Co-interior of 63° (parallel lines):
2. Co-interior of 81° (parallel lines):
3. Co-interior of 84° (parallel lines):
4. Co-interior of 50° (parallel lines):
5. Co-interior of 140° (parallel lines):
6. Co-interior of 105° (parallel lines):
7. Co-interior of 59° (parallel lines):
8. Co-interior of 78° (parallel lines):
9. Co-interior of 58° (parallel lines):
10. Co-interior of 57° (parallel lines):

Triangle angle sum

$$A + B + C = 180^\circ$$

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DEFINITIONS

Interior angle An angle INSIDE a shape, between two sides.

Triangle angle sum The three interior angles of ANY triangle always add to 180° .

KEY FORMULAS

- **Triangle rule:** angle A + angle B + angle C = 180°
- **To find a missing angle:** $180^\circ - (\text{sum of the other two})$
- **Equilateral:** all angles 60° ($60 + 60 + 60 = 180$)
- **Right-angled:** one angle is 90° , so the other two sum to 90°

WORKED EXAMPLES

Example 1: Two angles of a triangle are 50° and 60° . Find the third.

► Sum of all three = 180° .

Triangle rule.

► Known: $50^\circ + 60^\circ = 110^\circ$.

Add given angles.

► Third: $180^\circ - 110^\circ$.

Subtract from 180.

► = **70°** .

Done.

Example 2: Two angles are 45° and 75° . Third?

► $45 + 75 = 120$.

Add given.

► $180 - 120 = \mathbf{60^\circ}$.

Subtract.

EXERCISES (EASY → DIFFICULT)

1. Two angles 64° , 48° . Third?
2. Two angles 63° , 33° . Third?
3. Two angles 72° , 68° . Third?
4. Two angles 74° , 72° . Third?
5. Two angles 55° , 41° . Third?
6. Two angles 68° , 70° . Third?
7. Two angles 73° , 55° . Third?
8. Two angles 49° , 71° . Third?
9. Two angles 47° , 58° . Third?
10. Two angles 67° , 56° . Third?



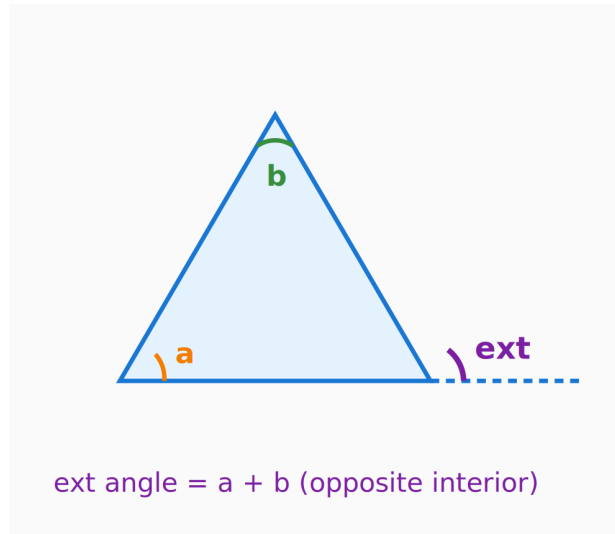
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Exterior angle of triangle

Exterior angle of a triangle



DEFINITIONS

Exterior angle The angle OUTSIDE a triangle, formed by extending one side.

Exterior angle theorem The exterior angle equals the SUM of the two opposite interior angles.

KEY FORMULAS

- **Exterior angle theorem:** exterior angle = sum of the two NON-ADJACENT interior angles
- **Also:** exterior angle + adjacent interior angle = 180° (straight line)

WORKED EXAMPLES

Example 1: Triangle with interior angles 60° and 70° . Find the exterior angle at the third vertex.

- Exterior angle = sum of two opposite interior angles.

Theorem.

- $= 60^\circ + 70^\circ$.

Add given angles.

- **$= 130^\circ$.**

Done.

Example 2: Interior angles 50° and 80° . Exterior at third vertex?

- $50 + 80 = 130^\circ$.

Exterior = sum.

EXERCISES (EASY → DIFFICULT)

1. Interior angles 49° , 68° . Exterior at third vertex:
2. Interior angles 51° , 62° . Exterior at third vertex:
3. Interior angles 63° , 64° . Exterior at third vertex:
4. Interior angles 44° , 80° . Exterior at third vertex:
5. Interior angles 45° , 77° . Exterior at third vertex:



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6. Interior angles 46° , 74° . Exterior at third vertex:
7. Interior angles 43° , 50° . Exterior at third vertex:
8. Interior angles 43° , 57° . Exterior at third vertex:
9. Interior angles 50° , 61° . Exterior at third vertex:
10. Interior angles 56° , 75° . Exterior at third vertex:

End of Chapter 8 — Mixed Exercise

Ten questions across the whole chapter, from easy to difficult.

1. Co-interior of 63° (parallel lines):
2. Two angles 63° , 33° . Third?
3. Interior angles 63° , 64° . Exterior at third vertex:
4. Co-interior of 50° (parallel lines):
5. Two angles 55° , 41° . Third?
6. Interior angles 46° , 74° . Exterior at third vertex:
7. Co-interior of 59° (parallel lines):
8. Two angles 49° , 71° . Third?
9. Interior angles 50° , 61° . Exterior at third vertex:
10. Co-interior of 57° (parallel lines):



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CHAPTER 9

Triangles, Quadrilaterals, Polygons

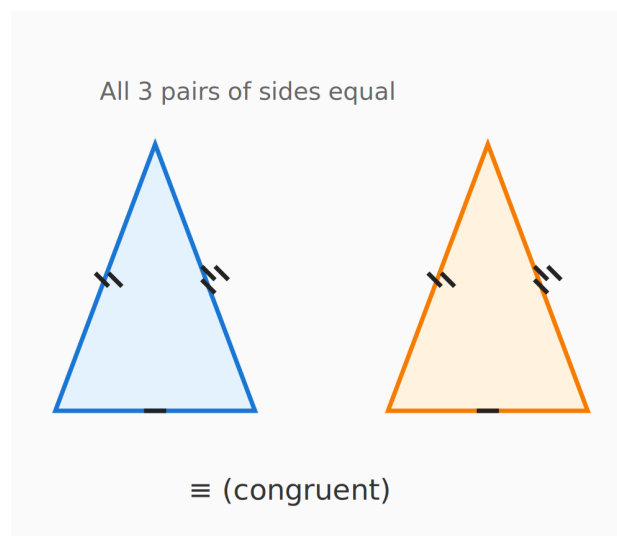
Congruent Congruent triangles

Similar Similar triangles

Sum Sum of interior angles

Each Each angle of a regular polygon

Congruent triangles



DEFINITIONS

Congruent Exactly the same size and shape — one fits perfectly on the other.

Congruency test A rule that proves two triangles are identical without measuring everything.

KEY FORMULAS

- **SSS** — Side-Side-Side: all three pairs of sides equal
- **SAS** — Side-Angle-Side: two sides and the angle between them equal
- **AAS** — Angle-Angle-Side: two angles and a corresponding side equal
- **RHS** — Right angle, Hypotenuse, Side (right triangles only)



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WORKED EXAMPLES

Example 1: Two triangles have all three corresponding sides equal. They are...

- ▶ All three sides match.

SSS test.

- ▶ Same size and shape.

Congruent definition.

- ▶ **Congruent.**

Final answer.

Example 2: What test proves congruency when two sides and the included angle match?

- ▶ Two sides + angle between them.

Identify the test.

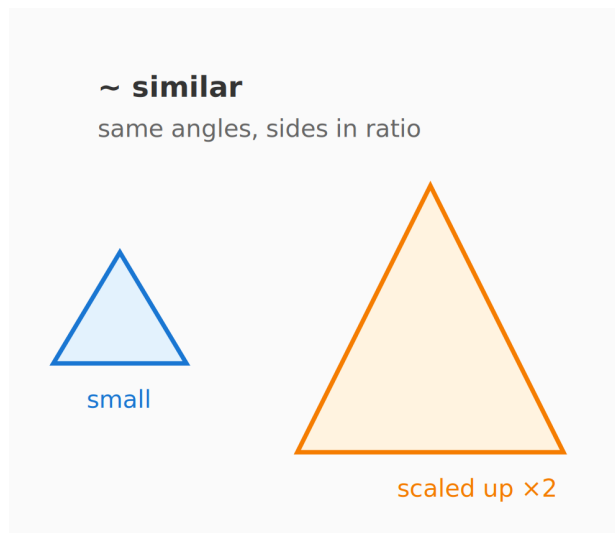
- ▶ **SAS.**

Side-Angle-Side.

