

FIRE JUNGLE

CAPS-aligned mathematics for South African learners



GRADE 9

Mathematics

TEXTBOOK

Definitions • Worked Examples • Exercises • Full Answers



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by Joseph Matthew Mitchell

Fire Jungle Grade 9 Mathematics

A CAPS-aligned study textbook for the FET phase

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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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CHAPTER 1

Real Numbers and Surds

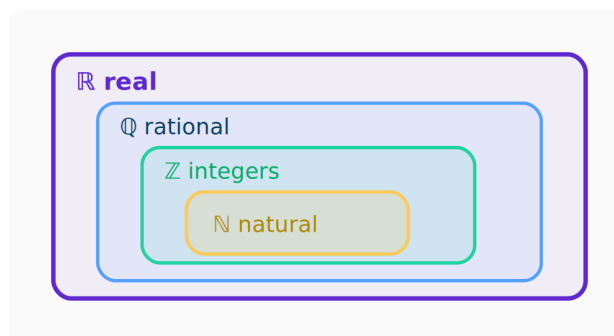
Rational Rational and irrational numbers

Surds: Simplifying surds

Add/subtract Adding and subtracting surds

Long Long Division — interactive game

Rational and irrational numbers



DEFINITIONS

Rational number	A number that can be written as a fraction a/b where a and b are integers and $b \neq 0$. Decimal either ends or repeats.
Irrational number	A number that cannot be written as a simple fraction. Its decimal goes on forever without repeating.
Real numbers	All rational and irrational numbers together — every number on the number line.

KEY FORMULAS

- **Rational examples:** $1/2$, 3 , 0.25 , $0.333...$ (repeating), $\sqrt{4} = 2$
- **Irrational examples:** π , $\sqrt{2}$, $\sqrt{3}$, $\sqrt{5}$, $\sqrt{7}$
- **Key test:** if $\sqrt[n]{n}$ gives a whole number, it's rational; otherwise irrational



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WORKED EXAMPLES

Example 1: Is $\sqrt{16}$ rational or irrational?

- Find $\sqrt{16}$.

What number times itself gives 16?

- $\sqrt{16} = 4$.

$$4 \times 4 = 16.$$

- 4 can be written as $4/1$ — a fraction.

Every whole number is rational.

- **$\sqrt{16}$ is rational.**

It simplifies to a whole number.

Example 2: Is $\sqrt{7}$ rational or irrational?

- Is there a whole number that times itself gives 7?

$2 \times 2 = 4$ (too small). $3 \times 3 = 9$ (too big). No whole answer.

- $\sqrt{7} \approx 2.6457513...$ (never ends, never repeats).

Calculator confirms this.

- **$\sqrt{7}$ is irrational.**

Cannot be written as a clean fraction.

EXERCISES (EASY → DIFFICULT)

1. Is $\sqrt{4}$ rational or irrational?
2. Is 2.5 rational or irrational?
3. Is $\sqrt{7}$ rational or irrational?
4. Is π rational or irrational?
5. Is $\sqrt{9}$ rational or irrational?
6. Is $\sqrt{10}$ rational or irrational?
7. Is 0.75 rational or irrational?
8. Is $\sqrt{2}$ rational or irrational?
9. Is $5/8$ rational or irrational?
10. Is $\sqrt{49}$ rational or irrational?

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Surd: simplify $\sqrt{n}$

Simplifying surds

$$\sqrt{a \cdot b} = \sqrt{a} \cdot \sqrt{b}$$

split out perfect-square factors

DEFINITIONS

Surd	A square root (like $\sqrt{2}$, $\sqrt{3}$, $\sqrt{7}$) that doesn't simplify to a whole number.
Perfect square	A whole number squared: 1, 4, 9, 16, 25, 36, 49, 64, 81, 100...
Simplify	Rewrite a surd in its smallest form by pulling out perfect square factors.

KEY FORMULAS

- **Surd product rule:** $\sqrt{a \cdot b} = \sqrt{a} \cdot \sqrt{b}$
- **Strategy:** find the largest perfect square that divides the number
- **Example:** $\sqrt{50} = \sqrt{(25 \cdot 2)} = \sqrt{25} \cdot \sqrt{2} = 5\sqrt{2}$

WORKED EXAMPLES

Example 1: Simplify $\sqrt{50}$.

- Find a perfect square that divides 50.

$25 \times 2 = 50$, and 25 is a perfect square.

$$\sqrt{50} = \sqrt{(25 \times 2)} = \sqrt{25} \times \sqrt{2}.$$

Split using the surd product rule.

$$= 5\sqrt{2}.$$

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

$$\sqrt{50} = 5\sqrt{2}.$$

Final simplified form.

Example 2: Simplify $\sqrt{72}$.

- Find the largest perfect square in 72.

$36 \times 2 = 72$, and $36 = 6^2$.

$$\sqrt{72} = \sqrt{(36 \times 2)} = \sqrt{36} \times \sqrt{2}.$$

Split the surd.

$$= 6\sqrt{2}.$$

$$\sqrt{36} = 6.$$

EXERCISES (EASY → DIFFICULT)

1. Simplify $\sqrt{18}$:
2. Simplify $\sqrt{50}$:
3. Simplify $\sqrt{12}$:
4. Simplify $\sqrt{75}$:
5. Simplify $\sqrt{8}$.
6. Simplify $\sqrt{12}$.
7. Simplify $\sqrt{18}$.



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8. Simplify $\sqrt{20}$.
9. Simplify $\sqrt{27}$.
10. Simplify $\sqrt{32}$.

Add/subtract surds

Adding and subtracting surds

$$\sqrt{(a \cdot b)} = \sqrt{a} \cdot \sqrt{b}$$

split out perfect-square factors

DEFINITIONS

Like surds	Surds with the same number under the root sign — they can be added or subtracted directly.
Unlike surds	Surds with different numbers under the root — they cannot be combined.
Coefficient	The number in front of a surd (e.g. the 3 in $3\sqrt{2}$).

KEY FORMULAS

- **Like surds add:** $a\sqrt{n} + b\sqrt{n} = (a + b)\sqrt{n}$
- **Like surds subtract:** $a\sqrt{n} - b\sqrt{n} = (a - b)\sqrt{n}$
- **Important:** $\sqrt{a} + \sqrt{b} \neq \sqrt{(a + b)}$ — you cannot add what's under the roots

WORKED EXAMPLES

Example 1: Simplify $2\sqrt{3} + 4\sqrt{3}$.

- Both surds are $\sqrt{3}$ — same number under the root.

They are LIKE surds, so we can combine.

- Add the coefficients: $2 + 4 = 6$.

Just like $2x + 4x = 6x$.

- $2\sqrt{3} + 4\sqrt{3} = 6\sqrt{3}$.

Keep the surd the same.

Example 2: Simplify $5\sqrt{2} - 2\sqrt{2}$.

- Both are $\sqrt{2}$ — same root.

Like surds.

- Subtract coefficients: $5 - 2 = 3$.

Treat $\sqrt{2}$ like a single 'thing'.

- $5\sqrt{2} - 2\sqrt{2} = 3\sqrt{2}$.

Done.

EXERCISES (EASY → DIFFICULT)

1. $3\sqrt{5} + 2\sqrt{5} = ?$
2. $2\sqrt{3} + 4\sqrt{3} = ?$
3. $5\sqrt{2} - 2\sqrt{2} = ?$
4. Simplify $2\sqrt{5} + 3\sqrt{5}$.



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5. Simplify $7\sqrt{2} - 4\sqrt{2}$.
6. Simplify $\sqrt{12} + \sqrt{3}$.
7. Simplify $\sqrt{18} + \sqrt{2}$.
8. Simplify $5\sqrt{3} - 2\sqrt{3}$.
9. Simplify $\sqrt{8} + \sqrt{2}$.
10. Simplify $6\sqrt{7} - \sqrt{7}$.

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.
2. Calculate $156 \div 12$.
3. Calculate $187 \div 11$.
4. Calculate $360 \div 15$.
5. Calculate $256 \div 8$.
6. Calculate $405 \div 9$.
7. Calculate $392 \div 7$.
8. Calculate $882 \div 14$.
9. Calculate $432 \div 6$.
10. Calculate $1008 \div 12$.



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End of Chapter 1 — Mixed Exercise

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

1. Is $\sqrt{4}$ rational or irrational?
2. Simplify $\sqrt{50}$.
3. $5\sqrt{2} - 2\sqrt{2} = ?$
4. Calculate $360 \div 15$.
5. Is $\sqrt{9}$ rational or irrational?
6. Simplify $\sqrt{12}$.
7. Simplify $\sqrt{18} + \sqrt{2}$.
8. Calculate $882 \div 14$.
9. Is $5/8$ rational or irrational?
10. Simplify $\sqrt{32}$.



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CHAPTER 2

Exponents

- Exponent** Exponent laws (product rule)
- Negative** Negative exponents
- Fractional** Fractional exponents and roots
- Scientific** Scientific notation

Exponent laws

Exponent laws (product rule)

$$a^m \cdot a^n = a^{m+n}$$

apply the exponent laws

DEFINITIONS

Base	The number being raised to a power. In 2^3 , the base is 2.
Exponent (power)	The small number telling you how many times to multiply the base by itself. In 2^3 , the exponent is 3.
Like bases	Two powers with the same base. Only with like bases can you add or subtract exponents directly.

KEY FORMULAS

- **Product rule (same base):** $a^m \times a^n = a^{m+n}$
- **Quotient rule:** $a^m \div a^n = a^{m-n}$
- **Power of a power:** $(a^m)^n = a^{mn}$
- **Power of a product:** $(a \cdot b)^n = a^n \cdot b^n$

WORKED EXAMPLES



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

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

When multiplying powers with the same base, ADD the exponents.

► $2^3 \times 2^4 = 2^{3+4} = 2^7$.

$3 + 4 = 7$.

► $= 128$.

$2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 128$.

Example 2: Simplify $5^6 \div 5^2$.

- Same base — use the quotient rule.

When dividing, SUBTRACT the exponents.

► $5^6 \div 5^2 = 5^{6-2} = 5^4$.

$6 - 2 = 4$.

► $= 625$.

$5 \times 5 \times 5 \times 5 = 625$.

EXERCISES (EASY → DIFFICULT)

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

Negative exponents

$$a^{-n} = 1 / a^n$$

apply the exponent laws

DEFINITIONS**Negative exponent**

An exponent that is below zero. It means "1 over the positive version".

Reciprocal

The "flip" of a number — 1 divided by it. The reciprocal of 4 is $1/4$.

KEY FORMULAS

- **Negative exponent rule:** $a^{-n} = 1 / a^n$
- **Reciprocal rule:** $a^{-1} = 1/a$
- **Move to denominator:** a negative exponent flips to the other side of the fraction

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WORKED EXAMPLES

Example 1: Write 3^{-1} as a fraction.

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

Negative exponent flips the base.

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

Just take the reciprocal.

Example 2: Simplify 2^{-3} .

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

Move to denominator AND apply the positive power.

- $2^{-3} = 1/2^3 = 1/8$.

First make positive, then evaluate.

- $2^{-3} = 1/8$.

Final answer.

EXERCISES (EASY → DIFFICULT)

1. 4^{-1} as fraction:
2. 2^{-1} as fraction:
3. 3^{-1} as fraction:
4. 5^{-1} as fraction:
5. Evaluate 2^{-3} as a fraction.
6. Evaluate 5^{-2} as a fraction.
7. Evaluate 10^{-3} as a fraction.
8. Evaluate 3^{-2} as a fraction.
9. Evaluate 4^{-2} as a fraction.
10. Evaluate 2^{-4} as a fraction.

Fractional exponents

Fractional exponents and roots

$$a^{(1/n)} = \sqrt[n]{a}$$

apply the exponent laws

DEFINITIONS

Fractional exponent

An exponent written as a fraction. It represents a root.

Square root ($\sqrt{}$)

The number that, when multiplied by itself, gives the original. $\sqrt{9} = 3$ because $3 \times 3 = 9$.



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KEY FORMULAS

- **Square root form:** $a^{(1/2)} = \sqrt{a}$
- **n-th root form:** $a^{(1/n)} = \sqrt[n]{a}$
- **Mixed:** $a^{(m/n)} = \sqrt[n]{a^m}$

WORKED EXAMPLES

Example 1: Evaluate $25^{(1/2)}$.

- The exponent $1/2$ means square root.

$$a^{(1/2)} = \sqrt{a}.$$

► $25^{(1/2)} = \sqrt{25} = 5.$

$$5 \times 5 = 25.$$

Example 2: Evaluate $64^{(1/2)}$.

- $1/2$ power means square root.

Same rule.

► $64^{(1/2)} = \sqrt{64} = 8.$

$$8 \times 8 = 64.$$

EXERCISES (EASY → DIFFICULT)

1. $25^{(1/2)} = ?$
2. $16^{(1/2)} = ?$
3. $9^{(1/2)} = ?$
4. $4^{(1/2)} = ?$
5. Evaluate $8^{(1/3)}$.
6. Evaluate $16^{(1/2)}$.
7. Evaluate $27^{(1/3)}$.
8. Evaluate $81^{(1/4)}$.
9. Evaluate $32^{(1/5)}$.
10. Evaluate $25^{(1/2)}$.



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Scientific notation

$$a \times 10^n \quad (1 \leq a < 10)$$

scientific notation

DEFINITIONS

Scientific notation	A way of writing 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.
Order of magnitude	The power of 10 in scientific notation — tells you the rough "size" of the number.

KEY FORMULAS

- **Standard form:** $a \times 10^n$ where $1 \leq a < 10$
- **Big numbers:** n is positive — move decimal RIGHT by n places
- **Small numbers:** n is negative — move decimal LEFT by n places
- **Examples:** $4 \times 10^4 = 40\,000$; $3 \times 10^{-2} = 0.03$

WORKED EXAMPLES

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

- Exponent is 4 (positive) — move decimal 4 places RIGHT.
Positive power = big number.
- Start with 4.0 and add zeros: $4 \rightarrow 40 \rightarrow 400 \rightarrow 4\,000 \rightarrow 40\,000$.
Each move right multiplies by 10.
- $4 \times 10^4 = 40\,000$.
Forty thousand.

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

- Exponent is 3 — move decimal 3 places RIGHT.
Positive power, three places.
- $2.5 \rightarrow 25 \rightarrow 250 \rightarrow 2\,500$.
Three moves right.
- $2.5 \times 10^3 = 2\,500$.
Two and a half thousand.

EXERCISES (EASY → DIFFICULT)

1. 2.5×10^3 as ordinary:
2. 4×10^4 as ordinary:
3. Write 4500 in scientific notation.
4. Write 67000 in scientific notation.
5. Write 920000 in scientific notation.
6. Write 0.0032 in scientific notation.
7. Write 0.00081 in scientific notation.



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8. Write 0.045 in scientific notation.
9. Write 250000 in scientific notation.
10. Write 0.0007 in scientific notation.

End of Chapter 2 — Mixed Exercise

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

1. $5^2 \times 5^2 = ?$
2. 2^{-1} as fraction:
3. $9^{(1/2)} = ?$
4. Write 67000 in scientific notation.
5. $4^2 \times 4^4 = ?$
6. Evaluate 5^{-2} as a fraction.
7. Evaluate $27^{(1/3)}$.
8. Write 0.045 in scientific notation.
9. $3^4 \times 3^3 = ?$
10. Evaluate 2^{-4} as a fraction.





CHAPTER 3

Algebraic Expressions

Simplify Simplifying algebraic expressions

Multiply Multiplying binomials (FOIL)

Common Factorising — common factor

Difference Difference of two squares

Factorise Factorising quadratic trinomials

Simplify expressions

Simplifying algebraic expressions

simplify by collecting like terms

take out / split into brackets

DEFINITIONS

Term	A single number, variable, or product of these — separated by + or – signs. E.g. in $3x + 2y - 5$, there are three terms.
Like terms	Terms with the same variable raised to the same power. $3x$ and $5x$ are like terms; $3x$ and $3y$ are NOT.
Coefficient	The number in front of a variable. In $7x$, the coefficient is 7.

KEY FORMULAS

- **Combine like terms:** add or subtract their coefficients
- **Keep the variable:** $3x + 5x = 8x$, not $8x^2$
- **Unlike terms stay separate:** $3x + 2y$ stays as $3x + 2y$

WORKED EXAMPLES



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**Example 1: Simplify $7x - 3x + 2y$.**

- Identify like terms: $7x$ and $3x$ are alike (both have x).

$2y$ is a separate term.

