Measurements

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Unit Conversions: Length and Mass

Length

1 km = 1000 m

1 m = 100 cm

1 cm = 10 mm

1 mile = $\approx$ 1.6 km

Mass

1 tonne = 1000 kg

1 kg = 1000 g

1 g = 1000 mg

Unit Conversions: Capacity and Time

Capacity & Volume

1 litre = 1000 ml

1 litre = 1000 cm^3

1 m^3 = 1,000,000 cm^3

Time

1 hour = 60 min = 3600 s

1 day = 24 hours

1 year = 365 days

Converting Area and Volume Units: Square and Cube the Conversion Factor!

Length	**Area** ($\times$ factor^2)	**Volume** ($\times$ factor^3)
1 m = 100 cm	1 m^2 = 10,000 cm^2	1 m^3 = 1,000,000 cm^3
1 cm = 10 mm	1 cm^2 = 100 mm^2	1 cm^3 = 1000 mm^3
1 km = 1000 m	1 km^2 = 1,000,000 m^2	—

Converting Between Units

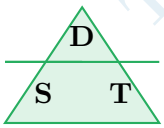
Smaller unit? **Multiply** $\times$

Larger unit? **Divide** $\div$

Key: 5 $m^2 \neq$ 500 cm^2

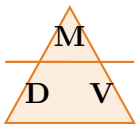
5 m^2 = 5 $\times$ 10,000 = 50,000 cm^2

Speed, Distance and Time

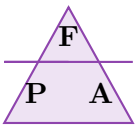


- $S = D \div T$ $D = S \times T$ $T = D \div S$
- **Units:** km/h, m/s, mph. Match units throughout!
- **Average speed:** $\dfrac{\text{total distance}}{\text{total time}}$
- **m/s $\leftrightarrow$ km/h:** divide by 3.6 OR multiply by 3.6

Density and Pressure



Density



Pressure

- **Density:** $D{=}M{\div}V$ $M{=}D{\times}V$ $V{=}M{\div}D$
- **Units:** g/cm^3, kg/m^3
- **Pressure:** $P{=}F{\div}A$ $F{=}P{\times}A$ $A{=}F{\div}P$
- **Units:** N/m^2 (Pa), N/cm^2

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Bounds and Error Intervals

If x is rounded to unit u:

$$x - \tfrac{u}{2} \leq \text{true value} < x + \tfrac{u}{2}$$

- **LB** $= x - \frac{u}{2}$ (included, $\leq$)
- **UB** $= x + \frac{u}{2}$ (excluded, $<$)

Example: $w = 23$ cm (nearest cm) $\Rightarrow 22.5 \leq w < 23.5$

Bounds in Calculations:

Op.	Maximum	Minimum
$A + B$	UB(A)+UB(B)	LB(A)+LB(B)
$A - B$	UB(A)−LB(B)	LB(A)−UB(B)
$A \times B$	UB×UB	LB×LB
$A \div B$	UB(A)÷LB(B)	LB(A)÷UB(B)

Common Traps and Pitfalls

1. **The Time Trap:** 1 hour 30 min = 1.5 h, **not** 1.3 h. Always convert minutes: hours + $\frac{\text{minutes}}{60}$.
2. **The Area/Volume Conversion Trap:** 1 m^2 $\neq$ 100 cm^2. It equals **10,000** cm^2 (square the factor). Same logic for volume: cube it.
3. **The Average Speed Trap:** Average speed $\neq$ average of the two speeds. Always use $\frac{\text{total } D}{\text{total } T}$.
4. **The Bounds Trap:** The upper bound uses $<$ (strict). A value of exactly UB would round **up**, so it belongs to the next interval.
5. **The Units Trap:** Always check that density units match (g with cm^3, or kg with m^3) before substituting into $D = M \div V$.

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Quick Exam Strategy

Identify the measure: "How fast/far/long?" $\rightarrow$ SDT "Heavy per cm^3?" $\rightarrow$ Density "Force per area?" $\rightarrow$ Pressure "Range of values?" $\rightarrow$ Bounds
Multi-stage speed: Find each time separately ($T = D \div S$), then $\bar{S} = \frac{\sum D}{\sum T}$.
Reverse problems: Rearrange the formula first (e.g. $V = M \div D$), then substitute.
Bounds calculations: For **max**: use UB on top / LB on bottom of any division. For **min**: swap them.
Always: State the formula $\rightarrow$ substitute $\rightarrow$ calculate $\rightarrow$ include units in your final answer.