EXERCISES (EASY → DIFFICULT)

- Two triangles with all 3 sides equal are:

Similar triangles



DEFINITIONS

Similar triangles

Same SHAPE but different SIZE. All angles equal; sides in the same ratio.

Scale factor

The number you multiply the small triangle's sides by to get the big triangle's sides.

KEY FORMULAS

- **If similar:** all corresponding angles are equal AND all sides are in the same ratio
- **Scale factor:** $\text{big} \div \text{small}$
- **Note:** congruent = same shape AND same size. Similar = same shape only.



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WORKED EXAMPLES

Example 1: Two triangles with the same shape but different sizes are...

- ▶ Same shape (same angles), different size.

Sides are scaled.

- ▶ Definition of similar.

Apply definition.

- ▶ **Similar.**

Final answer.

Example 2: Scale factor 3. Small side 5. Big side?

- ▶ Big = small $\times$ scale.

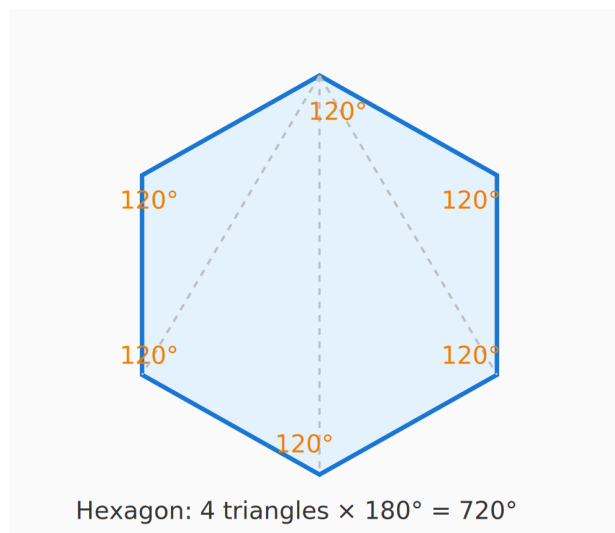
Definition.

- ▶ $5 \times 3 = 15$.

Multiply.

EXERCISES (EASY $\rightarrow$ DIFFICULT)

1. Triangles with the same shape but different sizes are:

Sum of interior angles of polygon

DEFINITIONS

Polygon	A closed shape with straight sides. Triangle is a 3-gon, square is a 4-gon, etc.
Interior angle	An angle inside the polygon, between two sides.

KEY FORMULAS

- **Sum of interior angles:** $(n - 2) \times 180^\circ$
- **n = number of sides**
- **Triangle (n=3):** 180°
- **Quadrilateral (n=4):** 360°
- **Pentagon (n=5):** 540°
- **Hexagon (n=6):** 720°



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WORKED EXAMPLES

Example 1: Sum of interior angles of a hexagon (6 sides)?

► Apply $(n - 2) \times 180^\circ$.

$n = 6$.

► $(6 - 2) \times 180 = 4 \times 180$.

Subtract first.

► **$= 720^\circ$.**

Multiply.

Example 2: Sum of interior angles of a pentagon (5 sides)?

► $(5 - 2) \times 180 = 3 \times 180$.

Apply formula.

► **$= 540^\circ$.**

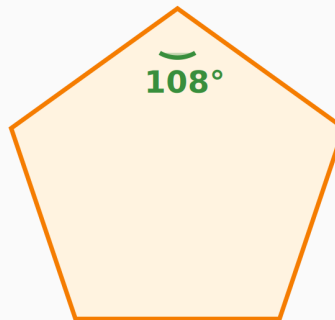
Calculate.

EXERCISES (EASY → DIFFICULT)

1. Sum of interior angles of a 8-sided polygon:
2. Sum of interior angles of a 3-sided polygon:
3. Sum of interior angles of a 5-sided polygon:
4. Sum of interior angles of a 6-sided polygon:
5. Sum of interior angles of a 4-sided polygon:
6. Sum of interior angles of a 7-sided polygon:

Each interior angle of regular polygon

Each angle of a regular polygon



Regular pentagon: each angle $= 540^\circ \div 5$

DEFINITIONS**Regular polygon**

A polygon where ALL sides AND all angles are equal. E.g. equilateral triangle, square.

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KEY FORMULAS

- **Step 1:** sum of interior angles = $(n - 2) \times 180^\circ$
- **Step 2:** divide by n to find each angle
- **Quick formula:** each angle = $(n - 2) \times 180^\circ \div n$
- **Square ($n=4$):** $360 \div 4 = 90^\circ$ per angle

WORKED EXAMPLES

Example 1: Find each interior angle of a regular hexagon (6 sides).

► Sum = $(6 - 2) \times 180 = 720^\circ$.

Total interior angles.

► Divide by 6: $720 \div 6$.

Equal angles → divide.

► = **120° each.**

Done.

Example 2: Each angle of a regular pentagon?

► Sum = $(5 - 2) \times 180 = 540^\circ$.

Total.

► $540 \div 5 = \mathbf{108^\circ}$.

Each angle.

EXERCISES (EASY → DIFFICULT)

1. Each interior angle of regular 6-gon:
2. Each interior angle of regular 10-gon:
3. Each interior angle of regular 8-gon:
4. Each interior angle of regular 4-gon:
5. Each interior angle of regular 3-gon:
6. Each interior angle of regular 5-gon:

End of Chapter 9 — Mixed Exercise

Ten questions across the whole chapter, from easy to difficult.

1. Two triangles with all 3 sides equal are:
2. Triangles with the same shape but different sizes are:
3. Sum of interior angles of a 5-sided polygon:
4. Each interior angle of regular 4-gon:
5. Two triangles with all 3 sides equal are:
6. Triangles with the same shape but different sizes are:
7. Sum of interior angles of a 7-sided polygon:
8. Each interior angle of regular 5-gon:
9. Two triangles with all 3 sides equal are:
10. Triangles with the same shape but different sizes are:

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CHAPTER 10

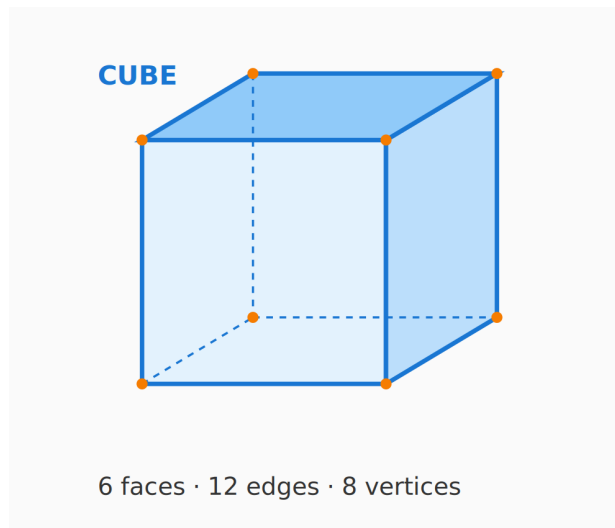
3D Objects

Faces, Faces, edges, vertices of 3D shapes

Nets Nets of 3D shapes

Faces, edges, vertices

Faces, edges, vertices of 3D shapes



DEFINITIONS

Face	A flat surface of a 3D shape. A cube has 6 faces.
Edge	A line where two faces meet. A cube has 12 edges.
Vertex (plural: vertices)	A corner point where edges meet. A cube has 8 vertices.
Euler's formula	For any convex polyhedron: $F + V - E = 2$.

KEY FORMULAS

- **Cube / Cuboid:** 6 faces, 12 edges, 8 vertices
- **Triangular prism:** 5 faces, 9 edges, 6 vertices
- **Square pyramid:** 5 faces, 8 edges, 5 vertices
- **Tetrahedron:** 4 faces, 6 edges, 4 vertices



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WORKED EXAMPLES

Example 1: How many vertices does a cube have?