- Combine: $7x - 3x = 4x$.

Subtract coefficients.

- Keep $2y$ as is.

Cannot combine with x -terms.

- **Answer: $4x + 2y$.**

Two simplified terms.

Example 2: Simplify $5a + 3b - 2a + b$.

- Group like terms.

a -terms: $5a - 2a$. b -terms: $3b + b$.

- $5a - 2a = 3a$.

Combine a -terms.

- $3b + b = 4b$.

Combine b -terms (b is the same as $1b$).

- **Answer: $3a + 4b$.**

Final simplified form.

EXERCISES (EASY → DIFFICULT)

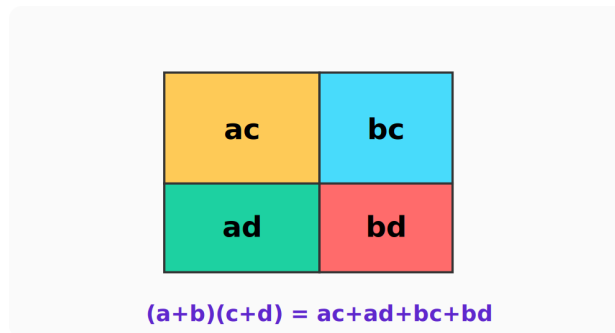
1. $6x - 3x + 5y = ?$
2. $6x - 3x + 3y = ?$
3. $4x - 5x + 5y = ?$
4. $6x - 3x + 4y = ?$
5. $6x - 5x + 4y = ?$
6. $9x - 5x + 2y = ?$
7. $5x - 2x + 4y = ?$
8. $7x - 4x + 4y = ?$
9. $6x - 2x + 2y = ?$
10. $8x - 3x + 3y = ?$

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Multiply binomials

Multiplying binomials (FOIL)



DEFINITIONS

Binomial	An algebraic expression with exactly two terms, like $(x + 3)$ or $(2x - 5)$.
FOIL	First, Outer, Inner, Last — the order to multiply terms when expanding two binomials.
Expand	Multiply out the brackets to write the expression without brackets.

KEY FORMULAS

- **FOIL method:** $(a + b)(c + d) = ac + ad + bc + bd$
- **First:** $a \times c$
- **Outer:** $a \times d$
- **Inner:** $b \times c$
- **Last:** $b \times d$

WORKED EXAMPLES

Example 1: Expand $(x + 2)(x + 3)$.

- **FIRST:** $x \times x = x^2$.
Multiply the first terms in each bracket.
- **OUTER:** $x \times 3 = 3x$.
Outermost terms.
- **INNER:** $2 \times x = 2x$.
Innermost terms.
- **LAST:** $2 \times 3 = 6$.
Last terms.
- **Combine:** $x^2 + 3x + 2x + 6 = x^2 + 5x + 6$.
Add the middle (like) terms.



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**Example 2: Expand $(x + 4)(x - 1)$.**

► FIRST: $x \times x = x^2$.

First terms.

► OUTER: $x \times (-1) = -x$.

Watch the sign.

► INNER: $4 \times x = 4x$.

Inner terms.

► LAST: $4 \times (-1) = -4$.

Last terms.

► Combine: $x^2 - x + 4x - 4 = x^2 + 3x - 4$.

Combine middle terms: $-x + 4x = 3x$.

EXERCISES (EASY → DIFFICULT)

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

Common factor

Factorising — common factor

take out the common factor

take out / split into brackets

DEFINITIONS

Factor	A number or expression that divides exactly into another. 3 is a factor of 12.
Factorise	Rewrite an expression as a product of its factors (the opposite of expanding).
HCF (Highest Common Factor)	The biggest number that divides into every term of the expression.

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KEY FORMULAS

- **Common factor method:** $ab + ac = a(b + c)$
- **Steps:** (1) find the HCF, (2) divide each term by it, (3) write $\text{HCF} \times (\text{the remaining factors})$
- **Check:** expand your answer — you should get back the original

WORKED EXAMPLES

Example 1: Factorise $6x + 9$.

- Find the HCF of 6 and 9.

Factors of 6: 1, 2, 3, 6. Factors of 9: 1, 3, 9. HCF = 3.

- Divide each term by 3: $6x \div 3 = 2x$; $9 \div 3 = 3$.

Pull the 3 out.

- **$6x + 9 = 3(2x + 3)$.**

Write HCF $\times$ bracket of remainders.

- Check: $3(2x + 3) = 6x + 9$.

Expanding gets us back.

Example 2: Factorise $10x + 15$.

- HCF of 10 and 15 is 5.

5 divides both: $10/5=2$ and $15/5=3$.

- **$10x + 15 = 5(2x + 3)$.**

Pull out the 5.

EXERCISES (EASY $\rightarrow$ DIFFICULT)

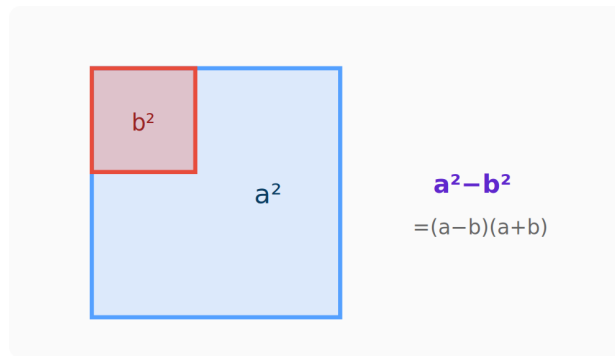
1. Factorise $20x + 15$:
2. Factorise $8x + 4$:
3. Factorise $12x + 8$:
4. Factorise $6x + 6$:
5. Factorise $10x + 4$:
6. Factorise $15x + 9$:
7. Factorise $16x + 12$:
8. Factorise $8x + 12$:
9. Factorise $9x + 9$:
10. Factorise $8x + 8$:



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Difference of two squares



DEFINITIONS

Difference of two squares An expression of the form $a^2 - b^2$ — one square minus another.

Perfect square A number that is the square of an integer (1, 4, 9, 16, 25, ...).

KEY FORMULAS

- **Difference of squares:** $a^2 - b^2 = (a - b)(a + b)$
- **Recognise the pattern:** two perfect squares connected by a MINUS sign
- **NOT a sum:** $a^2 + b^2$ does NOT factorise like this

WORKED EXAMPLES

Example 1: Factorise $x^2 - 25$.

- Recognise: x^2 is a square; $25 = 5^2$ is a square; minus sign between them.

Classic difference of two squares.

- Apply the formula $a^2 - b^2 = (a - b)(a + b)$ with $a = x$, $b = 5$.

Match the pattern.

- $x^2 - 25 = (x - 5)(x + 5)$.

Write as two brackets with opposite signs.

Example 2: Factorise $x^2 - 49$.

- $49 = 7^2$. So this is $x^2 - 7^2$.

Identify the squares.

- $x^2 - 49 = (x - 7)(x + 7)$.

Apply the formula.

EXERCISES (EASY → DIFFICULT)

1. Factorise $x^2 - 64$:
2. Factorise $x^2 - 4$:
3. Factorise $x^2 - 16$:
4. Factorise $x^2 - 9$:
5. Factorise $x^2 - 36$:
6. Factorise $x^2 - 25$:
7. Factorise $x^2 - 81$:
8. Factorise $x^2 - 49$:
9. Factorise $x^2 - 9$.



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10. Factorise $x^2 - 25$.

Factorise quadratic trinomials

Factorising quadratic trinomials

$$x^2 + bx + c \rightarrow (x + _)(x + _)$$

take out / split into brackets

DEFINITIONS

Trinomial	An algebraic expression with three terms, like $x^2 + 5x + 6$.
Quadratic trinomial	A trinomial with x^2 as its highest power.
Factor pair	Two numbers that multiply to give a target. For 6: (1,6), (2,3), (-1,-6), (-2,-3).

KEY FORMULAS

- **Form:** $x^2 + bx + c \rightarrow (x + p)(x + q)$
- **Find p and q such that:** $p \times q = c$ AND $p + q = b$
- **Both positive:** $b > 0, c > 0$. Both negative: $b < 0, c > 0$. Mixed: $c < 0$.

WORKED EXAMPLES

Example 1: Factorise $x^2 + 5x + 6$.

- Find two numbers that MULTIPLY to 6 AND ADD to 5.
These are our p and q.
- Factor pairs of 6: (1,6), (2,3). Test sums: $1+6=7$, $2+3=5$.
2 and 3 work.
- $x^2 + 5x + 6 = (x + 2)(x + 3)$.
Use those two numbers.
- Check: $(x + 2)(x + 3) = x^2 + 3x + 2x + 6 = x^2 + 5x + 6$.
Expand to verify.

Example 2: Factorise $x^2 + 7x + 12$.

- Two numbers that multiply to 12 AND add to 7.
Find p and q.
- Try 3 and 4: $3 \times 4 = 12$ and $3 + 4 = 7$.
Both conditions satisfied.
- $x^2 + 7x + 12 = (x + 3)(x + 4)$.
Use 3 and 4.

EXERCISES (EASY → DIFFICULT)

1. Factorise $x^2 + 5x + 6$:
2. Factorise $x^2 + 6x + 9$:
3. Factorise $x^2 + 4x + 3$:
4. Factorise $x^2 + 9x + 20$:



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5. Factorise $x^2 + 6x + 8$:
6. Factorise $x^2 + 6x + 5$:
7. Factorise $x^2 + 10x + 25$:
8. Factorise $x^2 + 7x + 10$:
9. Factorise $x^2 + 3x + 2$:
10. Factorise $x^2 + 8x + 16$:

End of Chapter 3 — Mixed Exercise

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

1. $6x - 3x + 5y = ?$
2. $(x + 1)(x + 5) = ?$
3. Factorise $12x + 8$:
4. Factorise $x^2 - 9$:
5. Factorise $x^2 + 6x + 8$:
6. $9x - 5x + 2y = ?$
7. $(x + 4)(x + 2) = ?$
8. Factorise $8x + 12$:
9. Factorise $x^2 - 9$.
10. Factorise $x^2 + 8x + 16$:



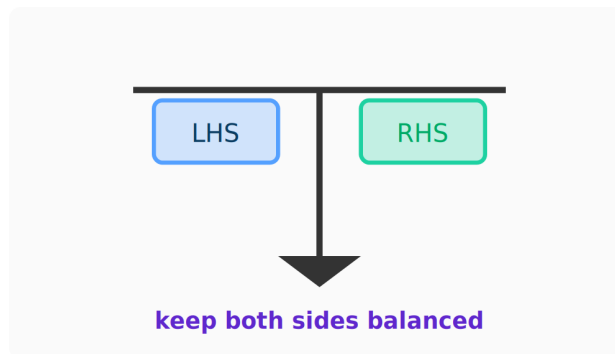
CHAPTER 4

Equations and Inequalities

- Solve** Solving linear equations
- Solve** Solving simultaneous equations
- Solve** Solving quadratics by factorising
- Solve** Solving linear inequalities

Solve linear equations

Solving linear equations



DEFINITIONS

Linear equation	An equation where the highest power of x is 1. E.g. $2x + 3 = 11$.
Solve	Find the value of the unknown variable 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 by using inverse operations
- **Order:** undo addition/subtraction first, then multiplication/division



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WORKED EXAMPLES

Example 1: Solve $2x + 5 = 13$.

- Subtract 5 from both sides: $2x = 8$.

Inverse of $+5$ is -5 .

- Divide both sides by 2: $x = 4$.

Inverse of $\times 2$ is $\div 2$.

- **$x = 4$.**

Check: $2(4) + 5 = 8 + 5 = 13$.

Example 2: Solve $3x - 7 = 14$.

- Add 7 to both sides: $3x = 21$.

Undo the -7 .

- Divide by 3: $x = 7$.

Undo the $\times 3$.

- **$x = 7$.**

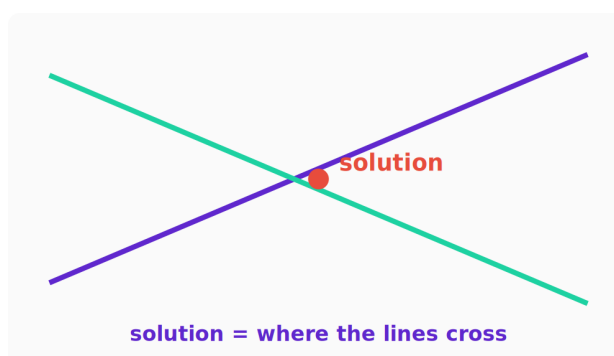
Check: $3(7) - 7 = 21 - 7 = 14$.

EXERCISES (EASY $\rightarrow$ DIFFICULT)

1. $2x + 5 = 19$. Find x .
2. $5x + 4 = 59$. Find x .
3. $4x + 8 = 36$. Find x .
4. $2x + 7 = 13$. Find x .
5. $4x + 8 = 40$. Find x .
6. $2x + 7 = 25$. Find x .
7. $4x + 6 = 34$. Find x .
8. $5x + 8 = 33$. Find x .
9. $3x + 4 = 16$. Find x .
10. $2x + 5 = 23$. Find x .

Solve simultaneous equations

Solving simultaneous equations



DEFINITIONS

Simultaneous equations

Two or more equations that must all be true at the same time.

Elimination

A method where you add or subtract equations to eliminate one variable.

Substitution

A method where you rearrange one equation and plug it into the other.

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KEY FORMULAS

- **Elimination strategy:** add or subtract the two equations to cancel one variable
- **Look for matching coefficients:** if x has $+1$ in one and -1 in the other, ADD them to eliminate x
- **Then back-substitute:** use the found value to get the other variable

WORKED EXAMPLES

Example 1: Solve $x + y = 10$ and $x - y = 4$.

- Notice $+y$ and $-y$. ADDING the equations eliminates y .

$$(+y) + (-y) = 0.$$

- Add: $(x + y) + (x - y) = 10 + 4 \rightarrow 2x = 14$.

Y terms cancel.

- Solve: $x = 7$.

Divide by 2.

- Substitute back: $7 + y = 10 \rightarrow y = 3$.

Plug $x = 7$ into either equation.

Example 2: Solve $x + y = 8$ and $x - y = 2$.

- Add to eliminate y : $2x = 10$.

y cancels.

- $x = 5$, then $5 + y = 8 \rightarrow y = 3$.

Back-substitute.

EXERCISES (EASY $\rightarrow$ DIFFICULT)

1. $x + y = 6$, $x - y = 0$. Find x .
2. $x + y = 9$, $x - y = -1$. Find x .
3. $x + y = 8$, $x - y = -2$. Find x .
4. $x + y = 7$, $x - y = 3$. Find x .
5. $x + y = 10$, $x - y = 0$. Find x .
6. $x + y = 9$, $x - y = 1$. Find x .
7. $x + y = 8$, $x - y = 0$. Find x .
8. $x + y = 5$, $x - y = -1$. Find x .
9. $x + y = 7$, $x - y = -3$. Find x .
10. $x + y = 7$, $x - y = 1$. Find x .

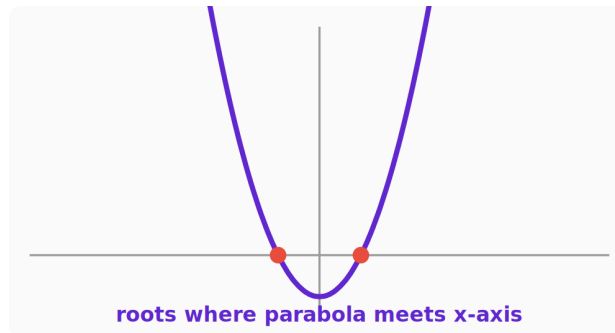


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Solve quadratic by factorising

Solving quadratics by factorising



DEFINITIONS

Quadratic equation

An equation of the form $ax^2 + bx + c = 0$ (highest power of x is 2).

Roots (or solutions)

The values of x that make the equation equal to zero.

Zero-product principle

If two things multiplied together give zero, then at least one of them must be zero.

KEY FORMULAS

- **Strategy:** factorise into $(x - p)(x - q) = 0$
- **Then:** either $x - p = 0$ or $x - q = 0$
- **Solutions:** $x = p$ or $x = q$

WORKED EXAMPLES

Example 1: Solve $x^2 - 5x + 6 = 0$.

- Factorise: find two numbers multiplying to 6, adding to -5 .

Both negative: -2 and -3 .

► $(x - 2)(x - 3) = 0$.

Factorised form.

- Apply zero-product: $x - 2 = 0$ OR $x - 3 = 0$.

One bracket must be zero.

