1 2D Pythagoras' Theorem

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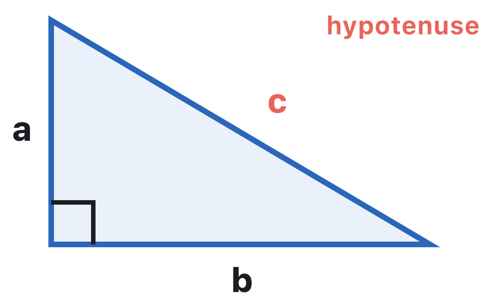
THE THEOREM

$$a^2 + b^2 = c^2$$

- Only works in a **right-angled triangle**.
- c is the **hypotenuse** — the **longest** side, **opposite** the right angle.
- a and b are the two shorter sides.

LABELLING THE TRIANGLE



The hypotenuse is always **opposite** the right angle.

FINDING THE HYPOTENUSE

Shorter sides 3 and 4. **Add** the squares.

$c^2 = 3^2 + 4^2 = 9 + 16 = 25$

$c = \sqrt{25} = \mathbf{5}$

Sides 5 and 12 → $\sqrt{169} = \mathbf{13}$

FINDING A SHORTER SIDE

Subtract the squares this time.

Hypotenuse 10, one side 6.

$a^2 = 10^2 - 6^2 = 100 - 36 = 64$

$a = \sqrt{64} = \mathbf{8}$

ADD OR SUBTRACT?

- Finding the **hypotenuse** (longest) → **add**.
- Finding a **shorter** side → **subtract**.
- **Check:** the hypotenuse must be the **biggest** answer.

ANSWERS THAT ARE NOT WHOLE

Sides 5 and 7:

$c^2 = 25 + 49 = 74$

$c = \sqrt{74} = \mathbf{8.60}$ (2 d.p.)

Keep the **exact** value until the last step.

IS IT RIGHT-ANGLED?

Test if $a^2+b^2=c^2$ for the **longest** side.

6, 8, 10: $36 + 64 = 100$ ✓ **right-angled**

4, 5, 7: $16 + 25 = 41 \neq 49$ ✗ **not**

COMMON TRIPLES

- 3, 4, 5 · 5, 12, 13 · 8, 15, 17
- Multiples also work: 6, 8, 10.

⚠ COMMON EXAM MISTAKES (recurring errors flagged in examiners' reports)

- ✗ **Adding** when you should **subtract** to find a shorter side.
- ✗ Forgetting the final **square root**.
- ✗ Choosing the wrong side as the **hypotenuse**.
- ✗ Using Pythagoras on a triangle with **no right angle**.
- ✗ **Rounding too early** in a multi-step question.

Revise it: find the missing side in each example with the answers covered.

2 Properties of 3D Shapes

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KEY WORDS

- **Face** — a flat (or curved) surface.
- **Edge** — where two faces meet.
- **Vertex** — a corner where edges meet (plural **vertices**).

FACES, EDGES & VERTICES

Shape	F	E	V
Cube	6	12	8
Cuboid	6	12	8
Triangular prism	5	9	6
Square pyramid	5	8	5
Tetrahedron	4	6	4
Cylinder	3	2	0

WHAT MAKES A PRISM

- A **prism** has the **same cross-section** all the way through.
- Slice it anywhere along its length and you get the **same shape**.
- It is named after that cross-section: **triangular** prism, **hexagonal** prism.
- A **cylinder** is a prism with a circular cross-section.

PRISM OR PYRAMID?

- **Prism** — two identical ends joined by rectangles.
- **Pyramid** — one base and triangular faces meeting at a **point** (apex).
- A **cone** is a pyramid-like shape with a circular base.

SPHERES & CONES

- A **sphere** has one curved surface, no edges, no vertices.
- A **cone** has 2 faces, 1 edge and 1 vertex.

NETS

- A **net** is the 2D shape that folds up into the solid.
- A cube net has **6 squares** — there are 11 different arrangements.
- Check a net works: no **overlapping** faces when folded.
- Nets are useful for finding **surface area**.

CYLINDER NET

- Two **circles** and one **rectangle**.
- The rectangle's length is the **circumference** of the circle.

EULER'S FORMULA

For any solid with flat faces:

F + V – E = 2

Cube: 6 + 8 – 12 = 2 ✓

A quick way to **check** your counting.

⚠ COMMON EXAM MISTAKES (recurring errors flagged in examiners' reports)

- ✕ Confusing **edges** and **vertices**.
- ✕ Forgetting the **hidden** faces and edges at the back.
- ✕ Calling a pyramid a prism — a prism has a **constant cross-section**.
- ✕ Drawing a net with **overlapping** faces.
- ✕ Saying a cylinder has vertices — it has **none**.