- ▶ A cube has corners where 3 edges meet.

Count the corners.

- ▶ Count: 4 on top + 4 on bottom = 8.

Top and bottom layers.

- ▶ **8 vertices.**

Done.

Example 2: How many edges does a triangular prism have?

- ▶ Two triangular ends: $3 + 3 = 6$ edges.

Top and bottom triangles.

- ▶ Plus 3 vertical edges connecting them.

Sides.

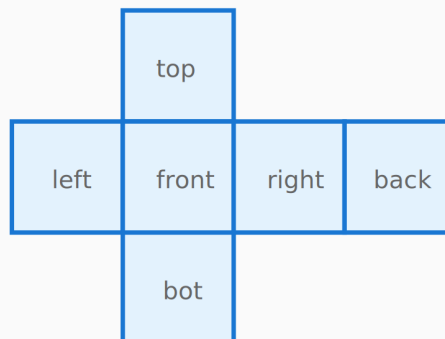
- ▶ **Total: 9 edges.**

Done.

EXERCISES (EASY → DIFFICULT)

1. Vertices of a triangular prism:
2. Vertices of a cube:
3. Vertices of a cuboid:
4. Vertices of a square pyramid:

Nets of 3D shapes



Net of a cube: 6 squares (= 6 faces)

DEFINITIONS

Net

A 2D pattern that can be folded up to form a 3D shape. Like opening up a cardboard box flat.



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KEY FORMULAS

- **Cube net:** 6 squares, arranged so they fold into a cube (e.g. cross shape)
- **Cuboid net:** 6 rectangles
- **Square pyramid net:** 1 square + 4 triangles
- **Triangular prism net:** 2 triangles + 3 rectangles

WORKED EXAMPLES

Example 1: How many squares does the net of a cube have?

- ▶ A cube has 6 flat faces.

Each face is a square.

- ▶ Each face becomes one square in the net.

One square per face.

- ▶ **6 squares.**

Done.

Example 2: How many rectangles in the net of a triangular prism?

- ▶ Triangular prism has 3 rectangular sides + 2 triangular ends.

Count faces.

- ▶ **3 rectangles** (plus 2 triangles).

Sides only.

EXERCISES (EASY → DIFFICULT)

1. How many squares in the net of a cube?

End of Chapter 10 — Mixed Exercise

Ten questions across the whole chapter, from easy to difficult.

1. Vertices of a triangular prism:
2. How many squares in the net of a cube?
3. Vertices of a cuboid:
4. How many squares in the net of a cube?
5. Vertices of a square pyramid:
6. How many squares in the net of a cube?
7. Vertices of a cube:
8. How many squares in the net of a cube?
9. Vertices of a cuboid:
10. How many squares in the net of a cube?

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CHAPTER 11

Pythagoras

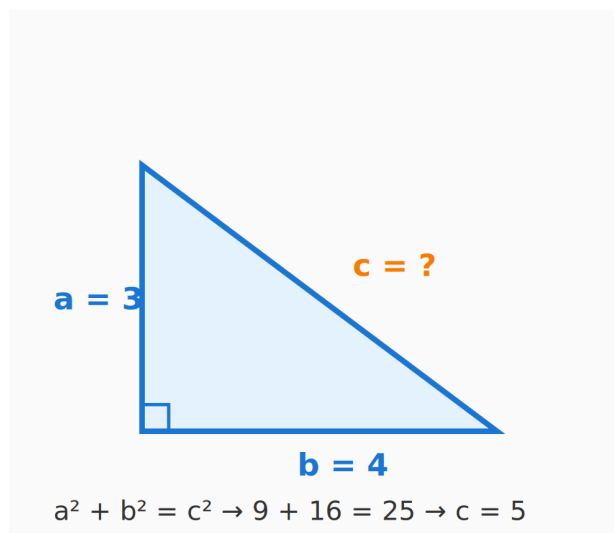
Pythagoras: Pythagoras — find the hypotenuse

Pythagoras: Pythagoras — find a missing leg

Verify Verifying a right triangle

Pythagoras: find hypotenuse

Pythagoras — find the hypotenuse



DEFINITIONS

Right-angled triangle

A triangle with one 90° angle.

Hypotenuse

The LONGEST side of a right triangle — always opposite the right angle.

Legs

The two SHORTER sides — they meet at the right angle.

KEY FORMULAS

- **Pythagoras' Theorem:** $a^2 + b^2 = c^2$
- **c = hypotenuse** (the longest side)
- **a, b = legs** (the two shorter sides)
- **To find c:** square each leg, add, then take the square root



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WORKED EXAMPLES

Example 1: Right triangle with legs 3 and 4. Find the hypotenuse.

- Apply $a^2 + b^2 = c^2$.

Pythagoras.

- $3^2 + 4^2 = 9 + 16 = 25$.

Square and add.

- $c = \sqrt{25} = 5$.

Square root. Classic 3-4-5.

Example 2: Legs 6 and 8. Hypotenuse?

- $6^2 + 8^2 = 36 + 64 = 100$.

Square and add.

- $c = \sqrt{100} = 10$.

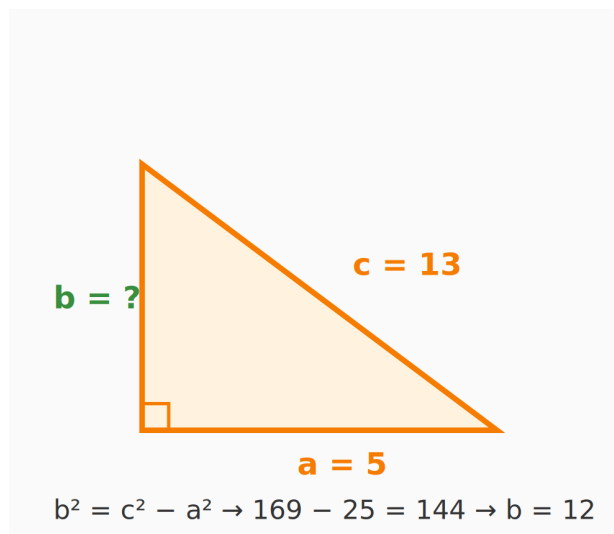
Square root.

EXERCISES (EASY → DIFFICULT)

1. Right triangle, sides 9 and 12. Hypotenuse?
2. Right triangle, sides 5 and 12. Hypotenuse?
3. Right triangle, sides 6 and 8. Hypotenuse?
4. Right triangle, sides 3 and 4. Hypotenuse?

Pythagoras: find leg

Pythagoras — find a missing leg

**DEFINITIONS****Leg**

One of the two shorter sides of a right triangle (not the hypotenuse).

KEY FORMULAS

- **From $a^2 + b^2 = c^2$:**
- **To find leg b:** $b^2 = c^2 - a^2 \rightarrow b = \sqrt{c^2 - a^2}$
- **Key idea:** SUBTRACT the known leg² from the hypotenuse²
- **Never:** the hypotenuse is always the LARGEST number

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WORKED EXAMPLES

Example 1: Hypotenuse 5, one leg 3. Find the other leg.

► Use $b^2 = c^2 - a^2$.

Rearrange Pythagoras.

► $= 5^2 - 3^2 = 25 - 9 = 16$.

Subtract.

► $b = \sqrt{16} = 4$.

Square root.

Example 2: Hypotenuse 13, one leg 5. Other leg?

► $b^2 = 169 - 25 = 144$.

Subtract squares.

► **$b = 12$.**

$\sqrt{144}$.

EXERCISES (EASY → DIFFICULT)

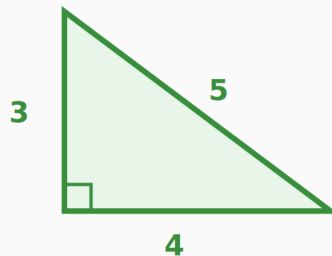
1. Hypotenuse 10, one leg 6. Other leg?
2. Hypotenuse 13, one leg 5. Other leg?
3. Hypotenuse 5, one leg 3. Other leg?