► **$x = 2$ or $x = 3$.**

Two solutions.

Example 2: Solve $x^2 - 7x + 12 = 0$.

- Find two numbers: $\times 12$, $+ (-7)$. Use -3 and -4 .

$(-3) \times (-4) = 12$ and $(-3) + (-4) = -7$.

► $(x - 3)(x - 4) = 0$.

Factorise.

► **$x = 3$ or $x = 4$.**

Solve each factor $= 0$.



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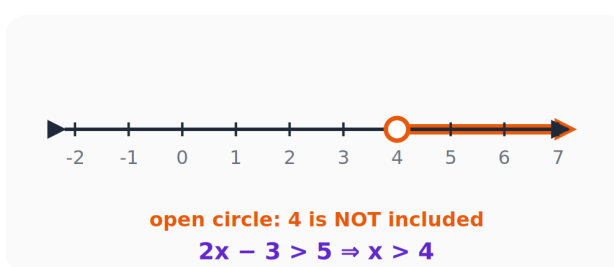
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EXERCISES (EASY → DIFFICULT)

1. Solve $x^2 - 5x + 6 = 0$:
2. Solve $x^2 - 6x + 8 = 0$:
3. Solve $x^2 - 6x + 9 = 0$:
4. Solve $x^2 - 8x + 15 = 0$:
5. Solve $x^2 - 11x + 30 = 0$:
6. Solve $x^2 - 12x + 36 = 0$:
7. Solve $x^2 - 9x + 20 = 0$:
8. Solve $x^2 - 7x + 12 = 0$:
9. Solve $x^2 - 9x + 18 = 0$:
10. Solve $x^2 - 10x + 24 = 0$:

Solve linear inequalities

Solving linear inequalities



DEFINITIONS

Inequality	A statement that one expression is greater than ($>$), less than ($<$), or equal to another.
Solution set	All the values of x that make the inequality true.
Flip rule	When you multiply or divide BOTH sides by a NEGATIVE number, you must FLIP the inequality sign.

KEY FORMULAS

- **Solve like an equation:** use inverse operations on both sides
- **Flip when negative:** if you $\div$ or $\times$ by a negative, flip $>$ to $<$ (or vice versa)
- **Express the answer:** $x > k$, $x \geq k$, $x < k$, or $x \leq k$

WORKED EXAMPLES

Example 1: Solve $x + 5 > 12$.

- Subtract 5 from both sides.

Inverse operation.

- $x > 7$.

Any number bigger than 7 satisfies.

- Check: $x = 10 \rightarrow 10 + 5 = 15 > 12$.

Verify with a test value.



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**Example 2: Solve $2x - 3 \geq 7$.**

- Add 3 to both sides: $2x \geq 10$.

Undo the -3 .

- Divide both sides by 2: $x \geq 5$.

Positive divisor $\rightarrow$ don't flip.

- **$x \geq 5$.**

Any number 5 or more works.

EXERCISES (EASY $\rightarrow$ DIFFICULT)

1. Solve $x + 7 > 14$:
2. Solve $x + 3 > 8$:
3. Solve $x + 2 > 5$:
4. Solve $x + 1 > 6$:
5. Solve $x + 9 > 16$:
6. Solve $x + 4 > 6$:
7. Solve $x + 9 > 10$:
8. Solve $x + 3 > 5$:
9. Solve $x + 4 > 9$:
10. Solve $x + 2 > 3$:

End of Chapter 4 — Mixed Exercise

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

1. $2x + 5 = 19$. Find x .
2. $x + y = 9$, $x - y = -1$. Find x .
3. Solve $x^2 - 6x + 9 = 0$:
4. Solve $x + 1 > 6$:
5. $4x + 8 = 40$. Find x .
6. $x + y = 9$, $x - y = 1$. Find x .
7. Solve $x^2 - 9x + 20 = 0$:
8. Solve $x + 3 > 5$:
9. $3x + 4 = 16$. Find x .
10. $x + y = 7$, $x - y = 1$. Find x .

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CHAPTER 5

Functions and Graphs

Linear Linear functions: $y = mx + c$

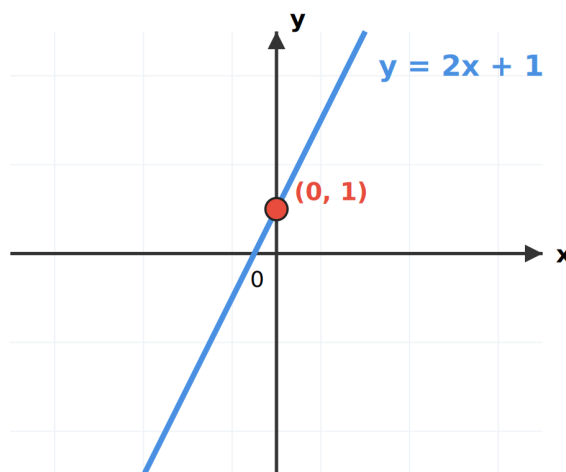
Find Finding gradient and y-intercept

Quadratic Quadratic functions (intro)

Hyperbola Hyperbola $y = k/x$

Linear function: $y = mx + c$

Linear functions: $y = mx + c$



DEFINITIONS

Function	A rule that takes an input (x) and gives one output (y).
Linear function	A function of the form $y = mx + c$. Its graph is a straight line.
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:** $y = mx + c$
- **m = gradient:** rise $\div$ run
- **c = y-intercept:** the value of y when $x = 0$
- **Substitution:** to find y for any x , replace x with that value



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WORKED EXAMPLES

Example 1: For $y = 3x + 2$, find y when $x = 4$.

- Substitute $x = 4$ into the equation.

Replace x with 4.

- $y = 3(4) + 2$.

Multiply first.

- $y = 12 + 2 = 14$.

Then add.

Example 2: For $y = 2x - 5$, find y when $x = 3$.

- Substitute $x = 3$.

Replace x with 3.

- $y = 2(3) - 5 = 6 - 5 = 1$.

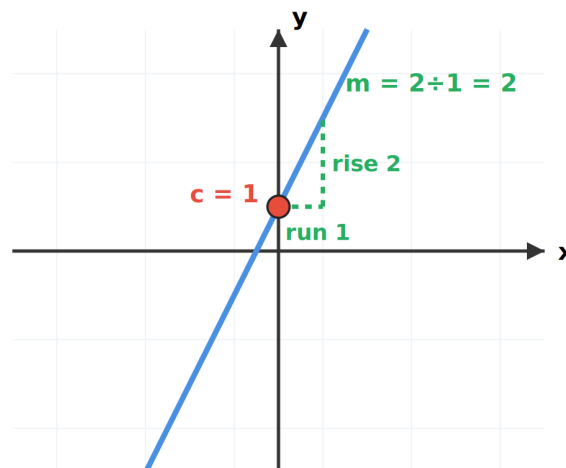
Calculate step by step.

EXERCISES (EASY → DIFFICULT)

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

Find gradient and intercept

Finding gradient and y-intercept

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DEFINITIONS

Gradient	The slope of a line. Positive = uphill, negative = downhill, zero = flat.
Y-intercept	The y-value where the line crosses the y-axis. Found by setting $x = 0$.
Standard form $y = mx + c$	m is the gradient, c is the y-intercept — read them off directly.

KEY FORMULAS

- **From $y = mx + c$:** gradient is m , y-intercept is c
- **From two points:** $m = (y_2 - y_1) / (x_2 - x_1)$
- **Rise over run:** for every 1 step right, the line goes up m units

WORKED EXAMPLES

Example 1: Find the gradient and y-intercept of $y = 3x + 5$.

- Compare with $y = mx + c$.
Identify which number is m and which is c .
- $m = 3$ (the number in front of x).
Gradient is the coefficient of x .
- $c = 5$ (the constant term).
Y-intercept is the standalone number.
- **Gradient = 3, y-intercept = 5.**
Read directly off the equation.

Example 2: Find the gradient of $y = -2x + 7$.

- The number in front of x is the gradient.
Standard form.
- **Gradient = -2.**
Negative — line goes downhill.

EXERCISES (EASY → DIFFICULT)

1. Gradient of $y = 4x + 9$:
2. Gradient of $y = 3x + 4$:
3. Gradient of $y = 2x + 0$:
4. Gradient of $y = 5x + 8$:
5. Gradient of $y = 5x + 6$:
6. Gradient of $y = 4x + 8$:
7. Gradient of $y = 2x + 3$:
8. Gradient of $y = 4x + 2$:
9. Gradient of $y = 5x + -1$:
10. Gradient of $y = 3x + 9$:



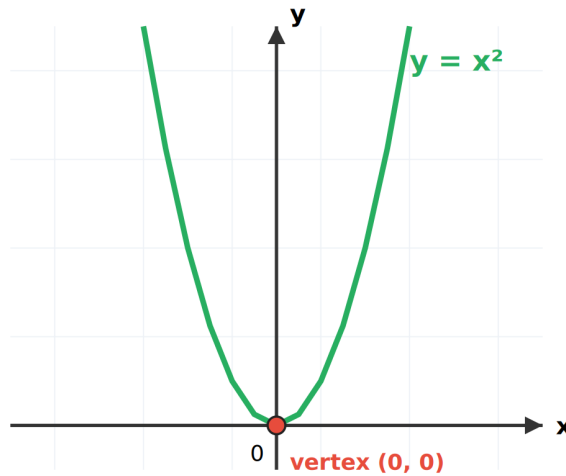
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Quadratic function (intro)

Quadratic functions (intro)



DEFINITIONS

Quadratic function

A function with x^2 as its highest power. Form: $y = ax^2 + bx + c$.

Parabola

The U-shaped curve made by a quadratic function.

Vertex

The lowest (or highest) point of the parabola — the "tip".

KEY FORMULAS

- **Simple form:** $y = ax^2$
- **Symmetry:** graph is symmetric about the y-axis (for $y = ax^2$)
- **Substitution:** $y = ax^2$ means $y = a \times x \times x$

WORKED EXAMPLES

Example 1: For $y = 2x^2$, find y when $x = 3$.

- Substitute $x = 3$.

Replace x .

- $y = 2 \times 3^2 = 2 \times 9$.

Square first, then multiply.

- **$y = 18$.**

Final answer.

Example 2: For $y = 3x^2$, find y when $x = 4$.

- Substitute $x = 4$.

Replace x .

- $y = 3 \times 4^2 = 3 \times 16 = 48$.

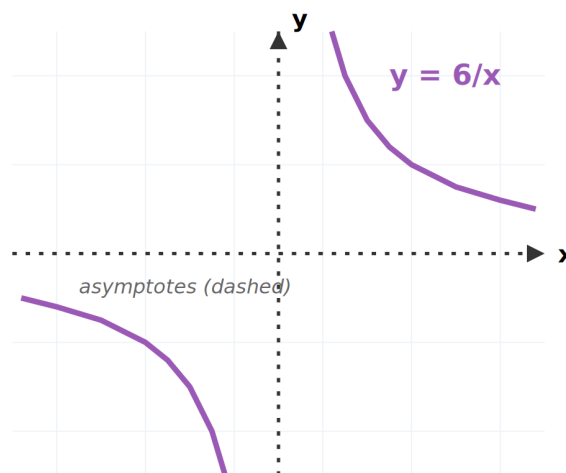
Square first.

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**EXERCISES (EASY → DIFFICULT)**

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

Hyperbola $y = k/x$ **DEFINITIONS**

Hyperbola	A function of the form $y = k/x$. It has two separate curves (branches).
Asymptote	A line that the curve gets closer and closer to, but never touches.

KEY FORMULAS

- **Basic hyperbola:** $y = k/x$
- **Asymptotes:** $x = 0$ (vertical) and $y = 0$ (horizontal)
- **Substitution:** divide k by the value of x

WORKED EXAMPLES

Example 1: For $y = 12/x$, find y when $x = 3$.

► Substitute $x = 3$.

Replace x .

► $y = 12 \div 3 = 4$.

Division.

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**Example 2: For $y = 6/x$, find y when $x = 2$.**

► Substitute $x = 2$.

Replace x .

► $y = 6 \div 2 = 3$.

Division.

EXERCISES (EASY → DIFFICULT)

1. $y = 11/x$. y when $x = 6$:
2. $y = 9/x$. y when $x = 2$:
3. $y = 3/x$. y when $x = 1$:
4. $y = 2/x$. y when $x = 1$:
5. $y = 12/x$. y when $x = 2$:
6. $y = 6/x$. y when $x = 3$:
7. $y = 9/x$. y when $x = 1$:
8. $y = 10/x$. y when $x = 2$:
9. $y = 10/x$. y when $x = 4$:
10. $y = 7/x$. y when $x = 6$:

End of Chapter 5 — Mixed Exercise

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

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





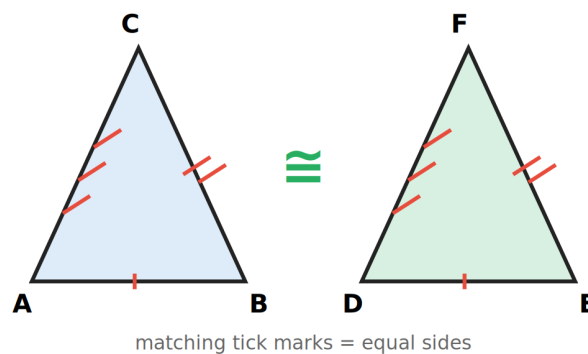
CHAPTER 6

Geometry

Triangle Triangle congruency tests
Similar Similar triangles
Properties Properties of quadrilaterals
Polygon Polygon angle sums

Triangle congruency (SSS, SAS, AAS, RHS)

Triangle congruency tests



DEFINITIONS

Congruent	Exactly the same size and shape. One can be placed perfectly on top of the other.
Congruency test	A rule that proves two triangles are congruent without measuring everything.
Included angle	The angle between two named sides of a triangle.

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: for right-angled triangles only



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WORKED EXAMPLES

Example 1: Two triangles have all three corresponding sides equal. Which test proves they're congruent?

- Identify what's given: three pairs of equal sides.

No angles, just sides.

- Match to the tests.

Three sides = SSS test.

- **SSS proves they're congruent.**

Side-Side-Side.

Example 2: Two right triangles have equal hypotenuses and one matching leg. Which test?

- Right angle is given.

Special case.

- Hypotenuse and one side match.

Classic RHS situation.

- **RHS proves congruence.**

Right angle, Hypotenuse, Side.

EXERCISES (EASY → DIFFICULT)

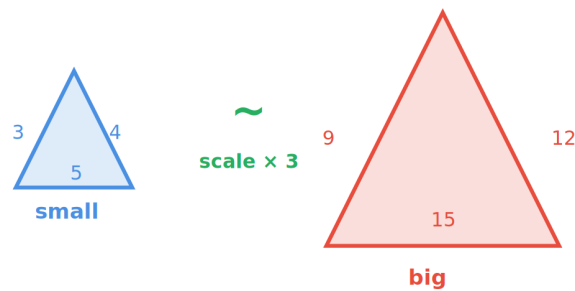
1. If 3 sides of one triangle equal 3 sides of another, the test is:
2. Which condition: all three sides equal?
3. Which condition: two sides and the included angle?
4. Which condition: two angles and a corresponding side?
5. Which condition: right angle, hypotenuse and one side?
6. Do congruent triangles have equal area?
7. Are all sides of congruent triangles equal?
8. Is SSA a valid congruency rule?
9. Congruent triangles are the same shape and ...?
10. Which condition: hypotenuse + side in right triangles?

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Similar triangles



DEFINITIONS

Similar triangles	Same shape but possibly different sizes. Corresponding angles are equal; corresponding sides are in the same ratio.
Scale factor	The number you multiply a side by to get the matching side in the similar triangle.
Corresponding sides	Sides in the same relative position in the two triangles.

KEY FORMULAS

- **If similar:** all angles equal AND all sides in the same ratio
- **Scale factor:** big side $\div$ small side
- **Finding a side:** known side $\times$ scale factor

WORKED EXAMPLES

Example 1: Two similar triangles have scale factor 3. If the small side is 5, what's the matching big side?

- Scale factor = 3, so big sides are 3 times the small ones.

Multiply by scale factor.

- Big side = 5×3 .

Apply the rule.

- = **15**.

Done.

Example 2: Two similar triangles have scale factor 2. If the small side is 7, what's the big side?

- Big = small $\times$ scale factor.

Standard rule.

- $7 \times 2 = \mathbf{14}$.

Multiply.



