Speed, Maps & Unit Conversion

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Speed, scale, and unit conversion questions are about keeping quantities consistent. A correct method can still give a wrong answer if kilometres, metres, hours, minutes, centimetres, or millimetres are mixed without conversion.

For CSEC, expect these ideas inside practical contexts: travel, maps, plans, construction, and measurement accuracy. Before using a formula, convert all quantities to compatible units and write the unit beside every answer. This shows comprehension, which is heavily weighted across the exam.

Measurements must often be converted between different units. Let's master the conversions!

Length Conversion

Length conversions change one-dimensional measurements. Move between units by multiplying or dividing by the conversion factor between them.

Unit	Conversion
1 km	1000 m
1 m	100 cm
1 cm	10 mm
1 inch	2.54 cm
1 foot	12 inches H30.48 cm
1 yard	3 feet H0.914 m
1 mile	1.609 km

📋 **Example**

Convert 5 km to m:

$$5 \text{ km} = 5 \times 1000 = 5000 \text{ m}$$

📋 **Example**

Convert 250 cm to m:

$$250 \text{ cm} = 250 \div 100 = 2.5 \text{ m}$$

📋 **Example**

Convert 8500 mm to cm:

$$8500 \text{ mm} = 8500 \div 10 = 850 \text{ cm}$$

Area Conversion

Area conversions must square the length conversion because area has two dimensions. This is why

1 m^2 is $10,000 \text{ cm}^2$, not 100 cm^2.

Unit	Conversion
1 km^2	1,000,000 m^2
1 m^2	10,000 cm^2
1 cm^2	100 mm^2

Key Rule: When converting area, **square the conversion factor!**

- 1 m = 100 cm, so 1 m^2 = 100^2 = 10,000 cm^2
- 1 km = 1000 m, so 1 km^2 = 1000^2 = 1,000,000 m^2

📋 **Example**

Convert 3 m^2 to cm^2:

$$3 \text{ m}^2 = 3 \times 10,000 = 30,000 \text{ cm}^2$$

📋 **Example**

Convert 50,000 cm^2 to m^2:

$$50,000 \text{ cm}^2 = 50,000 \div 10,000 = 5 \text{ m}^2$$

Volume Conversion

Volume conversions cube the length conversion because volume has three dimensions. This is a common place for exam mistakes.

Unit	Conversion
1 m^3	1,000,000 cm^3
1 cm^3	1000 mm^3
1 litre	1000 cm^3 = 1000 mL
1 m^3	1000 litres

Key Rule: When converting volume, **cube the conversion factor!**

- 1 m = 100 cm, so 1 m^3 = 100^3 = 1,000,000 cm^3

📋 **Example**

Convert 2 m^3 to cm^3:

$$2\ \mathrm{m}^3 = 2 \times 1,000,000 = 2,000,000\ \mathrm{cm}^3$$

📋 **Example**

Convert 5 litres to mL:

$$5\ \text{litres} = 5 \times 1000 = 5000\ \mathrm{mL}$$

Speed Conversion

Speed combines distance and time, so both units may need conversion. Convert the distance unit and the time unit separately before simplifying.

Speed relates distance to time.

From	To	Conversion
1 km/h	m/s	÷ 3.6 (or × 5/18)
1 m/s	km/h	× 3.6

📋 **Example**

Convert 72 km/h to m/s:

$$72\ \text{km/h} = 72 \times \frac{1000}{3600} = 72 \times \frac{5}{18} = 20\ \text{m/s}$$

📝 **Exam Tip**

Conversion strategy:

- 1. Identify what unit you have and what unit you need
- 2. Find the conversion factor
- 3. For area: multiply/divide by the SQUARE of the length conversion
- 4. For volume: multiply/divide by the CUBE of the length conversion
- 5. Double-check: does your answer make sense?