Verify right triangles

Verifying a right triangle

Test: $3^2 + 4^2 = 9 + 16 = 25$

$5^2 = 25$ ✓ right triangle



DEFINITIONS

Converse of Pythagoras

If $a^2 + b^2 = c^2$ holds, the triangle MUST be right-angled.

Pythagorean triple

Three whole numbers that satisfy $a^2 + b^2 = c^2$ (e.g. 3-4-5, 5-12-13).



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KEY FORMULAS

- **Test:** check if $(\text{shorter side})^2 + (\text{other shorter})^2 = (\text{longest})^2$
- **If yes:** it IS a right triangle
- **If no:** NOT a right triangle

WORKED EXAMPLES

Example 1: Is a triangle with sides 3, 4, 5 a right triangle?

- Longest side is 5. Square the two shorter sides.

Apply test.

- $3^2 + 4^2 = 9 + 16 = 25$.

Sum of squares.

- Compare with $5^2 = 25$. They MATCH .

Test holds.

- **Yes — right triangle.**

Confirmed.

Example 2: Is 5, 6, 9 a right triangle?

- $5^2 + 6^2 = 25 + 36 = 61$.

Sum.

- $9^2 = 81$. $61 \neq 81$.

Test fails.

- **No.**

Not right.

EXERCISES (EASY → DIFFICULT)

1. Is a triangle with sides 3, 4, 5 a right triangle?

End of Chapter 11 — Mixed Exercise

Ten questions across the whole chapter, from easy to difficult.

1. Right triangle, sides 9 and 12. Hypotenuse?
2. Hypotenuse 13, one leg 5. Other leg?
3. Is a triangle with sides 3, 4, 5 a right triangle?
4. Right triangle, sides 3 and 4. Hypotenuse?
5. Hypotenuse 5, one leg 3. Other leg?
6. Is a triangle with sides 3, 4, 5 a right triangle?
7. Right triangle, sides 5 and 12. Hypotenuse?
8. Hypotenuse 10, one leg 6. Other leg?
9. Is a triangle with sides 3, 4, 5 a right triangle?
10. Right triangle, sides 6 and 8. Hypotenuse?

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**CHAPTER 12**

Mensuration

Perimeter Perimeter of regular polygons

Area Area of a triangle

Area Area of a parallelogram

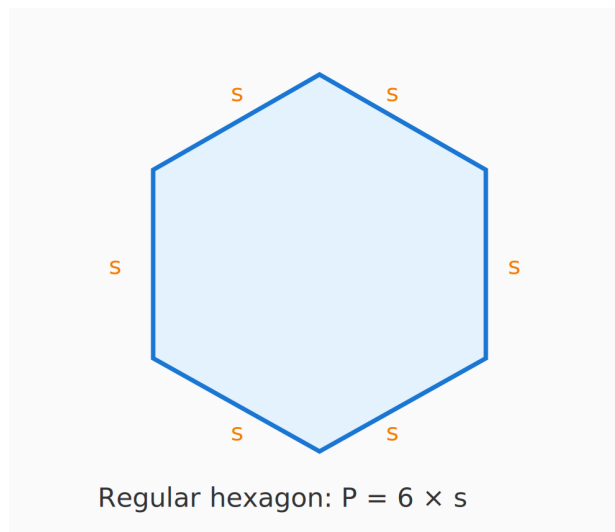
Area Area of a trapezium

Volume Volume of a cylinder

Surface Surface area of a rectangular prism

Perimeter of polygons

Perimeter of regular polygons



DEFINITIONS

Perimeter The total distance around the outside of a shape.

Regular polygon A polygon where all sides are equal in length.



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KEY FORMULAS

- **Regular polygon:** $P = n \times \text{side length}$
- **n = number of sides**
- **Example:** regular pentagon, side 4 cm $\rightarrow P = 5 \times 4 = 20$ cm
- **Irregular polygons:** just add all the sides up

WORKED EXAMPLES

Example 1: Perimeter of a regular hexagon with side 5.

► Apply $P = n \times \text{side}$.

$n = 6$ for hexagon.

► $P = 6 \times 5$.

Substitute.

► **= 30.**

Multiply.

Example 2: Regular pentagon, side 8. Perimeter?

► $P = 5 \times 8 = 40$.

$n \times \text{side}$.

EXERCISES (EASY $\rightarrow$ DIFFICULT)

1. Perimeter of regular 6-gon, side 4:
2. Perimeter of regular 4-gon, side 7:
3. Perimeter of regular 3-gon, side 4:
4. Perimeter of regular 4-gon, side 10:
5. Perimeter of regular 6-gon, side 10:
6. Perimeter of regular 3-gon, side 8:
7. Perimeter of regular 3-gon, side 7:
8. Perimeter of regular 5-gon, side 9:
9. Perimeter of regular 6-gon, side 9:
10. Perimeter of regular 6-gon, side 5:



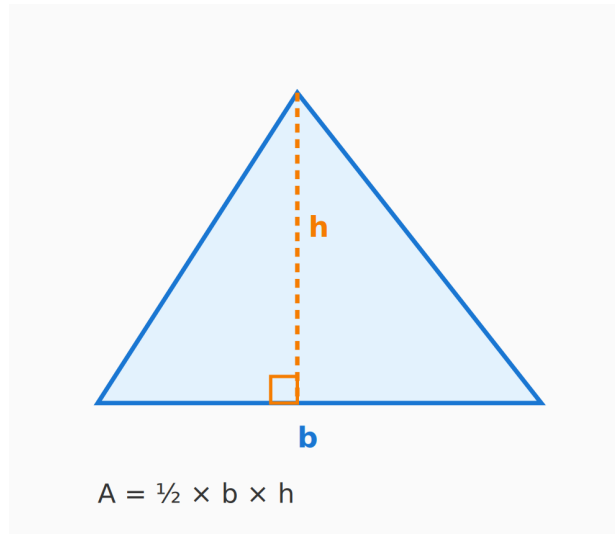
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Area of triangle

Area of a triangle



DEFINITIONS

Area	The space inside a shape, measured in square units (cm ² , m ²).
Base (b)	Any one side of the triangle, chosen as the bottom.
Height (h)	The PERPENDICULAR distance from the base to the opposite vertex.

KEY FORMULAS

- **Area of triangle:** $A = \frac{1}{2} \times \text{base} \times \text{height}$
- **Important:** height must be perpendicular to the base, not a slanted side
- **Units:** if base and height are in cm, area is in cm²

WORKED EXAMPLES

Example 1: Triangle base 8, height 5. Find the area.

- Apply $A = \frac{1}{2}bh$.
Triangle area formula.
- $A = \frac{1}{2} \times 8 \times 5$.
Substitute.
- $= \frac{1}{2} \times 40 = 20$.
Calculate.

Example 2: Base 6, height 4. Area?

- $A = \frac{1}{2} \times 6 \times 4 = 12$.
Apply formula.

EXERCISES (EASY → DIFFICULT)

1. Triangle base 10, height 6. Area:
2. Triangle base 4, height 10. Area:
3. Triangle base 4, height 7. Area:
4. Triangle base 4, height 6. Area:



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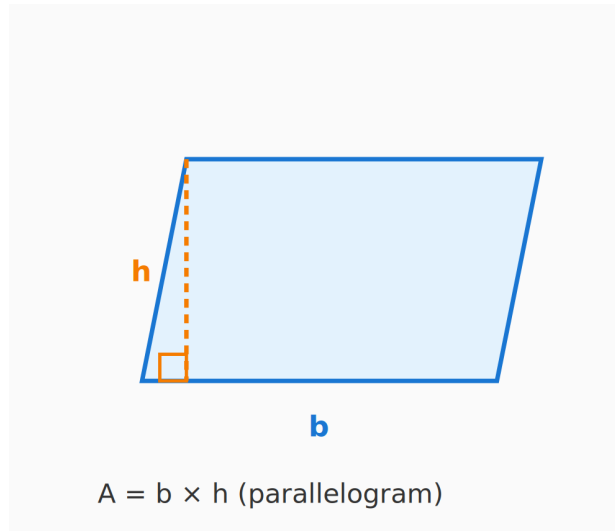
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5. Triangle base 12, height 9. Area:
6. Triangle base 12, height 3. Area:
7. Triangle base 4, height 3. Area:
8. Triangle base 8, height 6. Area:
9. Triangle base 8, height 10. Area:
10. Triangle base 6, height 9. Area:

Area of parallelogram

Area of a parallelogram



DEFINITIONS

Parallelogram A four-sided shape with two pairs of parallel sides.