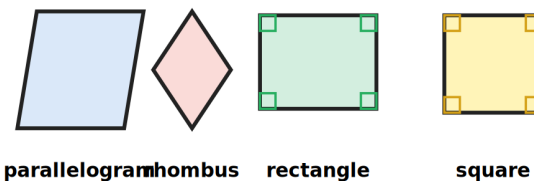
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EXERCISES (EASY → DIFFICULT)

- Two similar triangles, scale factor 2. If small side is 5, big side?
- Two similar triangles, scale factor 4. If small side is 5, big side?
- Two similar triangles, scale factor 3. If small side is 5, big side?
- Triangles are similar with sides 3,4,5 and 6,8,?. Find the missing side.
- Scale factor from 2 to 6 is?
- If sides scale $\times 4$, area scales $\times$?
- Similar triangles: $5 \rightarrow 15$, so $4 \rightarrow$?
- Similar triangles: $3 \rightarrow 12$, scale factor?
- Similar triangles have equal ...?
- Sides 2,3 scale to 8, so $3 \rightarrow$?

Properties of quadrilaterals



DEFINITIONS

Quadrilateral	A four-sided shape (any closed figure with 4 straight sides).
Parallelogram	A quadrilateral with two pairs of parallel sides. Opposite sides equal, opposite angles equal.
Rhombus	A parallelogram where ALL four sides are equal.
Rectangle	A parallelogram with all four angles equal to 90° .
Square	A rectangle AND a rhombus — all sides equal AND all angles 90° .

KEY FORMULAS

- Parallelogram:** opposite sides equal & parallel; opposite angles equal
- Rhombus:** all 4 sides equal; diagonals bisect at 90°
- Rectangle:** all 4 angles = 90° ; diagonals equal
- Square:** all sides equal AND all angles 90° (rectangle + rhombus)
- All quadrilaterals:** interior angles add to 360°

WORKED EXAMPLES

Example 1: A parallelogram has what property?

- Think about the definition.

Parallelogram = quadrilateral with two pairs of parallel sides.

- **Opposite sides are equal** (and parallel).

Direct property.



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**Example 2: What makes a square different from a rectangle?**

- Both have 4 right angles.

Shared property.

- A rectangle has opposite sides equal; a square has **all four sides equal**.

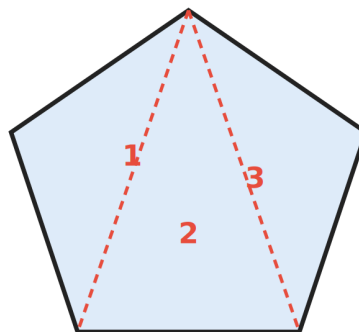
Equal sides is the extra condition.

EXERCISES (EASY → DIFFICULT)

1. A rectangle has:
2. A rhombus has:
3. A parallelogram has:
4. How many sides does a quadrilateral have?
5. Sum of interior angles of any quadrilateral?
6. A square has how many lines of symmetry?
7. Opposite sides of a parallelogram are?
8. Diagonals of a rhombus meet at what angle?
9. A rectangle has how many right angles?
10. All sides equal, all angles 90° — which shape?

Polygon angle sum

Polygon angle sums



5 sides → 3 triangles

$$3 \times 180^\circ = \mathbf{540^\circ}$$

DEFINITIONS

Polygon	A closed figure made of straight sides. A triangle is a 3-gon, square is a 4-gon, etc.
Interior angle	An angle inside the polygon, between two sides.
Regular polygon	A polygon where all sides and all angles are equal.

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KEY FORMULAS

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

WORKED EXAMPLES

Example 1: Find the sum of interior angles of a pentagon (5 sides).

- Use the formula $(n - 2) \times 180^\circ$.

$$n = 5.$$

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

Subtract first.

$$\text{► } = \mathbf{540^\circ}.$$

Multiply.

Example 2: Find the sum of interior angles of a hexagon (6 sides).

- Apply $(n - 2) \times 180^\circ$.

$$n = 6.$$

$$\text{► } (6 - 2) \times 180 = 4 \times 180 = \mathbf{720^\circ}.$$

Calculate.

EXERCISES (EASY → DIFFICULT)

1. Sum of interior angles of 3-gon:
2. Sum of interior angles of 5-gon:
3. Sum of interior angles of 4-gon:
4. Sum of interior angles of 9-gon:
5. Sum of interior angles of 10-gon:
6. Sum of interior angles of 8-gon:
7. Sum of interior angles of 7-gon:
8. Sum of interior angles of 6-gon:
9. Sum of interior angles of a 5-sided polygon?
10. Sum of interior angles of a 6-sided polygon?

End of Chapter 6 — Mixed Exercise

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

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1. If 3 sides of one triangle equal 3 sides of another, the test is:
2. Two similar triangles, scale factor 4. If small side is 5, big side?
3. A parallelogram has:
4. Sum of interior angles of 9-gon:
5. Which condition: right angle, hypotenuse and one side?
6. If sides scale $\times 4$, area scales $\times$?
7. Opposite sides of a parallelogram are?
8. Sum of interior angles of 6-gon:
9. Congruent triangles are the same shape and ...?
10. Sides 2,3 scale to 8, so 3 $\rightarrow$?



CHAPTER 7

Pythagoras

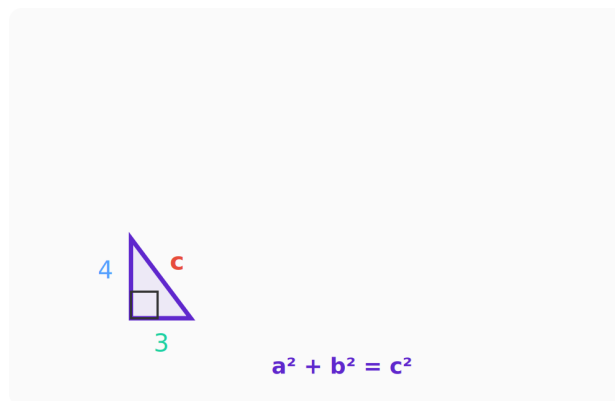
Find Pythagoras — find the hypotenuse

Find Pythagoras — find a missing leg

Verify Verifying a right triangle

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 of a right triangle — they form the right angle.

KEY FORMULAS

- **Pythagoras' Theorem:** $a^2 + b^2 = c^2$
- **c is the hypotenuse** (the longest side, opposite the right angle)
- **a and b are the legs** (the two shorter sides)
- **To find c:** $c = \sqrt{a^2 + b^2}$



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WORKED EXAMPLES

Example 1: Find the hypotenuse of a right triangle with legs 3 and 4.

► Apply $a^2 + b^2 = c^2$.

Pythagoras' Theorem.

► $3^2 + 4^2 = c^2 \rightarrow 9 + 16 = c^2 \rightarrow 25 = c^2$.

Square each leg and add.

► $c = \sqrt{25} = 5$.

Take the square root.

► **Hypotenuse = 5.**

Classic 3-4-5 triangle.

Example 2: Find the hypotenuse of a right triangle with legs 5 and 12.

► $5^2 + 12^2 = c^2 \rightarrow 25 + 144 = 169$.

Square and add.

► $c = \sqrt{169} = 13$.

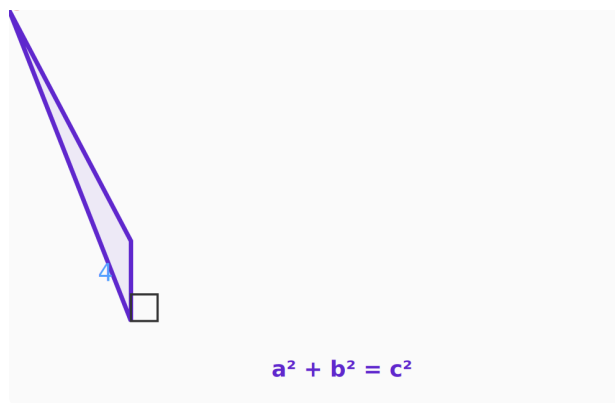
Take the root.

EXERCISES (EASY → DIFFICULT)

1. Right triangle, legs 8, 15. Hypotenuse?
2. Right triangle, legs 9, 12. Hypotenuse?
3. Right triangle, legs 5, 12. Hypotenuse?
4. Right triangle, legs 3, 4. Hypotenuse?
5. Right triangle, legs 6, 8. Hypotenuse?
6. Legs 3 and 4. Find the hypotenuse.
7. Legs 6 and 8. Find the hypotenuse.
8. Legs 5 and 12. Find the hypotenuse.
9. Legs 8 and 15. Find the hypotenuse.
10. Legs 9 and 12. Find the hypotenuse.

Find a leg

Pythagoras — find a missing leg



DEFINITIONS

Leg

One of the two shorter sides in a right triangle, perpendicular to the other.

Rearranging

Solving a formula for a different variable.

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KEY FORMULAS

- From $a^2 + b^2 = c^2$:
- To find leg a: $a^2 = c^2 - b^2 \rightarrow a = \sqrt{c^2 - b^2}$
- 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

WORKED EXAMPLES

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

- Use $a^2 + b^2 = c^2$. Let $a = 3$, $c = 5$, find b .

Label what's known.

- Rearrange: $b^2 = c^2 - a^2 = 25 - 9 = 16$.

Subtract.

- $b = \sqrt{16} = 4$.

Take the square root.

- **Other leg = 4.**

Classic 3-4-5.

Example 2: Hypotenuse = 13, one leg = 5. Find the other leg.

- $b^2 = 13^2 - 5^2 = 169 - 25 = 144$.

Subtract.

- $b = \sqrt{144} = 12$.

Square root.

EXERCISES (EASY → DIFFICULT)

1. Hypotenuse 10, leg 6. Other leg?
2. Hypotenuse 13, leg 5. Other leg?
3. Hypotenuse 5, leg 3. Other leg?
4. Hypotenuse 5, one leg 3. Find the other leg.
5. Hypotenuse 13, one leg 5. Find the other leg.
6. Hypotenuse 10, one leg 6. Find the other leg.
7. Hypotenuse 17, one leg 8. Find the other leg.
8. Hypotenuse 25, one leg 7. Find the other leg.
9. Hypotenuse 15, one leg 9. Find the other leg.
10. Hypotenuse 26, one leg 10. Find the other leg.



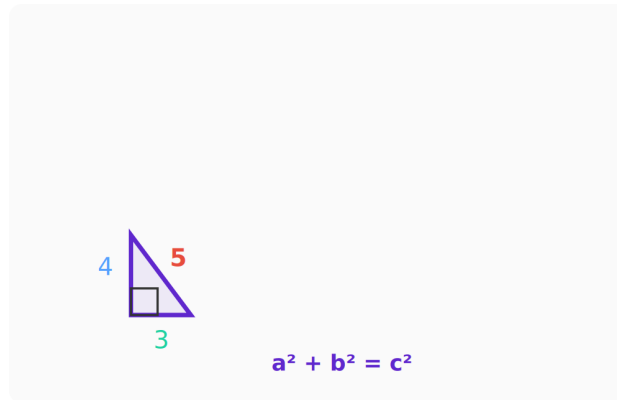
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Verify right triangle

Verifying a right triangle



DEFINITIONS

Converse of Pythagoras

If $a^2 + b^2 = c^2$ holds, then the triangle **MUST** have a right angle.

Pythagorean triple

Three whole numbers that satisfy $a^2 + b^2 = c^2$ (e.g. 3-4-5, 5-12-13, 8-15-17).

KEY FORMULAS

- **Test:** check if $(\text{smallest})^2 + (\text{middle})^2 = (\text{largest})^2$
- **If equal:** it **IS** a right triangle
- **If not equal:** it is **NOT** a right triangle

WORKED EXAMPLES

Example 1: Is a triangle with sides 6, 8, 10 a right triangle?

- Identify the longest side: 10.
That would be the hypotenuse if it's right-angled.
- Test: $6^2 + 8^2 = 36 + 64 = 100$.
Add the squares of the two shorter sides.
- Compare with $10^2 = 100$. They **MATCH**.
Both equal 100.
- **Yes — it IS a right triangle.**
Converse of Pythagoras holds.

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

- $5^2 + 6^2 = 25 + 36 = 61$.
Sum of squares of shorter sides.
- $9^2 = 81$. $61 \neq 81$.
Do not match.
- **No — NOT a right triangle.**
Test fails.

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**EXERCISES (EASY → DIFFICULT)**

1. Sides 6, 8, 10: right triangle? (yes/no)
2. Is a triangle with sides 3, 4, 5 right-angled?
3. Is a triangle with sides 5, 6, 7 right-angled?
4. Is a triangle with sides 6, 8, 10 right-angled?
5. Is a triangle with sides 5, 12, 13 right-angled?
6. Is a triangle with sides 4, 5, 6 right-angled?
7. Is a triangle with sides 8, 15, 17 right-angled?
8. Is a triangle with sides 9, 12, 15 right-angled?
9. Is a triangle with sides 2, 3, 4 right-angled?
10. Is a triangle with sides 7, 24, 25 right-angled?

End of Chapter 7 — Mixed Exercise

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

1. Right triangle, legs 8, 15. Hypotenuse?
2. Hypotenuse 13, leg 5. Other leg?
3. Is a triangle with sides 5, 6, 7 right-angled?
4. Right triangle, legs 3, 4. Hypotenuse?
5. Hypotenuse 13, one leg 5. Find the other leg.
6. Is a triangle with sides 4, 5, 6 right-angled?
7. Legs 6 and 8. Find the hypotenuse.
8. Hypotenuse 25, one leg 7. Find the other leg.
9. Is a triangle with sides 2, 3, 4 right-angled?
10. Legs 9 and 12. Find the hypotenuse.

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CHAPTER 8

Trigonometry

Define Trig ratios: sin, cos, tan

Find Calculating trig ratios from a triangle

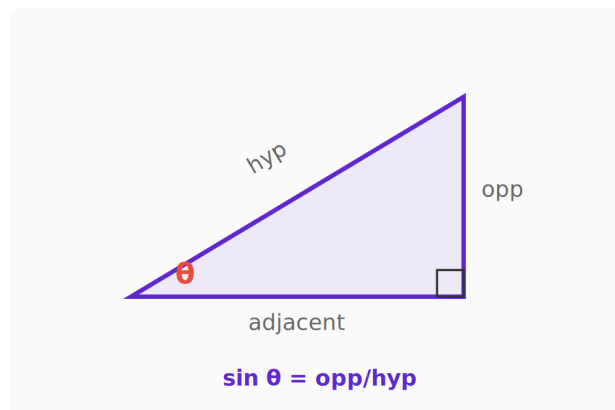
Find Calculating tangent

Find Finding angles using inverse trig

Find Finding a side using sin

Define sin, cos, tan

Trig ratios: sin, cos, tan



DEFINITIONS

Opposite side	The side ACROSS FROM the angle θ . It doesn't touch the angle.
Adjacent side	The side NEXT TO the angle θ (not the hypotenuse).
Hypotenuse	The longest side — always opposite the right angle.
Trig ratio	A ratio of two sides of a right triangle that depends only on the angle.

KEY FORMULAS

- **SOH** — $\sin \theta = \text{Opposite} \div \text{Hypotenuse}$
- **CAH** — $\cos \theta = \text{Adjacent} \div \text{Hypotenuse}$
- **TOA** — $\tan \theta = \text{Opposite} \div \text{Adjacent}$
- **Memory trick:** SOH CAH TOA ("Some Old Hippy Caught A High Tide Off Australia")



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WORKED EXAMPLES

Example 1: In a right triangle, what does $\sin \theta$ equal?

- Remember SOH-CAH-TOA.

SOH stands for Sine = Opposite over Hypotenuse.

- **$\sin \theta = \text{opposite} \div \text{hypotenuse}$.**

First letters spell SOH.

Example 2: Which ratio uses adjacent and hypotenuse?

- Check the three ratios.

SOH, CAH, TOA.

- **Cosine — $\text{CAH} = \text{Adjacent} \div \text{Hypotenuse}$.**

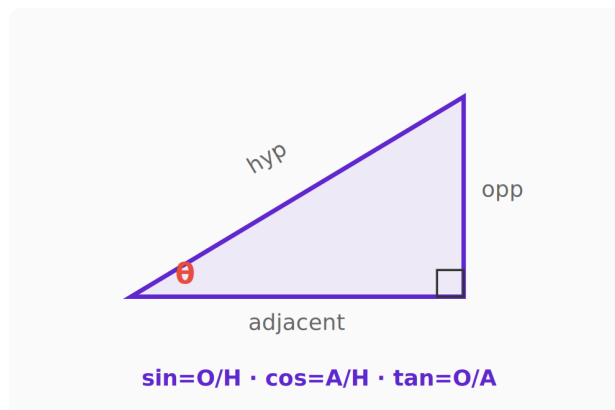
C for cos, A for adjacent, H for hypotenuse.