Revise it: count F, E and V for each solid, then check with Euler's formula.

3 Plans and Elevations

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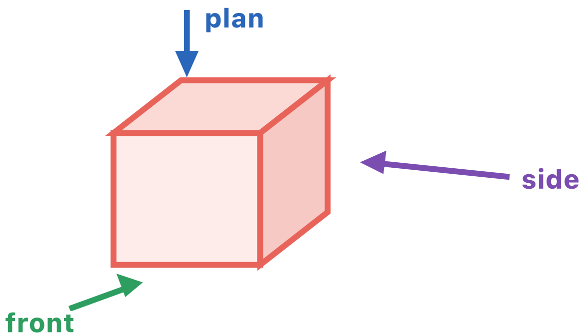
THE THREE VIEWS

- **Plan** — the view from **above**, looking straight down.
- **Front elevation** — the view from the **front**.
- **Side elevation** — the view from the **side**.
- All three are drawn as **flat 2D** shapes.

WHICH WAY YOU LOOK



Look **straight on** each time — you see no depth.

DRAWING THE VIEWS

- Use **squared paper** and keep the sizes accurate.
- Draw only what you can **see** from that direction.
- Show a change in depth with a **solid line** where faces meet.
- **Label** each view clearly.

VIEWS OF COMMON SOLIDS

Solid	Plan
Cube	Square
Cylinder (upright)	Circle
Square pyramid	Square with diagonals
Cone (upright)	Circle
Triangular prism	Rectangle

ELEVATIONS OF A CYLINDER

- Standing upright: **plan** is a circle, both **elevations** are rectangles.
- Lying down: the plan becomes a **rectangle**.
- The **orientation matters** — read the diagram carefully.

CONE & PYRAMID

- **Cone:** plan = circle (with a dot at the apex); elevations = **triangles**.
- **Square pyramid:** elevations = triangles; plan = square with **diagonals** to the apex.

BUILDING FROM CUBES

- For a stack of cubes, count how many are visible in each direction.
- The plan shows the **footprint**; the elevations show the **heights**.
- Different solids can share the **same** plan — you need all three views.

⚠ COMMON EXAM MISTAKES (recurring errors flagged in examiners' reports)

- ✕ Mixing up the **plan** and the **front elevation**.
- ✕ Drawing the shape in **3D** instead of a flat view.
- ✕ Getting the **dimensions** wrong between views — they must match up.
- ✕ Missing the **internal lines** where a depth changes.
- ✕ Not **labelling** which view is which.

Revise it: sketch the plan and both elevations of a cylinder and a square pyramid.

4 Volume & Surface Area of Prisms

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VOLUME OF ANY PRISM

V = area of cross-section × length

- Find the area of the **constant** face first, then multiply by the depth.
- Volume is measured in **cubic** units: cm^3, m^3.

STANDARD VOLUMES

Solid	Volume
Cuboid	l × w × h
Cube	s^3
Triangular prism	$\frac{b \times h}{2} \times$ length
Cylinder	$\pi r^2 h$

WORKED VOLUME

Cuboid 5 × 4 × 3 = **60 cm^3**

Triangular prism: base 6, height 4, length 10

12 × 10 = **120 cm^3**

Cylinder r = 3, h = 10: π×9×10 = **282.7 cm^3**

SURFACE AREA

- The **total area of all the faces** — think of the **net**.
- Measured in **square** units: cm^2, m^2.
- Work face by face and **list** them so none are missed.
- Opposite faces of a cuboid are **equal** — find 3 and double.

SURFACE AREA OF A CUBOID

Cuboid 5 × 4 × 3:

Faces: 5×4 = 20, 5×3 = 15, 4×3 = 12

2(20 + 15 + 12) = **94 cm^2**

CUBE

- All six faces are the same: **$SA = 6s^2$**.
- Side 4: 6 × 16 = 96 cm^2.

SURFACE AREA OF A CYLINDER

$$SA = 2\pi r^2 + 2\pi rh$$

- $2\pi r^2$ is the **two circles**.
- $2\pi rh$ is the **curved surface** — a rectangle of width $2\pi r$.
- An **open** cylinder (no lid) has only **one** circle.

TRIANGULAR PRISM SURFACE AREA

- **2 triangles** + **3 rectangles**.
- Each rectangle uses a **different side** of the triangle × the length.
- You may need **Pythagoras** to find a missing slant side first.

VOLUME OR SURFACE AREA?

- "How much **fits inside**" → **volume** (cm^3).
- "How much **paint / card**" → **surface area** (cm^2).
- The **units** in the answer tell you which is wanted.