KEY FORMULAS

- **Area of parallelogram:** $A = \text{base} \times \text{height}$
- **NO half:** unlike a triangle, just $b \times h$
- **Height:** must be perpendicular to the chosen base

WORKED EXAMPLES

Example 1: Parallelogram base 8, height 5. Area?

► Apply $A = bh$.

Parallelogram formula — no half.

► $A = 8 \times 5$.

Substitute.

► **= 40.**

Done.

Example 2: Base 7, height 4. Area?

► $A = 7 \times 4 = 28$.

Direct multiplication.



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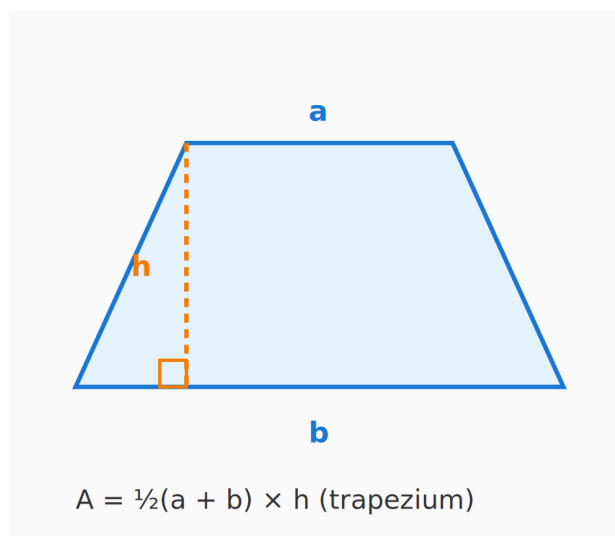
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**EXERCISES (EASY → DIFFICULT)**

1. Parallelogram base 6, height 9. Area:
2. Parallelogram base 12, height 5. Area:
3. Parallelogram base 6, height 8. Area:
4. Parallelogram base 5, height 10. Area:
5. Parallelogram base 11, height 7. Area:
6. Parallelogram base 5, height 5. Area:
7. Parallelogram base 4, height 7. Area:
8. Parallelogram base 8, height 5. Area:
9. Parallelogram base 11, height 10. Area:
10. Parallelogram base 7, height 3. Area:

Area of trapezium

Area of a trapezium

**DEFINITIONS**

Trapezium	A four-sided shape with ONE pair of parallel sides.
Parallel sides	The two sides that are parallel to each other — usually called a and b.

KEY FORMULAS

- **Area of trapezium:** $A = \frac{1}{2}(a + b) \times h$
- **a and b** = the two parallel sides
- **h** = perpendicular distance between them
- **Memory:** half the SUM of the parallel sides, times height

WORKED EXAMPLES**DIGITAL TEXTBOOK**

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**Example 1: Trapezium with parallel sides 6 and 8, height 4. Find area.**

► Apply $A = \frac{1}{2}(a + b)h$.

Trapezium formula.

► $A = \frac{1}{2} \times (6 + 8) \times 4 = \frac{1}{2} \times 14 \times 4$.

Substitute.

► $= \frac{1}{2} \times 56 = 28$.

Calculate.

Example 2: Parallel sides 4 and 6, height 5. Area?

► $A = \frac{1}{2}(4 + 6) \times 5 = \frac{1}{2} \times 10 \times 5$.

Apply formula.

► $= 25$.

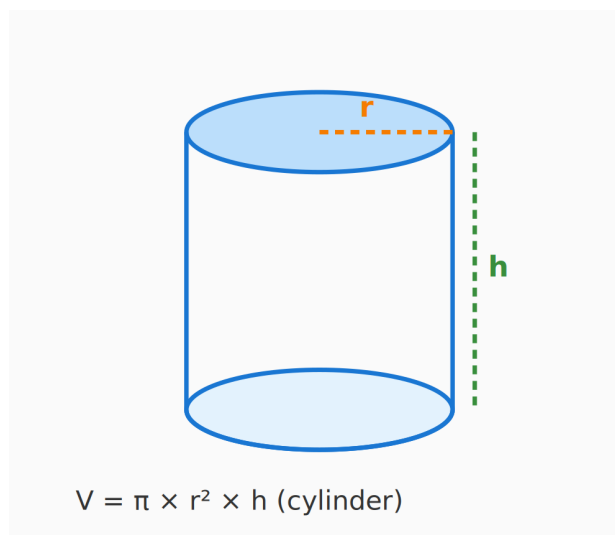
Calculate.

EXERCISES (EASY → DIFFICULT)

1. Trapezium: parallel sides 8 and 6, height 6. Area:
2. Trapezium: parallel sides 8 and 8, height 6. Area:
3. Trapezium: parallel sides 8 and 8, height 4. Area:
4. Trapezium: parallel sides 4 and 8, height 4. Area:
5. Trapezium: parallel sides 8 and 6, height 7. Area:
6. Trapezium: parallel sides 4 and 8, height 8. Area:
7. Trapezium: parallel sides 4 and 6, height 5. Area:
8. Trapezium: parallel sides 4 and 6, height 6. Area:
9. Trapezium: parallel sides 8 and 8, height 8. Area:
10. Trapezium: parallel sides 4 and 8, height 5. Area:

Volume of cylinder (use $\pi=3$)

Volume of a cylinder

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DEFINITIONS

Cylinder	A 3D shape with two circular ends connected by a curved surface — like a tin can.
Volume	The space inside a 3D shape, measured in cubic units (cm^3 , m^3).

KEY FORMULAS

- **Volume of cylinder:** $V = \pi r^2 h$
- **= (base area) $\times$ height** (base is a circle of area πr^2)
- **With $\pi = 3$:** $V \approx 3r^2 h$
- **Square the radius FIRST**, then multiply

WORKED EXAMPLES

Example 1: Cylinder $r = 4$, $h = 5$. Find V (use $\pi = 3$).

- Apply $V = \pi r^2 h$.

Volume formula.

- Square radius first: $4^2 = 16$.

Important step.

- $V = 3 \times 16 \times 5$.

Substitute.

- **= 240.**

Multiply.

Example 2: Cylinder $r = 3$, $h = 6$ ($\pi = 3$).

- $V = 3 \times 3^2 \times 6 = 3 \times 9 \times 6$.

Square first.

- **= 162.**

Calculate.

EXERCISES (EASY $\rightarrow$ DIFFICULT)

1. Cylinder $r=3$, $h=5$. Volume ($\pi=3$):
2. Cylinder $r=5$, $h=6$. Volume ($\pi=3$):
3. Cylinder $r=5$, $h=7$. Volume ($\pi=3$):
4. Cylinder $r=3$, $h=10$. Volume ($\pi=3$):
5. Cylinder $r=2$, $h=3$. Volume ($\pi=3$):
6. Cylinder $r=3$, $h=6$. Volume ($\pi=3$):
7. Cylinder $r=5$, $h=8$. Volume ($\pi=3$):
8. Cylinder $r=3$, $h=8$. Volume ($\pi=3$):
9. Cylinder $r=4$, $h=4$. Volume ($\pi=3$):
10. Cylinder $r=5$, $h=5$. Volume ($\pi=3$):



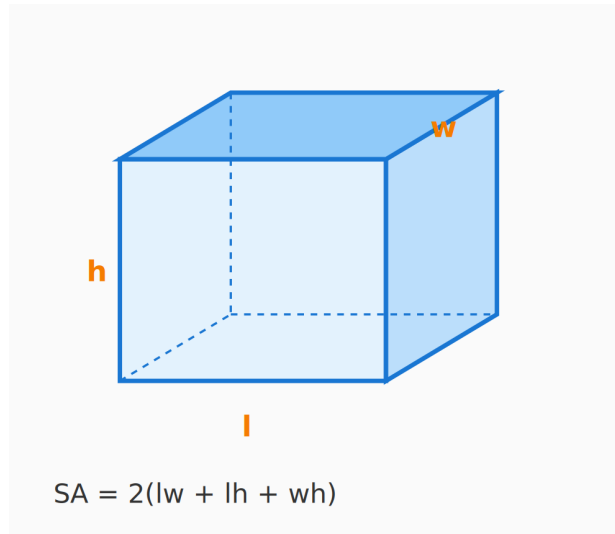
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Surface area of rectangular prism

Surface area of a rectangular prism



DEFINITIONS

Surface area	The TOTAL area of all the faces of a 3D shape.
Rectangular prism	A box-shaped 3D object with 6 rectangular faces.