EXERCISES (EASY → DIFFICULT)

1. In a right triangle, $\sin \theta = \text{opposite} \div ?$
2. $\sin \theta = \text{opposite} \div ?$
3. $\cos \theta = \text{adjacent} \div ?$
4. $\tan \theta = \text{opposite} \div ?$
5. SOH stands for $\sin = ?$
6. CAH stands for $\cos = ?$
7. TOA stands for $\tan = ?$
8. The longest side of a right triangle is the?
9. The side across from θ is the?
10. The side next to θ (not the hypotenuse) is the?

Find sin, cos, tan from triangle

Calculating trig ratios from a triangle



DEFINITIONS

Ratio

A comparison of two numbers, usually as a fraction.

Trig ratio

Specific to right triangles: opp/hyp , adj/hyp , or opp/adj .

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KEY FORMULAS

- $\sin \theta = \text{opp} \div \text{hyp}$
- $\cos \theta = \text{adj} \div \text{hyp}$
- $\tan \theta = \text{opp} \div \text{adj}$
- **Strategy:** identify the three sides relative to θ , then divide

WORKED EXAMPLES

Example 1: Right triangle with opp = 3, adj = 4, hyp = 5. Find $\sin \theta$.

- Use SOH: $\sin \theta = \text{opposite} \div \text{hypotenuse}$.

Pick the right ratio.

- Substitute: $3 \div 5$.

Plug in the values.

- **$\sin \theta = 3/5$.**

Express as a fraction.

Example 2: Same triangle (opp=3, adj=4, hyp=5). Find $\cos \theta$.

- Use CAH: $\cos \theta = \text{adjacent} \div \text{hypotenuse}$.

Cosine ratio.

- **$\cos \theta = 4/5$.**

$4 \div 5$.

EXERCISES (EASY → DIFFICULT)

1. Right triangle: opp=3, adj=4, hyp=5. $\sin \theta$?
2. Opposite 3, hypotenuse 5. $\sin \theta$?
3. Adjacent 4, hypotenuse 5. $\cos \theta$?
4. Opposite 3, adjacent 4. $\tan \theta$?
5. Opposite 6, hypotenuse 10. $\sin \theta$?
6. Adjacent 8, hypotenuse 10. $\cos \theta$?
7. Opposite 5, hypotenuse 13. $\sin \theta$?
8. Adjacent 12, hypotenuse 13. $\cos \theta$?
9. Opposite 5, adjacent 12. $\tan \theta$?
10. Opposite 8, adjacent 6. $\tan \theta$?



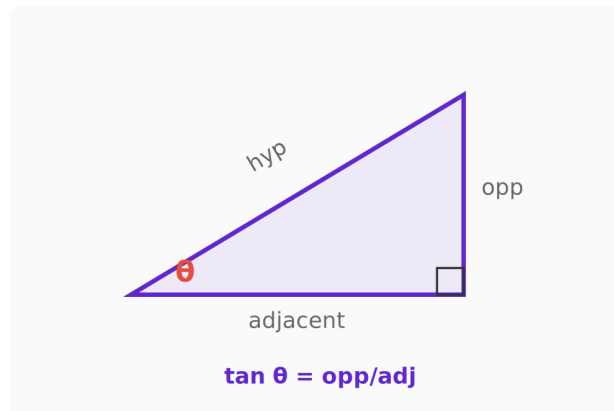
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Find tan in right triangle

Calculating tangent



DEFINITIONS

Tangent (tan) The ratio of opposite over adjacent in a right triangle.

KEY FORMULAS

- $\tan \theta = \text{opp} \div \text{adj}$
- **TOA** = Tangent equals Opposite over Adjacent
- **Note:** tangent doesn't involve the hypotenuse

WORKED EXAMPLES

Example 1: Right triangle, opp = 3, adj = 4. Find tan θ .

- Use TOA: $\tan \theta = \text{opposite} \div \text{adjacent}$.

Tangent uses opp and adj.

- Substitute: $3 \div 4$.

Plug in.

- **$\tan \theta = 3/4$.**

Express as fraction.

Example 2: opp = 5, adj = 12. Find tan θ .

- $\tan \theta = \text{opp}/\text{adj} = 5/12$.

Apply TOA.

- **$\tan \theta = 5/12$.**

Done.

EXERCISES (EASY → DIFFICULT)

1. Right triangle: opp=3, adj=4. tan θ ?
2. Opposite 6, adjacent 8. tan θ ?
3. Opposite 3, adjacent 4. tan θ ?
4. Opposite 5, adjacent 12. tan θ ?
5. Opposite 8, adjacent 15. tan θ ?
6. Opposite 7, adjacent 24. tan θ ?
7. Opposite 9, adjacent 12. tan θ ?
8. Opposite 4, adjacent 3. tan θ ?
9. Opposite 12, adjacent 5. tan θ ?



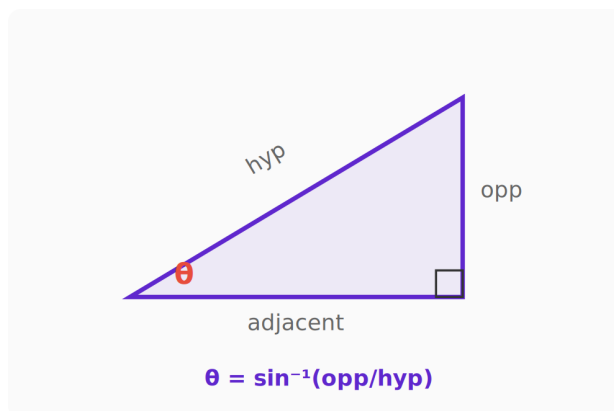
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10. Opposite 15, adjacent 8. $\tan \theta$?

Find an angle using $\sin^{-1}$

Finding angles using inverse trig



DEFINITIONS

Inverse sine ($\sin^{-1}$) The reverse of sine — given a ratio, find the angle. Also called arcsine.

Special angle An angle whose trig values are exact and worth memorising: 0° , 30° , 45° , 60° , 90° .

KEY FORMULAS

- $\sin \theta = k$ means $\theta = \sin^{-1}(k)$
- **Special values to remember:**
- $\sin 30^\circ = 0.5$ ($= 1/2$)
- $\sin 45^\circ \approx 0.707$ ($= \sqrt{2}/2$)
- $\sin 60^\circ \approx 0.866$ ($= \sqrt{3}/2$)

WORKED EXAMPLES

Example 1: If $\sin \theta = 0.5$, find θ .

► We want the angle whose sine is 0.5.

Use inverse sine.

► Recognise: $\sin 30^\circ = 0.5$ (special angle).

Memorised value.

► $\theta = 30^\circ$.

On a calculator: $\sin^{-1}(0.5) = 30^\circ$.

Example 2: If $\sin \theta = \sqrt{3}/2$, find θ .

► Recognise $\sqrt{3}/2 \approx 0.866$ as a special value.

It's $\sin 60^\circ$.

► $\theta = 60^\circ$.

Special angle.



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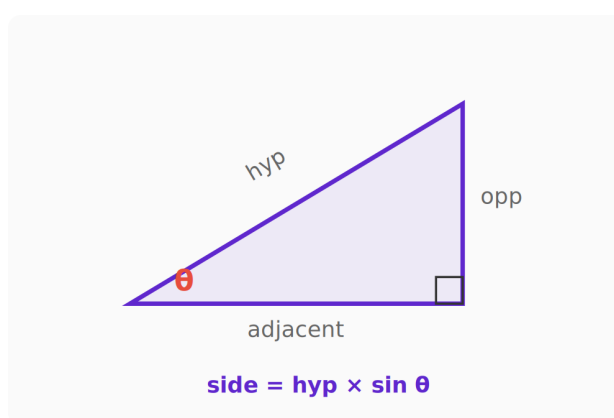
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EXERCISES (EASY → DIFFICULT)

1. In a right triangle, $\sin \theta = 0.5$. Find θ .
2. $\sin \theta = 0.5$, find θ .
3. $\sin \theta = 0.866$, find θ .
4. $\sin \theta = 0.707$, find θ .
5. $\cos \theta = 0.5$, find θ .
6. $\cos \theta = 0.866$, find θ .
7. $\tan \theta = 1$, find θ .
8. $\sin \theta = 1$, find θ .
9. $\cos \theta = 1$, find θ .
10. $\tan \theta = 0.577$, find θ .

Find a side using sin

Finding a side using sin



DEFINITIONS

Solving a triangle

Finding missing sides or angles using known information and trig.

KEY FORMULAS

- **Rearrange $\sin \theta = \text{opp}/\text{hyp}$:**
- **$\text{opp} = \text{hyp} \times \sin \theta$** (when you know hyp and angle)
- **$\text{hyp} = \text{opp} \div \sin \theta$** (when you know opp and angle)
- **Procedure:** draw the triangle, label, pick the right ratio, substitute

WORKED EXAMPLES

Example 1: Hypotenuse = 10, angle = 30° . Find the opposite side.

- Use $\sin \theta = \text{opp}/\text{hyp}$, rearranged: $\text{opp} = \text{hyp} \times \sin \theta$.

Solve for opp.

- Substitute: $\text{opp} = 10 \times \sin 30^\circ$.

Plug in values.

- $\sin 30^\circ = 0.5$, so $\text{opp} = 10 \times 0.5 = 5$.

Apply special angle.

- **Opposite side = 5.**

Final answer.



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**Example 2: Hypotenuse = 20, angle = 60°. Find opposite.**

► $\text{opp} = 20 \times \sin 60^\circ = 20 \times (\sqrt{3}/2).$

Apply formula.

► $= 10\sqrt{3} \approx 17.32.$

Calculate.

EXERCISES (EASY → DIFFICULT)

1. Hyp=10, angle=30°. Opposite side?
2. $\sin 30^\circ = x/10$. Find x.
3. Hypotenuse 20, angle 30°. Opposite?
4. $\sin 90^\circ = x/8$. Find x.
5. Hypotenuse 10, angle 45°. Opposite?
6. $\sin 60^\circ = x/10$. Find x.
7. Hypotenuse 12, angle 30°. Opposite?
8. $\sin 30^\circ = x/14$. Find x.
9. Hypotenuse 16, angle 90°. Opposite?
10. $\sin 45^\circ = x/20$. Find x.

End of Chapter 8 — Mixed Exercise

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

1. In a right triangle, $\sin \theta = \text{opposite} \div ?$
2. Opposite 3, hypotenuse 5. $\sin \theta?$
3. Opposite 3, adjacent 4. $\tan \theta?$
4. $\sin \theta = 0.707$, find θ .
5. Hypotenuse 10, angle 45°. Opposite?
6. CAH stands for $\cos = ?$
7. Opposite 5, hypotenuse 13. $\sin \theta?$
8. Opposite 4, adjacent 3. $\tan \theta?$
9. $\cos \theta = 1$, find θ .
10. $\sin 45^\circ = x/20$. Find x.

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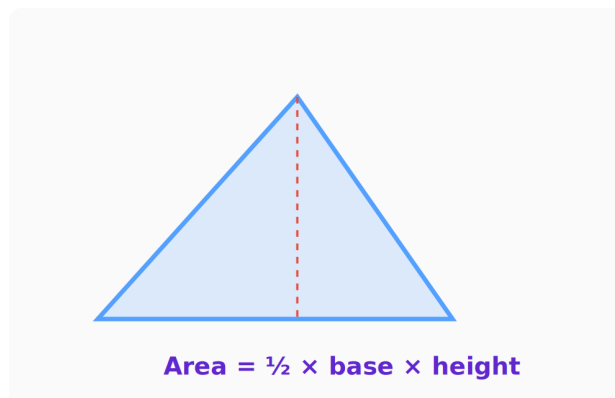
CHAPTER 9

Mensuration

- Area** Area of a triangle
- Area** Area of a circle
- Circumference** Circumference of a circle
- Volume** Volume of a rectangular prism
- Volume** Volume of a cylinder
- Surface** Surface area of a cylinder

Area of triangle

Area of a triangle



DEFINITIONS

Area	The amount of flat space inside a shape, measured in square units.
Base of a triangle	Any one side you choose as the bottom of the triangle.
Height (h)	The perpendicular distance from the base to the opposite vertex.

KEY FORMULAS

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



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WORKED EXAMPLES

Example 1: Triangle with base 8 cm and height 5 cm. Find the area.

► Apply $A = \frac{1}{2} \times b \times h$.

Triangle area formula.

► $A = \frac{1}{2} \times 8 \times 5$.

Substitute $b = 8$, $h = 5$.

► $= \frac{1}{2} \times 40 = 20 \text{ cm}^2$.

Multiply, then halve.

Example 2: Triangle with base 6 cm and height 9 cm. Find the area.

► $A = \frac{1}{2} \times 6 \times 9$.

Substitute.

► $= \frac{1}{2} \times 54 = 27 \text{ cm}^2$.

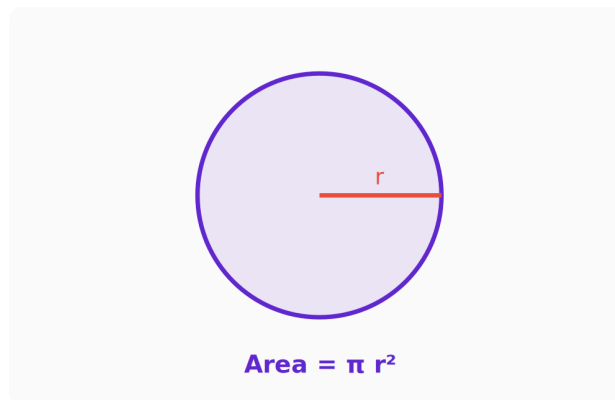
Calculate.

EXERCISES (EASY → DIFFICULT)

1. Triangle $b=6$, $h=6$. Area:
2. Triangle $b=6$, $h=3$. Area:
3. Triangle $b=4$, $h=4$. Area:
4. Triangle $b=12$, $h=7$. Area:
5. Triangle $b=4$, $h=6$. Area:
6. Triangle $b=4$, $h=10$. Area:
7. Triangle $b=6$, $h=7$. Area:
8. Triangle $b=12$, $h=8$. Area:
9. Triangle $b=10$, $h=8$. Area:
10. Triangle $b=6$, $h=5$. Area:

Area of circle ($\pi=3.14$)

Area of a circle



DEFINITIONS

Radius (r)	The distance from the centre of the circle to any point on its edge.
Diameter	The distance across the circle through the centre. Diameter = $2 \times$ radius.
π (pi)	A special number approximately equal to 3.14 (or $22/7$). It relates a circle's circumference to its diameter.



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KEY FORMULAS

- **Area of circle:** $A = \pi r^2$
- **Square the radius first**, then multiply by π
- **With $\pi = 3.14$:** $A \approx 3.14 \times r^2$
- **Units:** r in cm $\rightarrow$ A in cm^2

WORKED EXAMPLES

Example 1: Circle with radius 5. Find the area (use $\pi = 3.14$).

► Apply $A = \pi r^2$.

Circle area formula.

► Square first: $5^2 = 25$.

Always square the radius before multiplying.

► $A = 3.14 \times 25 = \mathbf{78.5}$.

Multiply by π .

Example 2: Circle with radius 3. Area? ($\pi = 3.14$)

► $A = \pi \times 3^2 = 3.14 \times 9$.

Substitute.

► = **28.26**.

Multiply.

EXERCISES (EASY $\rightarrow$ DIFFICULT)

1. Circle $r=3$. Area ($\pi=3.14$):
2. Circle $r=7$. Area ($\pi=3.14$):
3. Circle $r=4$. Area ($\pi=3.14$):
4. Circle $r=2$. Area ($\pi=3.14$):
5. Circle $r=5$. Area ($\pi=3.14$):
6. Circle $r=6$. Area ($\pi=3.14$):
7. Circle $r=8$. Area ($\pi=3.14$):
8. Area of a circle, $r = 5$ ($\pi = 3.14$).
9. Area of a circle, $r = 10$ ($\pi = 3.14$).
10. Area of a circle, $r = 3$ ($\pi = 3.14$).