Time, Distance, and Speed

The Basic Relationship

Distance, speed, and time form one relationship. If you know any two, you can find the third, but the units must match.

$$\text{Distance} = \text{Speed} \times \text{Time}$$

Or rearranged:

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}} \quad \text{and} \quad \text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

📋 **Example**

A car travels at 60 km/h for 3 hours. How far does it go?

$$D = S \times T = 60 \times 3 = 180\ \text{km}$$

📋 **Example**

A runner covers 400 m in 50 seconds. What's the speed?

$$S = \frac{D}{T} = \frac{400}{50} = 8 \text{ m/s}$$

📋 **Example**

How long does it take to travel 250 km at 50 km/h?

$$T = \frac{D}{S} = \frac{250}{50} = 5 \text{ hours}$$

Distance-Time Graphs

On a distance-time graph, the gradient represents speed. A steeper line means faster movement, and a horizontal line means no movement.

A **distance-time graph** shows how distance changes over time.

Key features:

- **Gradient (slope) = Speed**
- Steeper line = faster speed
- Horizontal line = stationary (not moving)
- Curved line = changing speed

📋 **Example**

A car travels at constant 60 km/h for 5 hours:

Time (h) | Distance (km)
0 | 0
1 | 60
2 | 120
3 | 180
4 | 240
5 | 300

Gradient = 300 ÷ 5 = 60 km/h (the speed!)

📋 **Example**

A car accelerates, then maintains constant speed, then brakes:

Speed-Time Graphs

On a speed-time graph, the height shows speed at each moment. Changes in height show acceleration or deceleration.

A **speed-time graph** shows how speed changes over time.

Key features:

- **Gradient (slope) = Acceleration**
- Horizontal line = constant speed
- Upward line = speeding up (acceleration)
- Downward line = slowing down (deceleration)
- **Area under curve = Distance traveled**

📋 **Example**

A car accelerates uniformly from 0 to 30 m/s in 10 seconds:

Acceleration = 30 ÷ 10 = 3 m/s^2

Distance = Area under graph = ½ × base × height = ½ × 10 × 30 = 150 m

(Triangle area because speed increases linearly)

Area Under Speed-Time Curve = Distance

The area under a speed-time graph represents distance because speed multiplied by time gives distance.

The area between the speed-time curve and the time axis equals the distance traveled.

You can break complex shapes into simpler shapes:

📋 **Example**

A journey with three stages:

Stage 1 (0-5 s): Accelerate from 0 to 20 m/s

- Shape: Triangle
- Area = ½ × 5 × 20 = 50 m

Stage 2 (5-12 s): Constant speed at 20 m/s

- Shape: Rectangle
- Area = 7 × 20 = 140 m

Stage 3 (12-16 s): Decelerate from 20 to 0 m/s

- Shape: Triangle
- Area = ½ × 4 × 20 = 40 m

Total distance = 50 + 140 + 40 = 230 m

Using Trapezium Formula for Area

If you have a trapezium shape (constant acceleration throughout), use:

$$\text{Area} = \frac{1}{2}(a + b) \times h$$

Where a and b are the two parallel sides (speeds) and h is the base (time).

📋 **Example**

A car accelerates from 10 m/s to 30 m/s over 8 seconds:

$$\text{Distance} = \frac{1}{2}(10 + 30) \times 8 = \frac{1}{2}(40) \times 8 = 20 \times 8 = 160 \text{ m}$$

Average Speed

Average speed uses total distance and total time for the whole journey. It is not usually the average of the separate speeds unless the time intervals are equal.

When speed changes during a journey, use average speed:

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

📋 **Example**

A journey has two parts:
- First 100 km at 50 km/h
- Next 100 km at 100 km/h

Time for first part: $T = \frac{100}{50} = 2$ hours

Time for second part: $T = \frac{100}{100} = 1$ hour

Total distance = 200 km
Total time = 3 hours

$$\text{Average speed} = \frac{200}{3} \approx 66.7 \text{ km/h}$$

Note: It's NOT (50 + 100) ÷ 2 = 75 km/h!

Margin of Error

All measurements have some error. The actual value could be slightly higher or lower than the measured value.

Relative Accuracy

Relative accuracy describes how much uncertainty a measurement has. A small absolute error may still matter if the measurement itself is small.