KEY FORMULAS

- **SA of a box:** $SA = 2(lw + lh + wh)$
- **Three pairs of identical faces:** top+bottom (lw), front+back (lh), left+right (wh)
- **Multiply each pair** by 2, then add

WORKED EXAMPLES

Example 1: Box $4 \times 3 \times 5$. Find SA.

- Identify $l = 4$, $w = 3$, $h = 5$.

Label dimensions.

- Calculate each pair: $lw = 12$, $lh = 20$, $wh = 15$.

Three face areas.

- $SA = 2(12 + 20 + 15) = 2 \times 47$.

Sum and double.

- **= 94.**

Done.

Example 2: Box $3 \times 4 \times 6$. SA?

- $lw = 12$, $lh = 18$, $wh = 24$.

Three pairs.

- $SA = 2(12 + 18 + 24) = 2 \times 54 = \mathbf{108}$.

Calculate.



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**EXERCISES (EASY → DIFFICULT)**

1. Surface area of $4 \times 5 \times 6$ box:
2. Surface area of $3 \times 5 \times 8$ box:
3. Surface area of $4 \times 6 \times 5$ box:
4. Surface area of $6 \times 8 \times 5$ box:
5. Surface area of $6 \times 6 \times 5$ box:
6. Surface area of $6 \times 3 \times 5$ box:
7. Surface area of $6 \times 3 \times 7$ box:
8. Surface area of $7 \times 8 \times 7$ box:
9. Surface area of $3 \times 7 \times 5$ box:
10. Surface area of $5 \times 3 \times 7$ box:

End of Chapter 12 — Mixed Exercise

Ten questions across the whole chapter, from easy to difficult.

1. Perimeter of regular 6-gon, side 4:
2. Triangle base 4, height 10. Area:
3. Parallelogram base 6, height 8. Area:
4. Trapezium: parallel sides 4 and 8, height 4. Area:
5. Cylinder $r=2$, $h=3$. Volume ($\pi=3$):
6. Surface area of $6 \times 3 \times 5$ box:
7. Perimeter of regular 3-gon, side 7:
8. Triangle base 8, height 6. Area:
9. Parallelogram base 11, height 10. Area:
10. Trapezium: parallel sides 4 and 8, height 5. Area:

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CHAPTER 13

Transformations

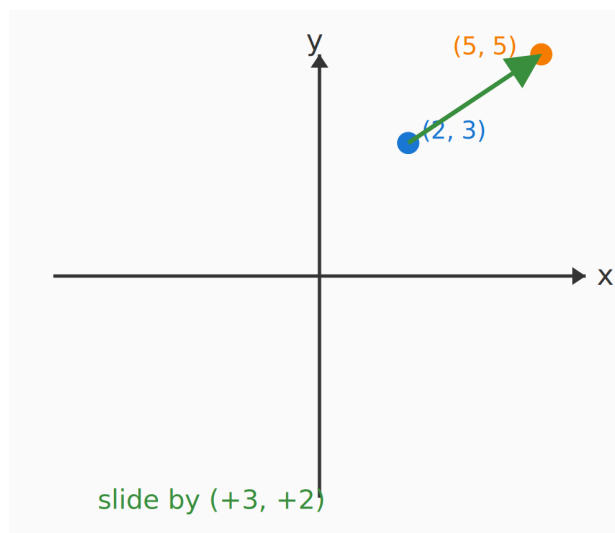
Translation Translation

Reflection Reflection in the x-axis

Reflection Reflection in the y-axis

Rotation Rotation 180° about the origin

Translation



DEFINITIONS

Translation Sliding a shape WITHOUT rotating or flipping. Every point moves the same distance in the same direction.

Translation vector How far to slide: (right, up). E.g. (3, 2) means 3 right and 2 up.

KEY FORMULAS

- **Translation rule:** $(x, y) \rightarrow (x + a, y + b)$ for translation (a, b)
- **Add the translation vector** to each coordinate
- **Right:** add to x. **Up:** add to y. **Left/Down:** negative values



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WORKED EXAMPLES

Example 1: Translate (2, 3) by (3, 2).

► Add 3 to x: $2 + 3 = 5$.

x-coordinate.

► Add 2 to y: $3 + 2 = 5$.

y-coordinate.

► **New point: (5, 5).**

Done.

Example 2: Translate (4, 1) by (3, 2).

► x: $4 + 3 = 7$.

Add a.

► y: $1 + 2 = 3$.

Add b.

► **(7, 3).**

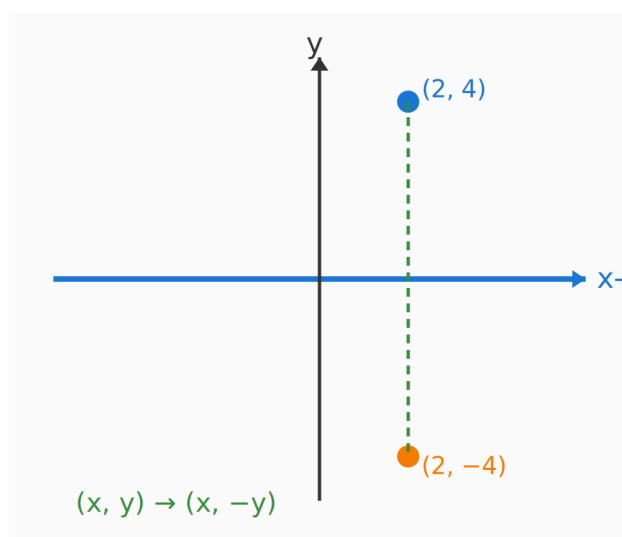
Done.

EXERCISES (EASY → DIFFICULT)

1. Translate (4, 1) by (3, 2):
2. Translate (5, 1) by (3, 2):
3. Translate (3, 3) by (3, 2):
4. Translate (2, 4) by (3, 2):
5. Translate (5, 4) by (3, 2):
6. Translate (3, 4) by (3, 2):
7. Translate (2, 1) by (3, 2):
8. Translate (4, 5) by (3, 2):
9. Translate (4, 4) by (3, 2):
10. Translate (1, 1) by (3, 2):

Reflection in x-axis

Reflection in the x-axis

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DEFINITIONS

Reflection	A flip — the shape ends up as a mirror image.
X-axis	The horizontal axis. Reflecting in it means flipping ABOVE/BELOW.

KEY FORMULAS

- **Reflection in x-axis rule:** $(x, y) \rightarrow (x, -y)$
- **X stays the same**, Y negates (sign flips)
- **Example:** $(3, 4) \rightarrow (3, -4)$

WORKED EXAMPLES

Example 1: Reflect (2, 5) in the x-axis.

- X stays the same: 2.

Reflection in x-axis.

- Y becomes negative: -5.

Flip sign.

- **(2, -5).**

Done.

Example 2: Reflect (4, 3) in the x-axis.

- x: 4 (same). y: -3 (flipped).

Apply rule.

- **(4, -3).**

Done.