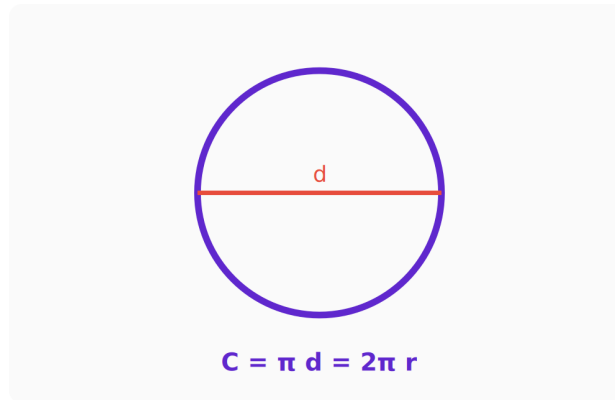
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Circumference ($\pi=3.14$)

Circumference of a circle



DEFINITIONS

Circumference The distance all the way around a circle — the perimeter of the circle.

π (pi) Ratio of circumference to diameter, approximately 3.14.

KEY FORMULAS

- **Circumference:** $C = 2\pi r$ (radius form) OR $C = \pi d$ (diameter form)
- **With $\pi = 3.14$:** $C \approx 2 \times 3.14 \times r = 6.28 \times r$
- **Units:** r in cm $\rightarrow$ C in cm (NOT cm^2)

WORKED EXAMPLES

Example 1: Circle with radius 4. Find the circumference ($\pi = 3.14$).

- Apply $C = 2\pi r$.

Circumference formula.

- $C = 2 \times 3.14 \times 4$.

Substitute.

- = **25.12**.

Multiply.

Example 2: Circle with radius 5. Find C. ($\pi = 3.14$)

- $C = 2 \times 3.14 \times 5$.

Apply formula.

- = **31.4**.

Calculate.

EXERCISES (EASY $\rightarrow$ DIFFICULT)

1. Circle $r=6$. Circumference:
2. Circle $r=2$. Circumference:
3. Circle $r=3$. Circumference:
4. Circle $r=7$. Circumference:
5. Circle $r=4$. Circumference:
6. Circle $r=8$. Circumference:
7. Circle $r=5$. Circumference:



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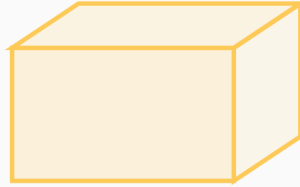
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8. Circumference, $r = 5$ ($\pi = 3.14$).
9. Circumference, $r = 10$ ($\pi = 3.14$).
10. Circumference, $r = 7$ ($\pi = 3.14$).

Volume of prism

Volume of a rectangular prism



$$V = \text{base area} \times \text{height}$$

DEFINITIONS

Volume	The amount of 3D space inside a solid shape, measured in cubic units.
Rectangular prism (box)	A 3D shape with 6 rectangular faces. Has length, width, and height.

KEY FORMULAS

- **Volume of a box:** $V = \text{length} \times \text{width} \times \text{height}$
- **Or simply:** $V = lwh$
- **Units:** if l , w , h are in cm , V is in cm^3 (cubic)

WORKED EXAMPLES

Example 1: Box with length 4, width 3, height 5. Find the volume.

- Apply $V = l \times w \times h$.

Prism volume formula.

- $V = 4 \times 3 \times 5$.

Multiply all three.

- $= 60 \rightarrow$ **60 cubic units.**

Final answer.

Example 2: Box $2 \times 6 \times 8$. Find V .

- $V = 2 \times 6 \times 8 = 96$.

Just multiply.

- **96 cubic units.**

Done.

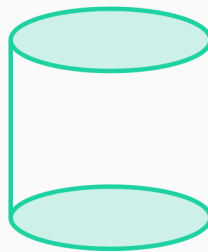


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**EXERCISES (EASY → DIFFICULT)**

1. Box $2 \times 2 \times 8$. Volume:
2. Box $6 \times 7 \times 2$. Volume:
3. Box $4 \times 4 \times 3$. Volume:
4. Box $7 \times 5 \times 2$. Volume:
5. Box $5 \times 5 \times 6$. Volume:
6. Box $8 \times 7 \times 6$. Volume:
7. Box $3 \times 7 \times 6$. Volume:
8. Box $4 \times 7 \times 2$. Volume:
9. Box $4 \times 3 \times 8$. Volume:
10. Box $3 \times 3 \times 8$. Volume:

Volume of cylinder ($\pi=3$)*Volume of a cylinder*

$$V = \pi r^2 h$$

DEFINITIONS**Cylinder**

A 3D shape with two circular bases connected by a curved surface (like a tin can).

Base area

For a cylinder, the area of the circular top or bottom $= \pi r^2$.

KEY FORMULAS

- **Volume of cylinder:** $V = \pi r^2 h$
- **= (base area) $\times$ height**
- **With $\pi = 3$:** $V \approx 3 \times r^2 \times h$
- **Units:** r and h in $\text{cm} \rightarrow V$ in cm^3

WORKED EXAMPLES**DIGITAL TEXTBOOK**

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

► Apply $V = \pi r^2 h$.

Cylinder volume formula.

► Square r first: $4^2 = 16$.

Square the radius.

► $V = 3 \times 16 \times 5$.

Substitute.

► = **240**.

Multiply through.

Example 2: Cylinder $r = 3$, $h = 7$. ($\pi = 3$)

► $V = \pi \times 3^2 \times 7 = 3 \times 9 \times 7$.

Square radius first.

► = **189**.

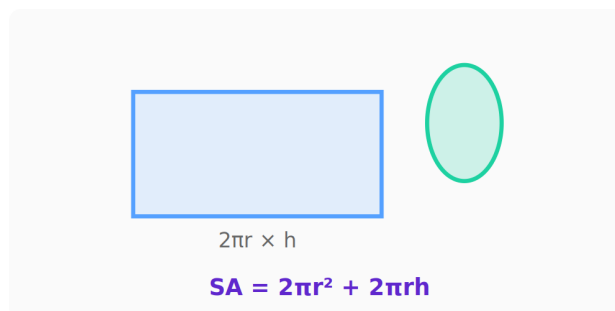
Multiply.

EXERCISES (EASY → DIFFICULT)

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

Surface area of cylinder

Surface area of a cylinder

**DEFINITIONS**

Surface area The TOTAL area of every face of a 3D shape.

Curved surface The "wraparound" of a cylinder — when unrolled, it's a rectangle of width $2\pi r$ and height h .

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KEY FORMULAS

- **Surface area of cylinder:** $SA = 2\pi r^2 + 2\pi rh$
- $2\pi r^2$ = the two circular caps (top + bottom)
- $2\pi rh$ = the curved surface (rolled-out rectangle)
- **With $\pi = 3$:** $SA \approx 6r^2 + 6rh$

WORKED EXAMPLES

Example 1: Cylinder with $r = 3$, $h = 4$. Find SA. ($\pi = 3$)

- Apply $SA = 2\pi r^2 + 2\pi rh$.

Two parts: caps and curved wall.

- Top + bottom: $2 \times 3 \times 3^2 = 2 \times 3 \times 9 = 54$.

Two circular caps.

- Curved: $2 \times 3 \times 3 \times 4 = 72$.

Wraparound.

- Total: $54 + 72 = \mathbf{126}$.

Add both.

Example 2: Cylinder $r = 2$, $h = 5$. SA? ($\pi = 3$)

- Caps: $2 \times 3 \times 4 = 24$.

$2\pi r^2$.

- Curved: $2 \times 3 \times 2 \times 5 = 60$.

$2\pi rh$.

- Total: $24 + 60 = \mathbf{84}$.

Sum.

EXERCISES (EASY → DIFFICULT)

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



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End of Chapter 9 — Mixed Exercise

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

1. Triangle $b=6$, $h=6$. Area:
2. Circle $r=7$. Area ($\pi=3.14$):
3. Circle $r=3$. Circumference:
4. Box $7 \times 5 \times 2$. Volume:
5. Cylinder $r=4$, $h=7$. V ($\pi=3$):
6. Cylinder $r=3$, $h=4$. SA ($\pi=3$):
7. Triangle $b=6$, $h=7$. Area:
8. Area of a circle, $r = 5$ ($\pi = 3.14$).
9. Circumference, $r = 10$ ($\pi = 3.14$).
10. Box $3 \times 3 \times 8$. Volume:



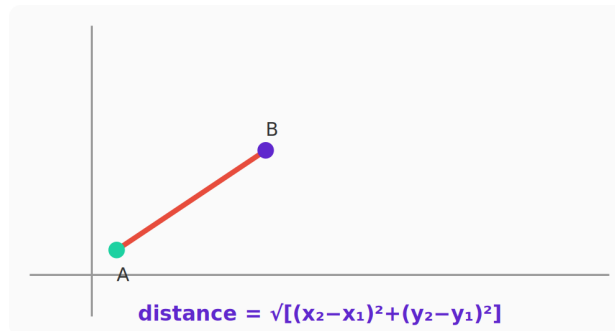


CHAPTER 10

Coordinate Geometry

- Distance** Distance formula
- Midpoint** Midpoint formula
- Gradient** Gradient (slope) of a line

Distance formula



DEFINITIONS

- Coordinate plane** A flat surface with an x-axis (horizontal) and y-axis (vertical) used to plot points.
- Ordered pair (x, y)** A pair of numbers giving a point's position: first is horizontal, second is vertical.
- Distance between two points** The straight-line distance from one point to another on the plane.

KEY FORMULAS

- Distance formula:** $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$
- From the origin (0,0):** $d = \sqrt{x^2 + y^2}$
- Comes from Pythagoras:** the differences in x and y are the legs of a right triangle



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WORKED EXAMPLES

Example 1: Find the distance from (0,0) to (3,4).

► Apply $d = \sqrt{x^2 + y^2}$.

Distance from origin.

► $= \sqrt{3^2 + 4^2} = \sqrt{9 + 16}$.

Square each coordinate, add.

► $= \sqrt{25} = 5$.

Take square root. Classic 3-4-5.

Example 2: Distance from (0,0) to (6,8)?

► $d = \sqrt{6^2 + 8^2} = \sqrt{36 + 64} = \sqrt{100}$.

Apply formula.

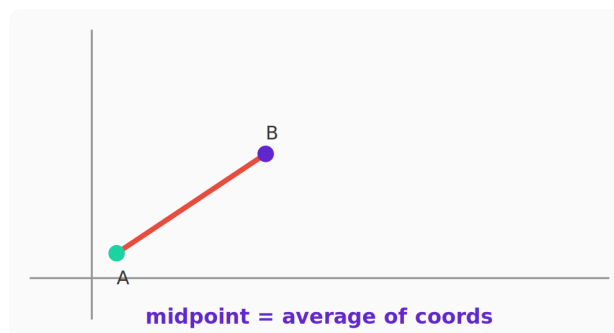
► $= 10$.

Square root.

EXERCISES (EASY → DIFFICULT)

1. Distance from (0,0) to (6,8):
2. Distance from (0,0) to (3,4):
3. Distance from (0,0) to (5,12):
4. Distance between (0,0) and (3,4).
5. Distance between (0,0) and (6,8).
6. Distance between (1,2) and (4,6).
7. Distance between $(-1, -1)$ and $(2, 3)$.
8. Distance between (0,0) and (5,12).
9. Distance between (2,3) and (2,8).
10. Distance between (0,0) and (8,15).

Midpoint formula



DEFINITIONS

Midpoint

The exact middle point of a line segment, halfway between its two endpoints.

KEY FORMULAS

- **Midpoint formula:** $M = ((x_1 + x_2)/2, (y_1 + y_2)/2)$
- **In words:** average the x-coordinates, average the y-coordinates
- **It's just the average of the two points' coordinates**



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WORKED EXAMPLES

Example 1: Find the midpoint of (0,0) and (6,8).

- Average the x-coords: $(0 + 6)/2 = 3$.

Sum and halve.

- Average the y-coords: $(0 + 8)/2 = 4$.

Same for y.

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

Halfway between the two points.

Example 2: Midpoint of (2,3) and (8,9)?

- x: $(2 + 8)/2 = 5$.

Average x.

- y: $(3 + 9)/2 = 6$.

Average y.

- **Midpoint = (5, 6).**

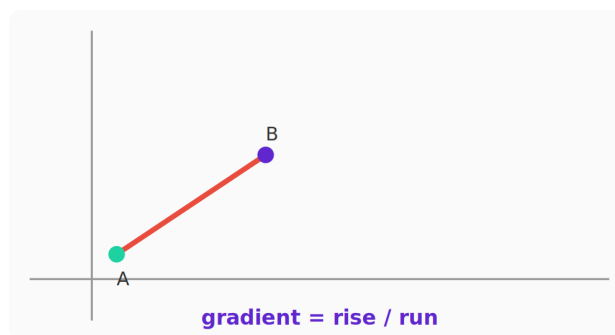
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EXERCISES (EASY → DIFFICULT)

1. Midpoint of (0,0) and (12,8):
2. Midpoint of (0,0) and (16,8):
3. Midpoint of (0,0) and (10,4):
4. Midpoint of (0,0) and (8,4):
5. Midpoint of (0,0) and (8,16):
6. Midpoint of (0,0) and (6,6):
7. Midpoint of (0,0) and (14,4):
8. Midpoint of (0,0) and (14,10):
9. Midpoint of (0,0) and (8,6):
10. Midpoint of (0,0) and (12,10):

Gradient of a line

Gradient (slope) of a line



DEFINITIONS

Gradient	The steepness of a line — how much y changes for each step in x.
Rise	The vertical change between two points (Δy).
Run	The horizontal change between two points (Δx).



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KEY FORMULAS

- **Gradient formula:** $m = (y_2 - y_1) / (x_2 - x_1)$
- **= rise ÷ run**
- **Positive m:** line goes uphill from left to right
- **Negative m:** line goes downhill
- **Zero m:** horizontal line

WORKED EXAMPLES

Example 1: Find the gradient of the line through (0,0) and (4,8).

- Apply $m = (y_2 - y_1) / (x_2 - x_1)$.

Gradient formula.

► $m = (8 - 0) / (4 - 0) = 8/4$.

Substitute.

► **$m = 2$.**

For every 1 step right, line goes up 2.

Example 2: Gradient through (0,0) and (3,9)?

► $m = (9 - 0) / (3 - 0) = 9/3$.

Apply formula.

► **$m = 3$.**

Steep uphill line.

EXERCISES (EASY → DIFFICULT)

1. Gradient through (0,0) and (5,8):
2. Gradient through (0,0) and (5,10):
3. Gradient through (0,0) and (3,5):
4. Gradient through (0,0) and (4,4):
5. Gradient through (0,0) and (2,6):
6. Gradient through (0,0) and (5,2):
7. Gradient through (0,0) and (3,10):
8. Gradient through (0,0) and (2,7):
9. Gradient through (0,0) and (3,3):
10. Gradient through (0,0) and (5,9):

End of Chapter 10 — Mixed Exercise

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

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1. Distance from $(0,0)$ to $(6,8)$:
2. Midpoint of $(0,0)$ and $(16,8)$:
3. Gradient through $(0,0)$ and $(3,5)$:
4. Distance between $(0,0)$ and $(3,4)$.
5. Midpoint of $(0,0)$ and $(8,16)$:
6. Gradient through $(0,0)$ and $(5,2)$:
7. Distance between $(-1,-1)$ and $(2,3)$.
8. Midpoint of $(0,0)$ and $(14,10)$:
9. Gradient through $(0,0)$ and $(3,3)$:
10. Distance between $(0,0)$ and $(8,15)$.





CHAPTER 11

Statistics

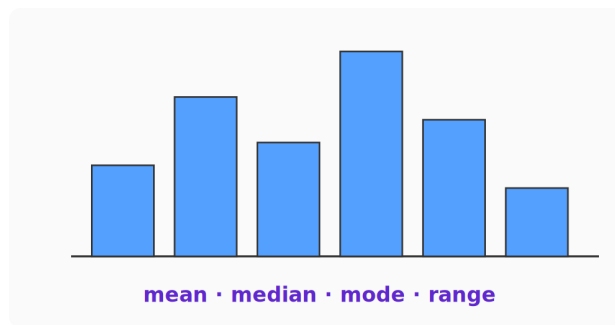
Mean, Mean, median, mode and range

Frequency Frequency tables and mode

Read Reading bar, line and pie graphs

Mean, median, mode, range

Mean, median, mode and range



DEFINITIONS

Mean (average)	Add all the numbers and divide by how many there are.
Median	The middle value when the numbers are sorted in order.
Mode	The value that appears most often.
Range	The biggest value minus the smallest value.

KEY FORMULAS

- **Mean = sum ÷ count**
- **Median:** sort the data, pick the middle one (or the average of the two middle ones if even count)
- **Mode:** the most frequent number (there can be more than one, or none)
- **Range = max – min**



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WORKED EXAMPLES

Example 1: Find the mean of 3, 5, 5, 7, 10.