The **margin of error** depends on the **precision** of the measuring instrument.

Precision	Example	Range
Nearest millimetre	7 mm	error of 0.5 mm (range: 6.5 to 7.5 mm)
Nearest centimetre	12 cm	error of 0.5 cm (range: 11.5 to 12.5 cm)
Nearest metre	25 m	error of 0.5 m (range: 24.5 to 25.5 m)

General rule: Margin of error = half the measuring unit

📋 Example

A length is measured as 8.5 cm to the nearest mm.

Margin of error: 0.5 mm (or 0.05 cm)

Actual length is between:
- Minimum: 8.5 - 0.05 = 8.45 cm
- Maximum: 8.5 + 0.05 = 8.55 cm

Maximum and Minimum Values

Rounded measurements represent a range of possible actual values. Maximum and minimum values help you find the largest or smallest possible result.

When you calculate with measured values, the answer also has a range.

📋 Example

Rectangle: length 10 cm (error 0.5 cm), width 6 cm (error 0.5 cm)

Maximum area:

$$(10.5) \times (6.5) = 68.25 \text{ cm}^2$$

Minimum area:

$$(9.5) \times (5.5) = 52.25 \text{ cm}^2$$

Calculated area (using measured values):

$$10 \times 6 = 60 \text{ cm}^2$$

So the area is between 52.25 and 68.25 cm^2.

Maps and Scale Drawings

A **scale** shows the ratio between distances on a map/drawing and real distances.

Understanding Scale

A scale drawing keeps shape the same while changing size. The scale tells how a length on the drawing corresponds to a real length.

Scale	Map Distance	Real Distance
1:100	1 cm	100 cm = 1 m

1:1000	1 cm	1000 cm = 10 m
1:50000	1 cm	50 km

Note: Larger second number = smaller map (less detailed)

📋 **Example**

On a map with scale 1:50000, the distance between two towns is 8 cm.

Real distance = 8 × 50000 = 400,000 cm = 4 km

📋 **Example**

Two cities are 30 km apart in reality. On a map with scale 1:100000, how far apart are they?

Map distance = 30 km ÷ 100000 = 3,000,000 cm ÷ 100000 = 30 cm

Scale Areas

Area scale factors are squared because area is two-dimensional. If lengths are multiplied by 3, areas are multiplied by 9.

Important: If scale is 1:n for length, then area scale is 1:n^2.

📋 **Example**

On a scale 1:100 map, a field measures 4 cm × 3 cm.

Length scale: 1:100
Area scale: 1:10000 (because 100^2 = 10000)

Map area = 4 × 3 = 12 cm^2
Real area = 12 × 10000 = 120,000 cm^2 = 12 m^2

Or: Real dimensions are 4 × 100 = 400 cm = 4 m and 3 × 100 = 300 cm = 3 m
Real area = 4 × 3 = 12 m^2

Problem-Solving with Measurement

Real-world problems combine multiple concepts.

📋 **Example**

A cylindrical swimming pool has radius 4 m and depth 1.5 m. How many litres of water does it hold?

Volume = $\pi r^2 h = \pi(4)^2(1.5) = 24\pi \approx 75.4$ m³

Convert to litres: 75.4 m³ × 1000 litres/m³ = 75,400 litres

📋 **Example**

A car travels at 80 km/h for 2 hours, then at 100 km/h for 1.5 hours.

Distance = (80 × 2) + (100 × 1.5) = 160 + 150 = 310 km
Total time = 2 + 1.5 = 3.5 hours
Average speed = 310 ÷ 3.5 ≈88.6 km/h

📝 **Exam Tip**

CSEC Measurement exam tips:

- 1. **Always show units** in your answer
- 2. **Use appropriate precision**, if given 2 decimal places, give answer to 2 d.p.
- 3. **Watch for "perimeter vs. area"**, they're different!
- 4. **For 3D shapes, know the formulas**, no cheating!
- 5. **Check your unit conversions**, common mistake area
- 6. **For scale drawings, remember 1:n means ÷n or ×n**
- 7. **For combined shapes, break them into simple parts**