EXERCISES (EASY → DIFFICULT)

1. Reflect (5, 4) in the x-axis:
2. Reflect (1, 3) in the x-axis:
3. Reflect (4, 3) in the x-axis:
4. Reflect (5, 1) in the x-axis:
5. Reflect (3, 1) in the x-axis:
6. Reflect (4, 4) in the x-axis:
7. Reflect (2, 1) in the x-axis:
8. Reflect (3, 3) in the x-axis:
9. Reflect (3, 4) in the x-axis:
10. Reflect (4, 5) in the x-axis:

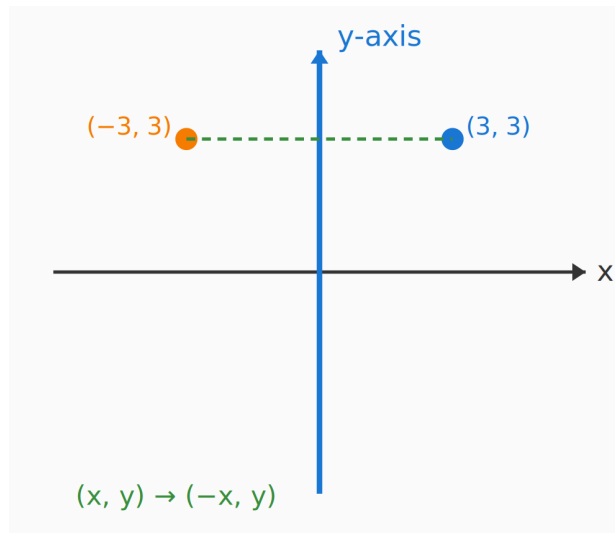


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Reflection in y-axis

Reflection in the y-axis



DEFINITIONS

Y-axis

The vertical axis. Reflecting in it means flipping LEFT/RIGHT.

KEY FORMULAS

- **Reflection in y-axis rule:** $(x, y) \rightarrow (-x, y)$
- **X negates**, Y stays the same
- **Example:** $(3, 4) \rightarrow (-3, 4)$

WORKED EXAMPLES

Example 1: Reflect (2, 5) in the y-axis.

- X becomes negative: -2.

Flip sign of x.

- Y stays: 5.

Y unchanged.

- **(-2, 5).**

Done.

Example 2: Reflect (4, 3) in the y-axis.

- x: -4. y: 3.

Apply rule.

- **(-4, 3).**

Done.

EXERCISES (EASY → DIFFICULT)

1. Reflect (3, 3) in the y-axis:
2. Reflect (3, 4) in the y-axis:
3. Reflect (5, 3) in the y-axis:
4. Reflect (2, 5) in the y-axis:
5. Reflect (2, 1) in the y-axis:



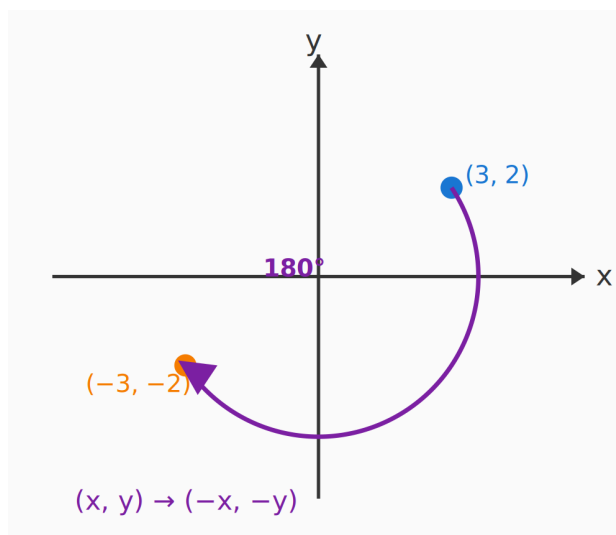
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6. Reflect (5, 2) in the y-axis:
7. Reflect (1, 5) in the y-axis:
8. Reflect (3, 2) in the y-axis:
9. Reflect (5, 1) in the y-axis:
10. Reflect (1, 1) in the y-axis:

Rotation 180° about origin

Rotation 180° about the origin



DEFINITIONS

Rotation	Turning a shape around a fixed point (the centre of rotation).
Origin	The point (0, 0) where the x and y axes meet.
180° rotation	A half-turn. The point ends up on the OPPOSITE side of the origin.

KEY FORMULAS

- **180° rotation about origin:** $(x, y) \rightarrow (-x, -y)$
- **Both x and y negate**
- **Example:** $(3, 4) \rightarrow (-3, -4)$

WORKED EXAMPLES

Example 1: Rotate (2, 5) by 180° about the origin.

- Apply $(x, y) \rightarrow (-x, -y)$.

180° rotation rule.

- x: -2. y: -5.

Negate both.

- **(-2, -5).**

Done.



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**Example 2: Rotate (4, 3) by 180° .**

► $(-4, -3)$.

Negate both.

► **$(-4, -3)$.**

Done.

EXERCISES (EASY → DIFFICULT)

1. Rotate (4, 2) 180° about origin:
2. Rotate (2, 3) 180° about origin:
3. Rotate (5, 1) 180° about origin:
4. Rotate (2, 4) 180° about origin:
5. Rotate (3, 5) 180° about origin:
6. Rotate (1, 1) 180° about origin:
7. Rotate (2, 1) 180° about origin:
8. Rotate (5, 3) 180° about origin:
9. Rotate (5, 4) 180° about origin:
10. Rotate (1, 3) 180° about origin:

End of Chapter 13 — Mixed Exercise

Ten questions across the whole chapter, from easy to difficult.

1. Translate (4, 1) by (3, 2):
2. Reflect (1, 3) in the x-axis:
3. Reflect (5, 3) in the y-axis:
4. Rotate (2, 4) 180° about origin:
5. Translate (5, 4) by (3, 2):
6. Reflect (4, 4) in the x-axis:
7. Reflect (1, 5) in the y-axis:
8. Rotate (5, 3) 180° about origin:
9. Translate (4, 4) by (3, 2):
10. Reflect (4, 5) in the x-axis:





ANSWERS

Worked solutions to all exercises

Each answer gives the final result first, followed by the key working steps. For fully animated, step-by-step solutions, open the digital edition with the QR code on any page.

CHAPTER 1 — Real Numbers and Exponents

Rational and irrational numbers

1. rational
2. irrational
3. irrational
4. rational

Exponent laws: product

1. 5
2. 7
3. 7
4. 5
5. 5
6. 6
7. 5
8. 6
9. 5
10. 6

Exponent laws: quotient

1. 2
2. 3
3. 3
4. 4
5. 3
6. 3
7. 1
8. 5
9. 4
10. 1

Exponent laws: power of a power

1. 8
2. 9
3. 6
4. 6



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5. 9
6. 8
7. 6
8. 4
9. 6
10. 8

Zero and negative exponents

1. 1
2. 1
3. 1
4. 1
5. 1
6. 1
7. 1
8. 1

Scientific notation

1. 30000
2. 400000
3. 2500

End of Chapter 1 — Mixed Exercise

1. rational
2. 7
3. 3
4. 6
5. 1
6. 2500
7. rational
8. 6
9. 4
10. 8

CHAPTER 2 — Integers, Fractions, Decimals

Operations with integers

1. 4
2. 63
3. 30
4. 24
5. 27
6. 8
7. 72
8. 40
9. 18
10. 12

Operations with fractions

1. 2
2. $\frac{1}{2}$
3. $\frac{2}{5}$
4. $\frac{11}{12}$



**Operations with decimals**

1. 27
2. 33.66
3. 21.6
4. 34.32
5. 7.92
6. 48.72
7. 46.8
8. 45.24
9. 34.77
10. 15.66

Long Division (game)

1. play

End of Chapter 2 — Mixed Exercise

1. 4
2. $\frac{1}{2}$
3. 21.6
4. play
5. 27
6. $\frac{11}{12}$
7. 46.8
8. play
9. 18
10. 2

CHAPTER 3 — Ratio, Proportion, Percentage

Direct and inverse proportion

1. 136
2. 50
3. 52
4. 95
5. 96
6. 55
7. 66
8. 24
9. 28
10. 84

Sharing in a ratio

1. 50
2. 75
3. 62.5
4. 37.5

Percent change (profit/loss)

1. 25
2. 20
3. 10



**Simple interest**

1. 389.52
2. 1214.5
3. 1429.6
4. 1817.2
5. 515.85
6. 711.6
7. 806.75
8. 886.5
9. 791.1
10. 480.32

End of Chapter 3 — Mixed Exercise

1. 136
2. 75
3. 10
4. 1817.2
5. 96
6. 37.5
7. 25
8. 886.5
9. 28
10. 50

CHAPTER 4 — Number Patterns

Linear number patterns

1. 32
2. 27
3. 20
4. 36
5. 33
6. 26
7. 29
8. 16
9. 39
10. 18

Find general term T_n

1. $7n + 6$
2. $3n + 6$
3. $3n + 3$
4. $2n + 9$
5. $5n + 5$
6. $4n + 5$
7. $3n + 4$
8. $6n + 2$
9. $2n + 2$
10. $2n + 4$