⚠ COMMON EXAM MISTAKES (recurring errors flagged in examiners' reports)

- ✕ **Confusing volume and surface area.**
- ✕ Missing faces — especially the **hidden** ones.
- ✕ Cylinder: forgetting the **two circular ends**.
- ✕ Using the **slant** side instead of the perpendicular height for the triangle.
- ✕ Wrong units — cm^3 for volume, cm^2 for surface area.
- ✕ Mixing **cm and m** in one calculation without converting.

Revise it: find the volume and surface area of a 5×4×3 cuboid with the answers covered.

Area & Volume Unit Conversions

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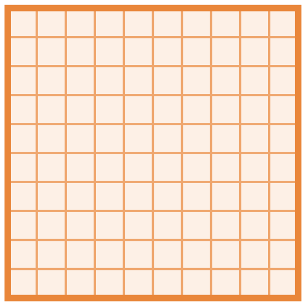
THE BIG IDEA

- For **area**, **square** the length conversion.
- For **volume**, **cube** the length conversion.
- You **cannot** just use the length factor — the most common error on this topic.

WHY 1 CM² = 100 MM²

10 mm



10 mm

10 × 10 = 100

A 1 cm square holds **100** little mm squares — not 10.

AREA CONVERSIONS

From	To	Multiply by
cm^2	mm^2	100 (10^2)
m^2	cm^2	10 000 (100^2)
km^2	m^2	1 000 000

VOLUME CONVERSIONS

From	To	Multiply by
cm^3	mm^3	1000 (10^3)
m^3	cm^3	1 000 000 (100^3)

WORKED EXAMPLES

5 cm^2 = **500 mm^2**
3 m^2 = **30 000 cm^2**
2 m^3 = **2 000 000 cm^3**

GOING THE OTHER WAY

- To a **bigger** unit, **divide** by the same factor.
- 45 000 cm^2 = 45 000 ÷ 10 000 = **4.5 m^2**
- 8000 mm^3 = **8 cm^3**

CAPACITY LINKS

- **1 cm^3 = 1 ml**
- **1000 cm^3 = 1 litre**
- 1 m^3 = 1000 litres
- Useful for tanks, bottles and “how much will it hold” questions.

CONVERT FIRST, THEN CALCULATE

- If a shape mixes **cm and m**, convert the **lengths** first.
- That is far safer than converting the area or volume afterwards.

⚠ COMMON EXAM MISTAKES (recurring errors flagged in examiners’ reports)

- ✕ Using the **length** factor for area — e.g. 1 m^2 = 100 cm^2 (it is **10 000**).
- ✕ Using 1000 for area instead of volume.
- ✕ Multiplying when you should **divide**.
- ✕ Mixing units **within** one calculation.
- ✕ Forgetting 1 cm^3 = 1 ml.

Revise it: write the area and volume factors from memory, then convert the examples.

6 Compound Measures

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THE THREE FORMULAS

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

REARRANGING THEM

- distance = speed × time
- time = $\frac{\text{distance}}{\text{speed}}$
- mass = density × volume
- Same skill as **changing the subject**.

UNITS GIVE IT AWAY

- **Speed:** m/s or km/h — distance **per** time.
- **Density:** g/cm^3 — mass **per** volume.
- The word **"per"** means **divide**.

SPEED EXAMPLES

150 km in 2 hours: 150 ÷ 2 = **75 km/h**

60 km/h for 3 h: 60 × 3 = **180 km**

240 km at 80 km/h: 240 ÷ 80 = **3 hours**

DENSITY EXAMPLES

Mass 300 g, volume 60 cm^3:

300 ÷ 60 = **5 g/cm^3**

Density 8, volume 20: 8 × 20 = **160 g**

PRESSURE EXAMPLE

Force 200 N on 4 m^2:

200 ÷ 4 = **50 N/m^2**

⚠ TIME IN HOURS

- 2 h 30 min = **2.5** hours, **not** 2.3.
- 1 h 15 min = 1.25 hours.
- 45 min = 0.75 hours.
- Divide the minutes by **60** to get a decimal.

MATCHING THE UNITS

- For km/h, distance must be in **km** and time in **hours**.
- For m/s, use **metres** and **seconds**.
- Convert **before** you calculate.

AVERAGE SPEED

average speed = $\frac{\text{total distance}}{\text{total time}}$

60 km in 1 h then 90 km in 2 h:

150 ÷ 3 = **50 km/h**

Never average the two speeds.

⚠ COMMON EXAM MISTAKES (recurring errors flagged in examiners' reports)

- ✕ Writing 2 h 30 min as **2.3** hours instead of 2.5.
- ✕ Multiplying when the formula needs a **division**.
- ✕ **Averaging the speeds** instead of using total distance ÷ total time.
- ✕ Mixing **minutes and hours**, or metres and kilometres.
- ✕ Leaving off the **compound units** in the answer.

Revise it: write all three formulas, then work out one of each with the answers covered.