- Add all the numbers: $3 + 5 + 5 + 7 + 10 = 30$.

Find the total.

- Count how many: 5 numbers.

Used as the divisor.

- Divide: $30 \div 5 = 6$.

Mean = 6.

Example 2: Find the median of 3, 5, 5, 7, 10.

- Data is already in order.

Good — proceed.

- Five values: middle is the 3rd one.

Position $(5+1)/2 = 3$.

- **Median = 5.**

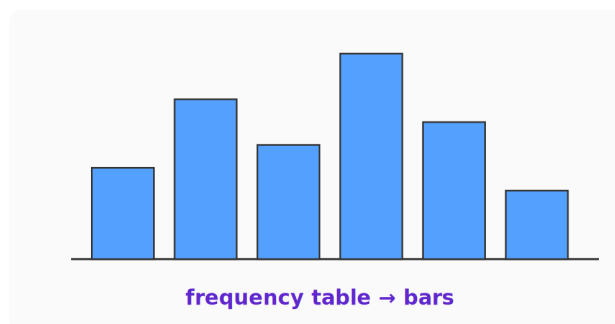
The 3rd value.

EXERCISES (EASY → DIFFICULT)

1. Mean of 3, 5, 5, 7, 10:
2. Mean of 2, 4, 6.
3. Median of 2, 3, 5, 7, 9.
4. Mode of 2, 2, 3, 4.
5. Range of 3, 8, 5, 1.
6. Mean of 10, 20, 30, 40.
7. Median of 4, 8, 6, 2.
8. Mode of 5, 5, 6, 7, 7, 7.
9. Range of 12, 4, 9, 20.
10. Mean of 6, 6, 6, 6.

Frequency tables

Frequency tables and mode



DEFINITIONS

Frequency How many times a value appears in a data set.

Frequency table A table showing each value and its frequency.

Mode The value with the highest frequency.



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KEY FORMULAS

- **To find mode:** count how many times each value appears, the most frequent is the mode
- **From a frequency table:** the mode is the value with the highest count
- **Can have multiple modes:** if two values tie for the highest frequency, both are modes

WORKED EXAMPLES

Example 1: Find the mode of 2, 2, 3, 3, 3, 5.

- ▶ Count each value: 2 appears 2 times, 3 appears 3 times, 5 appears 1 time.

Tally.

- ▶ The highest count is 3 (for the value 3).

Compare counts.

- ▶ **Mode = 3.**

Most frequent.

Example 2: Find the mode of 4, 4, 7, 8, 8, 8, 9.

- ▶ 4 appears 2 times; 7 once; 8 appears 3 times; 9 once.

Count.

- ▶ Highest count is 3, for value 8.

Find the max.

- ▶ **Mode = 8.**

Done.

EXERCISES (EASY → DIFFICULT)

1. In data 2,2,3,3,3,5: mode?
2. Values 4,4,5,5,5,6 — frequency of 5?
3. Frequencies 2,3,5 — total?
4. Values 7,7,7,8 — frequency of 7?
5. Frequencies 1,4,2,3 — total?
6. Values 2,2,2,2 — frequency of 2?
7. Frequencies 5,5 — total?
8. Values 9,9,10 — frequency of 9?
9. Frequencies 6,1,3 — total?
10. Values 3,3,3,3,3 — frequency of 3?



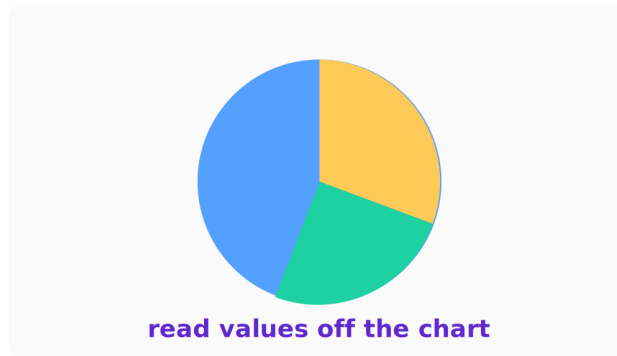
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Read graphs (line, bar, pie)

Reading bar, line and pie graphs



DEFINITIONS

Bar graph	A chart using bars to compare quantities — bar height = the value.
Line graph	A graph using points joined by lines, often showing change over time.
Pie chart	A circle divided into slices showing fractions of a whole.
Total	The sum of all the values represented.

KEY FORMULAS

- **To read a bar:** find the bar, look at its height on the y-axis
- **To find a total:** add up all the values shown
- **To compare:** see which bar/line/slice is bigger

WORKED EXAMPLES

Example 1: Bar A shows 20 and Bar B shows 30. What's the total?

- Add the two bar heights.

Total = sum of all values.

► $20 + 30 = 50$.

Simple addition.

Example 2: Bar A = 15, Bar B = 25, Bar C = 10. Total?

- Add all three: $15 + 25 + 10 = 50$.

Sum the bars.

EXERCISES (EASY → DIFFICULT)

1. Bar A=21, Bar B=27. Total?
2. Bar A=29, Bar B=36. Total?
3. Bar A=32, Bar B=22. Total?
4. Bar A=11, Bar B=33. Total?
5. Bar A=40, Bar B=39. Total?
6. Bar A=28, Bar B=20. Total?
7. Bar A=16, Bar B=34. Total?
8. Bar A=28, Bar B=22. Total?
9. Bar A=38, Bar B=33. Total?



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10. Bar A=23, Bar B=17. Total?

End of Chapter 11 — Mixed Exercise

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

1. Mean of 3, 5, 5, 7, 10:
2. Values 4,4,5,5,5,6 — frequency of 5?
3. Bar A=32, Bar B=22. Total?
4. Mode of 2, 2, 3, 4.
5. Frequencies 1,4,2,3 — total?
6. Bar A=28, Bar B=20. Total?
7. Median of 4, 8, 6, 2.
8. Values 9,9,10 — frequency of 9?
9. Bar A=38, Bar B=33. Total?
10. Mean of 6, 6, 6, 6.



CHAPTER 12

Probability

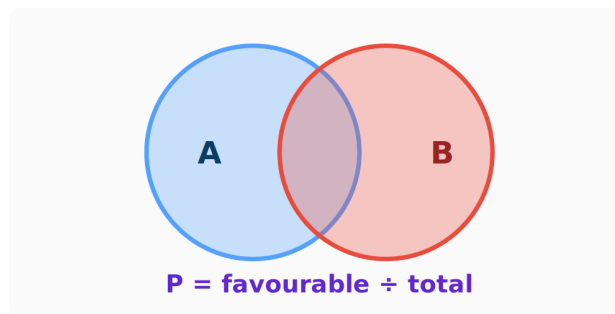
Probability Probability of a single event

Independent Independent events

Complement Complement of an event

Probability of single event

Probability of a single event



DEFINITIONS

Probability	A measure of how likely an event is, from 0 (impossible) to 1 (certain).
Outcome	A single possible result of an experiment (e.g. rolling a 5 on a die).
Favourable outcome	An outcome that counts as the event happening.
Sample space	The set of ALL possible outcomes.

KEY FORMULAS

- $P(\text{event}) = \text{favourable outcomes} \div \text{total outcomes}$
- $0 \leq P(\text{event}) \leq 1$
- $P = 0$: impossible. $P = 1$: certain. $P = 1/2$: even chance

WORKED EXAMPLES



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**Example 1: A bag has 10 balls; 3 are red. What's the probability of picking red?**

- Identify favourable: 3 red balls.

Outcomes we want.

- Identify total: 10 balls.

Total outcomes.

- **$P(\text{red}) = 3/10$.**

Favourable $\div$ total.

Example 2: Roll a fair 6-sided die. What's $P(\text{getting a 4})$?

- Favourable: just one outcome (rolling 4).

Only one face shows 4.

- Total: 6 possible outcomes.

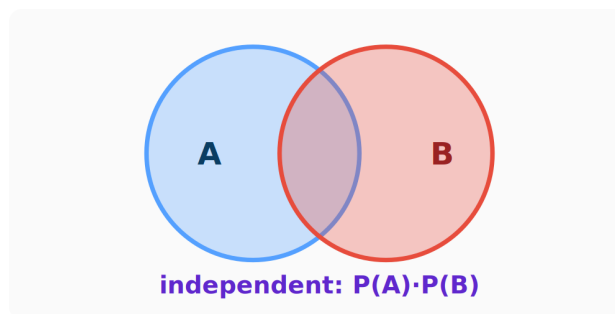
Six faces.

- **$P(4) = 1/6$.**

Apply formula.

EXERCISES (EASY $\rightarrow$ DIFFICULT)

1. Bag has 8 balls; 3 red. $P(\text{red})$?
2. Bag has 12 balls; 3 red. $P(\text{red})$?
3. Bag has 8 balls; 6 red. $P(\text{red})$?
4. Bag has 12 balls; 10 red. $P(\text{red})$?
5. Bag has 10 balls; 4 red. $P(\text{red})$?
6. Bag has 9 balls; 8 red. $P(\text{red})$?
7. Bag has 10 balls; 7 red. $P(\text{red})$?
8. Bag has 7 balls; 4 red. $P(\text{red})$?
9. Bag has 7 balls; 3 red. $P(\text{red})$?
10. Bag has 8 balls; 2 red. $P(\text{red})$?

Independent events**DEFINITIONS****Independent events**

Two events where the outcome of one does NOT affect the other (e.g. flipping two coins).

AND rule

For two independent events: $P(A \text{ AND } B) = P(A) \times P(B)$.

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KEY FORMULAS

- **AND rule:** $P(A \text{ and } B) = P(A) \times P(B)$, for independent events
- **Examples of independent events:** two coin flips, two dice rolls, drawing-with-replacement
- **Important:** events must NOT influence each other

WORKED EXAMPLES

Example 1: Toss two coins. What's the probability of getting two heads?

- ▶ $P(\text{heads on coin 1}) = 1/2$.

Even chance.

- ▶ $P(\text{heads on coin 2}) = 1/2$.

Same for coin 2.

- ▶ Coins are independent — multiply: $(1/2) \times (1/2) = 1/4$.

AND rule.

Example 2: Roll a 6 twice in a row. Probability?

- ▶ $P(6 \text{ on first roll}) = 1/6$.

One favourable in six.

- ▶ $P(6 \text{ on second roll}) = 1/6$.

Same — independent.

- ▶ $P(\text{both}) = 1/6 \times 1/6 = 1/36$.

Multiply.

EXERCISES (EASY → DIFFICULT)

1. $P(2 \text{ heads in } 2 \text{ coin tosses})$:
2. $P(A)=1/2$, $P(B)=1/3$. $P(A \text{ and } B)$?
3. $P(A)=1/2$, $P(B)=1/2$. $P(A \text{ and } B)$?
4. $P(\text{head})$ then $P(\text{head})$?
5. $P(6)$ then $P(6)$ on a die?
6. $P(A)=0.5$, $P(B)=0.4$. $P(A \text{ and } B)$?
7. $P(A)=1/3$, $P(B)=1/3$. $P(A \text{ and } B)$?
8. $P(\text{red})=1/2$ twice. $P(\text{both red})$?
9. $P(A)=0.2$, $P(B)=0.5$. $P(A \text{ and } B)$?
10. $P(\text{tail})$ then $P(6)$?

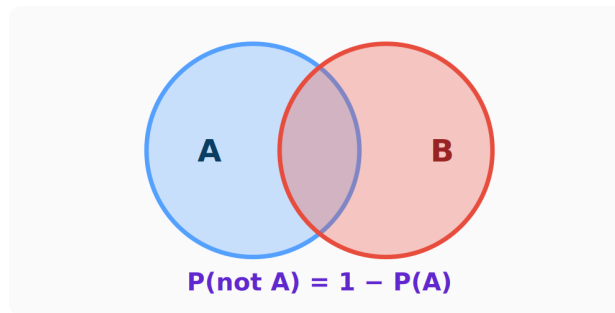


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Complement of an event



DEFINITIONS

Complement	The opposite of an event — "the event does NOT happen". Written A' or "not A".
Complement rule	$P(\text{not } A) = 1 - P(A)$. The probabilities of an event and its complement always add to 1.

KEY FORMULAS

- **Complement rule:** $P(\text{not } A) = 1 - P(A)$
- **$P(A) + P(\text{not } A) = 1$**
- **Useful when:** it's easier to count what you DON'T want, then subtract

WORKED EXAMPLES

Example 1: $P(\text{rain}) = 0.3$. What's $P(\text{no rain})$?

- Apply: $P(\text{not } A) = 1 - P(A)$.

Complement rule.

- $P(\text{no rain}) = 1 - 0.3$.

Substitute.

- **$= 0.7$.**

Subtract.

Example 2: $P(\text{passing}) = 0.85$. $P(\text{not passing})$?

- $P(\text{not pass}) = 1 - 0.85 = \mathbf{0.15}$.

Apply complement rule.

EXERCISES (EASY → DIFFICULT)

1. If $P(\text{rain}) = 0.3$, $P(\text{no rain})$?
2. $P(A) = 0.3$. $P(\text{not } A)$?
3. $P(\text{rain}) = 0.25$. $P(\text{no rain})$?
4. Complement of $P = 1/4$?
5. $P(A) = 0.6$. $P(\text{not } A)$?
6. $P(\text{win}) = 0.1$. $P(\text{not win})$?
7. Complement of $P = 2/5$?
8. $P(A) = 0.85$. $P(\text{not } A)$?
9. $P(\text{six}) = 1/6$. $P(\text{not six})$?
10. Complement of $P = 0.5$?



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End of Chapter 12 — Mixed Exercise

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

1. Bag has 8 balls; 3 red. $P(\text{red})$?
2. $P(A)=1/2$, $P(B)=1/3$. $P(A \text{ and } B)$?
3. $P(\text{rain})=0.25$. $P(\text{no rain})$?
4. Bag has 12 balls; 10 red. $P(\text{red})$?
5. $P(6)$ then $P(6)$ on a die?
6. $P(\text{win})=0.1$. $P(\text{not win})$?
7. Bag has 10 balls; 7 red. $P(\text{red})$?
8. $P(\text{red})=1/2$ twice. $P(\text{both red})$?
9. $P(\text{six})=1/6$. $P(\text{not six})$?
10. Bag has 8 balls; 2 red. $P(\text{red})$?





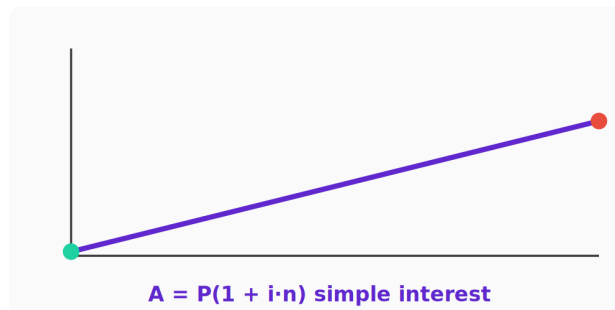
CHAPTER 13

Finance

Simple Simple interest

Hire Hire purchase

Simple interest



DEFINITIONS

Principal (P)	The amount of money initially invested or borrowed.
Interest rate (r)	The percentage charged or earned per year, e.g. 8% per annum.
Time (t)	How long the money is invested or borrowed, usually in years.
Simple interest	Interest calculated only on the original principal — the interest does NOT earn more interest.

KEY FORMULAS

- **Simple interest:** $I = (P \times r \times t) \div 100$
- **Total amount after t years:** $A = P + I$
- **Per annum (p.a.):** means "per year"
- **Units:** if P in rand, I in rand

WORKED EXAMPLES



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**Example 1: $P = R2\ 000$, $r = 8\%$ per year, $t = 3$ years. Find the interest.**

► Apply $I = Prt/100$.

Simple interest formula.

► $I = (2000 \times 8 \times 3) \div 100$.

Substitute.

► $= 48\ 000 \div 100 = \mathbf{R480}$.

Calculate.

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

► $I = (5000 \times 10 \times 2)/100$.

Plug in.

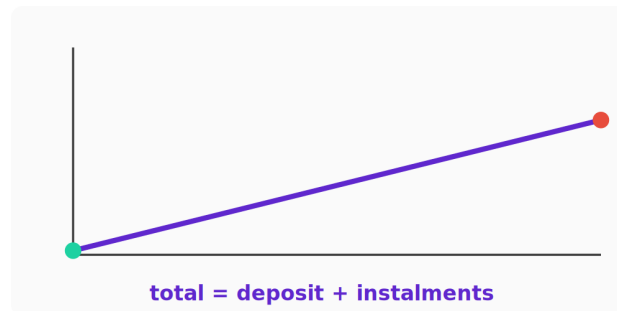
► $= 100\ 000/100 = \mathbf{R1\ 000}$.