**Quadratic patterns (intro)**

1. 25

End of Chapter 4 — Mixed Exercise

1. 32

2. $3n + 6$

3. 25

4. 36

5. $5n + 5$

6. 25

7. 29

8. $6n + 2$

9. 25

10. 18

CHAPTER 5 — Algebraic Expressions**Simplify by collecting like terms**

1. $7x + 4y$

2. $11x + 4y$

3. $9x + 5y$

4. $13x + 3y$

5. $8x + 3y$

6. $10x + 4y$

7. $10x + 3y$

8. $13x + 5y$

9. $10x + 2y$

10. $6x + 5y$

Distributive property

1. $2x - 6$

2. $3x - 6$

3. $4x - 4$

4. $4x - 20$

5. $5x - 10$

6. $5x - 15$

7. $4x - 12$

8. $5x - 25$

9. $2x - 8$

10. $3x - 3$

Multiply algebraic terms

1. $6x^2$

2. $8x^2$

3. $15x^2$

4. $12x^2$

5. $8x^2$

6. $12x^2$

7. $25x^2$

8. $20x^2$

9. $15x^2$

10. $6x^2$



**Divide algebraic terms**

1. $3x^2$
2. $3x^2$
3. $4x^2$
4. $2x^2$
5. $4x^2$
6. $4x^2$
7. $2x^2$
8. $2x^2$
9. $4x^2$
10. $3x^2$

Substitute into expressions

1. 88
2. 10
3. 40
4. 54
5. 28
6. 18
7. 70

End of Chapter 5 — Mixed Exercise

1. $7x + 4y$
2. $3x - 6$
3. $15x^2$
4. $2x^2$
5. 28
6. $10x + 4y$
7. $4x - 12$
8. $20x^2$
9. $4x^2$
10. 70

CHAPTER 6 — Linear Equations**Solve linear equations**

1. 7
2. 4
3. 10
4. 2
5. 8
6. 11
7. 12
8. 5
9. 3
10. 4

Equations with brackets

1. 6
2. 2
3. 6
4. 6
5. 7
6. 6
7. 3





8. 3
9. 6
10. 7

Equations: variable on both sides

1. 3
2. 3
3. 4
4. 7
5. 2
6. 6
7. 4
8. 4
9. 5
10. 4

Word problems → equations

1. 11
2. 7
3. 6
4. 8
5. 12
6. 9
7. 13
8. 15
9. 14
10. 10

End of Chapter 6 — Mixed Exercise

1. 7
2. 2
3. 4
4. 8
5. 8
6. 6
7. 4
8. 15
9. 3
10. 7

CHAPTER 7 — Functions and Graphs

Cartesian plane

1. 3
2. 4
3. 4
4. 4
5. 2
6. 2
7. 1
8. 4
9. 1
10. 3



**Linear function: $y = mx$**

1. 8
2. 15
3. 4
4. 12
5. 25
6. 4
7. 15
8. 20
9. 6
10. 10

Linear function: $y = mx + c$

1. 12
2. 17
3. 7
4. 16
5. 9
6. 12
7. 8
8. 13
9. 7
10. 21

Find gradient

1. 2
2. 4
3. 5
4. 3

Find y-intercept

1. 3
2. 4
3. 9
4. 9
5. 7
6. 1
7. 9
8. 7
9. 2
10. 2

End of Chapter 7 — Mixed Exercise

1. 3
2. 15
3. 7
4. 3
5. 7
6. 2
7. 15
8. 13
9. 2
10. 2



CHAPTER 8 — Lines and Angles

Parallel lines and transversals

1. 117
2. 99
3. 96
4. 130
5. 40
6. 75
7. 121
8. 102
9. 122
10. 123

Triangle angle sum

1. 68
2. 84
3. 40
4. 34
5. 84
6. 42
7. 52
8. 60
9. 75
10. 57

Exterior angle of triangle

1. 117
2. 113
3. 127
4. 124
5. 122
6. 120
7. 93
8. 100
9. 111
10. 131

End of Chapter 8 — Mixed Exercise

1. 117
2. 84
3. 127
4. 130
5. 84
6. 120
7. 121
8. 60
9. 111
10. 123





CHAPTER 9 — Triangles, Quadrilaterals, Polygons

Congruent triangles

1. congruent

Similar triangles

1. similar

Sum of interior angles of polygon

1. 1080
2. 180
3. 540
4. 720
5. 360
6. 900

Each interior angle of regular polygon

1. 120
2. 144
3. 135
4. 90
5. 60
6. 108

End of Chapter 9 — Mixed Exercise

1. congruent
2. similar
3. 540
4. 90
5. congruent
6. similar
7. 900
8. 108
9. congruent
10. similar

CHAPTER 10 — 3D Objects

Faces, edges, vertices

1. 6
2. 8
3. 8
4. 5

Nets of 3D shapes

1. 6

End of Chapter 10 — Mixed Exercise

1. 6
2. 6
3. 8
4. 6
5. 5





6. 6
7. 8
8. 6
9. 8
10. 6

CHAPTER 11 — Pythagoras

Pythagoras: find hypotenuse

1. 15
2. 13
3. 10
4. 5

Pythagoras: find leg

1. 8
2. 12
3. 4

Verify right triangles

1. yes

End of Chapter 11 — Mixed Exercise

1. 15
2. 12
3. yes
4. 5
5. 4
6. yes
7. 13
8. 8
9. yes
10. 10

CHAPTER 12 — Mensuration

Perimeter of polygons

1. 24
2. 28
3. 12
4. 40
5. 60
6. 24
7. 21
8. 45
9. 54
10. 30

Area of triangle

1. 30
2. 20
3. 14
4. 12
5. 54





6. 18
7. 6
8. 24
9. 40
10. 27

Area of parallelogram

1. 54
2. 60
3. 48
4. 50
5. 77
6. 25
7. 28
8. 40
9. 110
10. 21

Area of trapezium

1. 42
2. 48
3. 32
4. 24
5. 49
6. 48
7. 25
8. 30
9. 64
10. 30

Volume of cylinder (use $\pi=3$)

1. 135
2. 450
3. 525
4. 270
5. 36
6. 162
7. 600
8. 216
9. 192
10. 375

Surface area of rectangular prism

1. 148
2. 158
3. 148
4. 236
5. 192
6. 126
7. 162
8. 322
9. 142
10. 142



**End of Chapter 12 — Mixed Exercise**

1. 24
2. 20
3. 48
4. 24
5. 36
6. 126
7. 21
8. 24
9. 110
10. 30

CHAPTER 13 — Transformations**Translation**

1. (7,3)
2. (8,3)
3. (6,5)
4. (5,6)
5. (8,6)
6. (6,6)
7. (5,3)
8. (7,7)
9. (7,6)
10. (4,3)

Reflection in x-axis

1. (5,−4)
2. (1,−3)
3. (4,−3)
4. (5,−1)
5. (3,−1)
6. (4,−4)
7. (2,−1)
8. (3,−3)
9. (3,−4)
10. (4,−5)

Reflection in y-axis

1. (−3,3)
2. (−3,4)
3. (−5,3)
4. (−2,5)
5. (−2,1)
6. (−5,2)
7. (−1,5)
8. (−3,2)
9. (−5,1)
10. (−1,1)



**Rotation 180° about origin**

1. $(-4, -2)$
2. $(-2, -3)$
3. $(-5, -1)$
4. $(-2, -4)$
5. $(-3, -5)$
6. $(-1, -1)$
7. $(-2, -1)$
8. $(-5, -3)$
9. $(-5, -4)$
10. $(-1, -3)$

End of Chapter 13 — Mixed Exercise

1. $(7, 3)$
2. $(1, -3)$
3. $(-5, 3)$
4. $(-2, -4)$
5. $(8, 6)$
6. $(4, -4)$
7. $(-1, 5)$
8. $(-5, -3)$
9. $(7, 6)$
10. $(4, -5)$





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