Compute.

EXERCISES (EASY → DIFFICULT)

1. $P=R1025$, $r=5\%$, $t=5$ yr. Interest?
2. $P=R4629$, $r=5\%$, $t=3$ yr. Interest?
3. $P=R2277$, $r=10\%$, $t=3$ yr. Interest?
4. $P=R1259$, $r=8\%$, $t=3$ yr. Interest?
5. $P=R4148$, $r=5\%$, $t=4$ yr. Interest?
6. $P=R3806$, $r=8\%$, $t=3$ yr. Interest?
7. $P=R2385$, $r=8\%$, $t=2$ yr. Interest?
8. $P=R3719$, $r=10\%$, $t=2$ yr. Interest?
9. $P=R1097$, $r=8\%$, $t=4$ yr. Interest?
10. $P=R4498$, $r=5\%$, $t=3$ yr. Interest?

Hire purchase

**DEFINITIONS**

Hire purchase (HP)	Buying an item by paying a deposit upfront, then making regular instalments.
Deposit	An upfront payment, usually a percentage of the cash price.
Instalment	A regular fixed payment (often monthly) over a fixed period.
Total cost	The deposit plus all instalments — usually more than the cash price.

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KEY FORMULAS

- **Deposit amount:** $\text{deposit \%} \times \text{cash price}$
- **Total instalments:** $\text{number of payments} \times \text{amount per payment}$
- **Total paid:** $\text{deposit} + \text{total instalments}$
- **Extra cost (interest):** $\text{total paid} - \text{cash price}$

WORKED EXAMPLES

Example 1: Cost R3 000, deposit 20%, then 6 months $\times$ R500. Total paid?

- Deposit: $20\% \text{ of R3 000} = \text{R600}$.

Multiply cost by percentage.

- Total instalments: $6 \times 500 = \text{R3 000}$.

Months times monthly amount.

- Total paid: $\text{R600} + \text{R3 000} = \text{R3 600}$.

Sum deposit and instalments.

Example 2: Cost R2 000, deposit 25%, then 8 months $\times$ R200.

- Deposit: $25\% \times 2000 = \text{R500}$.

Upfront.

- Instalments: $8 \times 200 = \text{R1 600}$.

Monthly total.

- Total: $500 + 1\,600 = \text{R2 100}$.

Add.

EXERCISES (EASY $\rightarrow$ DIFFICULT)

1. Cost R1985, deposit 20%, then 11 months $\times$ R274. Total paid?
2. Cost R3227, deposit 20%, then 12 months $\times$ R242. Total paid?
3. Cost R4166, deposit 20%, then 6 months $\times$ R197. Total paid?
4. Cost R4935, deposit 20%, then 10 months $\times$ R212. Total paid?
5. Cost R1217, deposit 20%, then 10 months $\times$ R256. Total paid?
6. Cost R4801, deposit 20%, then 7 months $\times$ R278. Total paid?
7. Cost R1039, deposit 20%, then 11 months $\times$ R205. Total paid?
8. Cost R4181, deposit 20%, then 11 months $\times$ R210. Total paid?
9. Cost R4827, deposit 20%, then 10 months $\times$ R256. Total paid?
10. Cost R4064, deposit 20%, then 12 months $\times$ R291. Total paid?

End of Chapter 13 — Mixed Exercise

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

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1. $P=R1025$, $r=5\%$, $t=5\text{yr}$. Interest?
2. Cost R3227, deposit 20%, then 12 months $\times$ R242. Total paid?
3. $P=R2277$, $r=10\%$, $t=3\text{yr}$. Interest?
4. Cost R4935, deposit 20%, then 10 months $\times$ R212. Total paid?
5. $P=R4148$, $r=5\%$, $t=4\text{yr}$. Interest?
6. Cost R4801, deposit 20%, then 7 months $\times$ R278. Total paid?
7. $P=R2385$, $r=8\%$, $t=2\text{yr}$. Interest?
8. Cost R4181, deposit 20%, then 11 months $\times$ R210. Total paid?
9. $P=R1097$, $r=8\%$, $t=4\text{yr}$. Interest?
10. Cost R4064, deposit 20%, then 12 months $\times$ R291. Total paid?





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 Surds

Rational and irrational numbers

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

Surds: simplify $\sqrt{n}$

1. $3\sqrt{2}$
2. $5\sqrt{2}$
3. $2\sqrt{3}$
4. $5\sqrt{3}$
5. $2\sqrt{2}$
6. $2\sqrt{3}$
7. $3\sqrt{2}$
8. $2\sqrt{5}$
9. $3\sqrt{3}$
10. $4\sqrt{2}$

Add/subtract surds

1. $5\sqrt{5}$
2. $6\sqrt{3}$
3. $3\sqrt{2}$
4. $5\sqrt{5}$
5. $3\sqrt{2}$
6. $3\sqrt{3}$
7. $4\sqrt{2}$
8. $3\sqrt{3}$
9. $3\sqrt{2}$
10. $5\sqrt{7}$



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**Long Division (game)**

1. play
2. 13
3. 17
4. 24
5. 32
6. 45
7. 56
8. 63
9. 72
10. 84

End of Chapter 1 — Mixed Exercise

1. rational
2. $5\sqrt{2}$
3. $3\sqrt{2}$
4. 24
5. rational
6. $2\sqrt{3}$
7. $4\sqrt{2}$
8. 63
9. rational
10. $4\sqrt{2}$

CHAPTER 2 — Exponents**Exponent laws**

1. 625
2. 256
3. 729
4. 243
5. 4096
6. 16384
7. 16
8. 81
9. 2187
10. 15625

Negative exponents

1. $1/4$
2. $1/2$
3. $1/3$
4. $1/5$
5. $1/8$
6. $1/25$
7. $1/1000$
8. $1/9$
9. $1/16$
10. $1/16$



**Fractional exponents**

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

Scientific notation

1. 2500
2. 40000
3. 4.5×10^3
4. 6.7×10^4
5. 9.2×10^5
6. 3.2×10^{-3}
7. 8.1×10^{-4}
8. 4.5×10^{-2}
9. 2.5×10^5
10. 7×10^{-4}

End of Chapter 2 — Mixed Exercise

1. 625
2. $\frac{1}{2}$
3. 3
4. 6.7×10^4
5. 4096
6. $\frac{1}{25}$
7. 3
8. 4.5×10^{-2}
9. 2187
10. $\frac{1}{16}$

CHAPTER 3 — Algebraic Expressions**Simplify expressions**

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



**Multiply binomials**

1. $x^2 + 10x + 25$
2. $x^2 + 6x + 5$
3. $x^2 + 4x + 3$
4. $x^2 + 8x + 15$
5. $x^2 + 8x + 16$
6. $x^2 + 6x + 8$
7. $x^2 + 6x + 8$
8. $x^2 + 8x + 15$
9. $x^2 + 5x + 6$
10. $x^2 + 5x + 4$

Common factor

1. $5(4x + 3)$
2. $2(4x + 2)$
3. $4(3x + 2)$
4. $2(3x + 3)$
5. $2(5x + 2)$
6. $3(5x + 3)$
7. $4(4x + 3)$
8. $4(2x + 3)$
9. $3(3x + 3)$
10. $4(2x + 2)$

Difference of two squares

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

Factorise quadratic trinomials

1. $(x + 2)(x + 3)$
2. $(x + 3)(x + 3)$
3. $(x + 3)(x + 1)$
4. $(x + 4)(x + 5)$
5. $(x + 2)(x + 4)$
6. $(x + 1)(x + 5)$
7. $(x + 5)(x + 5)$
8. $(x + 5)(x + 2)$
9. $(x + 2)(x + 1)$
10. $(x + 4)(x + 4)$

End of Chapter 3 — Mixed Exercise

1. $3x + 5y$
2. $x^2 + 6x + 5$
3. $4(3x + 2)$
4. $(x - 3)(x + 3)$
5. $(x + 2)(x + 4)$
6. $4x + 2y$





7. $x^2 + 6x + 8$
8. $4(2x + 3)$
9. $(x - 3)(x + 3)$
10. $(x + 4)(x + 4)$

CHAPTER 4 — Equations and Inequalities

Solve linear equations

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

Solve simultaneous equations

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

Solve quadratic by factorising

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

Solve linear inequalities

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



**End of Chapter 4 — Mixed Exercise**

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

CHAPTER 5 — Functions and Graphs**Linear function: $y = mx + c$**

1. 13
2. 15
3. 23
4. 21
5. 16
6. 6
7. 10
8. 21
9. 8
10. 14

Find gradient and intercept

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

Quadratic function (intro)

1. 2
2. 32
3. 27
4. 8
5. 48
6. 4
7. 9
8. 18
9. 12
10. 1



**Hyperbola $y = k/x$**

1. 1.83
2. 4.5
3. 3
4. 2
5. 6
6. 2
7. 9
8. 5
9. 2.5
10. 1.17

End of Chapter 5 — Mixed Exercise

1. 13
2. 3
3. 27
4. 2
5. 16
6. 4
7. 9
8. 5
9. 8
10. 3

CHAPTER 6 — Geometry**Triangle congruency (SSS, SAS, AAS, RHS)**

1. SSS
2. SSS
3. SAS
4. AAS
5. RHS
6. Yes
7. Yes
8. No
9. size
10. RHS

Similar triangles

1. 10
2. 20
3. 15
4. 10
5. 3
6. 16
7. 12
8. 4
9. angles
10. 12



**Properties of quadrilaterals**

1. all angles 90°
2. all sides equal
3. opposite sides equal
4. 4
5. 360°
6. 4
7. equal and parallel
8. 90°
9. 4
10. square

Polygon angle sum

1. 180
2. 540
3. 360
4. 1260
5. 1440
6. 1080
7. 900
8. 720
9. 540°
10. 720°

End of Chapter 6 — Mixed Exercise

1. SSS
2. 20
3. opposite sides equal
4. 1260
5. RHS
6. 16
7. equal and parallel
8. 720
9. size
10. 12

CHAPTER 7 — Pythagoras**Find hypotenuse**

1. 17
2. 15
3. 13
4. 5
5. 10
6. 5
7. 10
8. 13
9. 17
10. 15



**Find a leg**

1. 8
2. 12
3. 4
4. 4
5. 12
6. 8
7. 15
8. 24
9. 12
10. 24

Verify right triangle

1. yes
2. Yes
3. No
4. Yes
5. Yes
6. No
7. Yes
8. Yes
9. No
10. Yes

End of Chapter 7 — Mixed Exercise

1. 17
2. 12
3. No
4. 5
5. 12
6. No
7. 10
8. 24
9. No
10. 15

CHAPTER 8 — Trigonometry**Define sin, cos, tan**

1. hypotenuse
2. hypotenuse
3. hypotenuse
4. adjacent
5. opposite/hypotenuse
6. adjacent/hypotenuse
7. opposite/adjacent
8. hypotenuse
9. opposite
10. adjacent



**Find sin, cos, tan from triangle**

1. $\frac{3}{5}$
2. 0.6
3. 0.8
4. 0.75
5. 0.6
6. 0.8
7. ≈ 0.385
8. ≈ 0.923
9. ≈ 0.417
10. ≈ 1.333

Find tan in right triangle

1. $\frac{3}{4}$
2. 0.75
3. 0.75
4. ≈ 0.417
5. ≈ 0.533
6. ≈ 0.292
7. 0.75
8. ≈ 1.333
9. 2.4
10. 1.875

Find an angle using $\sin^{-1}$

1. 30
2. 30°
3. 60°
4. 45°
5. 60°
6. 30°
7. 45°
8. 90°
9. 0°
10. 30°

Find a side using sin

1. 5
2. 5
3. 10
4. 8
5. ≈ 7.07
6. ≈ 8.66
7. 6
8. 7
9. 16
10. ≈ 14.14

End of Chapter 8 — Mixed Exercise

1. hypotenuse
2. 0.6
3. 0.75
4. 45°
5. ≈ 7.07
6. adjacent/hypotenuse





7. ≈ 0.385
8. ≈ 1.333
9. 0°
10. ≈ 14.14

CHAPTER 9 — Mensuration

Area of triangle

1. 18
2. 9
3. 8
4. 42
5. 12
6. 20
7. 21
8. 48
9. 40
10. 15

Area of circle ($\pi=3.14$)

1. 28.26
2. 153.86
3. 50.24
4. 12.56
5. 78.5
6. 113.04
7. 200.96
8. 78.5
9. 314.0
10. 28.26

Circumference ($\pi=3.14$)

1. 37.68
2. 12.56
3. 18.84
4. 43.96
5. 25.12
6. 50.24
7. 31.4
8. 31.4
9. 62.8
10. 43.96

Volume of prism

1. 32
2. 84
3. 48
4. 70
5. 150
6. 336
7. 126
8. 56
9. 96
10. 72



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

1. 36
2. 450
3. 480
4. 81
5. 336
6. 72
7. 108
8. 600
9. 48
10. 216

Surface area of cylinder

1. 108
2. 162
3. 168
4. 288
5. 330
6. 126
7. 360
8. 216
9. 96
10. 270

End of Chapter 9 — Mixed Exercise

1. 18
2. 153.86
3. 18.84
4. 70
5. 336
6. 126
7. 21
8. 78.5
9. 62.8
10. 72

CHAPTER 10 — Coordinate Geometry

Distance formula

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



**Midpoint formula**

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

Gradient of a line

1. 1.6
2. 2
3. 1.67
4. 1
5. 3
6. 0.4
7. 3.33
8. 3.5
9. 1
10. 1.8

End of Chapter 10 — Mixed Exercise

1. 10
2. (8,4)
3. 1.67
4. 5
5. (4,8)
6. 0.4
7. 5
8. (7,5)
9. 1
10. 17

CHAPTER 11 — Statistics**Mean, median, mode, range**

1. 6
2. 4
3. 5
4. 2
5. 7
6. 25
7. 5
8. 7
9. 16
10. 6



**Frequency tables**

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

Read graphs (line, bar, pie)

1. 48
2. 65
3. 54
4. 44
5. 79
6. 48
7. 50
8. 50
9. 71
10. 40

End of Chapter 11 — Mixed Exercise

1. 6
2. 3
3. 54
4. 2
5. 10
6. 48
7. 5
8. 2
9. 71
10. 6

CHAPTER 12 — Probability**Probability of single event**

1. $\frac{3}{8}$
2. $\frac{3}{12}$
3. $\frac{6}{8}$
4. $\frac{10}{12}$
5. $\frac{4}{10}$
6. $\frac{8}{9}$
7. $\frac{7}{10}$
8. $\frac{4}{7}$
9. $\frac{3}{7}$
10. $\frac{2}{8}$



**Independent events**

1. $\frac{1}{4}$
2. $\frac{1}{6}$
3. $\frac{1}{4}$
4. $\frac{1}{4}$
5. $\frac{1}{36}$
6. 0.2
7. $\frac{1}{9}$
8. $\frac{1}{4}$
9. 0.1
10. $\frac{1}{12}$

Complement of an event

1. 0.7
2. 0.7
3. 0.75
4. $\frac{3}{4}$
5. 0.4
6. 0.9
7. $\frac{3}{5}$
8. 0.15
9. $\frac{5}{6}$
10. 0.5

End of Chapter 12 — Mixed Exercise

1. $\frac{3}{8}$
2. $\frac{1}{6}$
3. 0.75
4. $\frac{10}{12}$
5. $\frac{1}{36}$
6. 0.9
7. $\frac{7}{10}$
8. $\frac{1}{4}$
9. $\frac{5}{6}$
10. $\frac{2}{8}$

CHAPTER 13 — Finance**Simple interest**

1. 256.25
2. 694.35
3. 683.1
4. 302.16
5. 829.6
6. 913.44
7. 381.6
8. 743.8
9. 351.04
10. 674.7



**Hire purchase**

1. 3411
2. 3549.4
3. 2015.2
4. 3107
5. 2803.4
6. 2906.2
7. 2462.8
8. 3146.2
9. 3525.4
10. 4304.8

End of Chapter 13 — Mixed Exercise

1. 256.25
2. 3549.4
3. 683.1
4. 3107
5. 829.6
6. 2906.2
7. 381.6
8. 3146.2
9. 351.04
10. 4304.8





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