1.1
Motion lesson

GIOPHYSICS / MOTION LESSON

Units

Measurements become useful when every number carries a clear unit.

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Learning goals

- Distinguish qualitative observations from quantitative measurements.
- Use SI base units, derived units, and metric prefixes correctly.
- Convert linear, squared, cubed, and compound units without losing scale.

A measurement has two parts

A quantitative measurement combines a number with a unit. The number tells how much; the unit tells what scale was used. '14.2 cm' is complete, while '14.2' is not.

Qualitative observations use descriptions such as warm, bright, or rough. Quantitative observations use measured values such as 22 deg C or 0.45 kg.

- Record the number, unit, and uncertainty when it is known.
- Keep units beside every value during a calculation.
- Give the final answer in a unit appropriate to the physical quantity.

SI base quantities

Quantity	SI unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

Prefixes and powers of ten

A prefix changes the size of the unit, not the physical quantity. For area, square the conversion factor. For volume, cube it.

$$1\ \mathrm{km} = 10^{3}\ \mathrm{m}$$
$$1\ \mathrm{cm}^{2} = (10^{-2}\ \mathrm{m})^{2} = 10^{-4}\ \mathrm{m}^{2}$$
$$1\ \mathrm{cm}^{3} = (10^{-2}\ \mathrm{m})^{3} = 10^{-6}\ \mathrm{m}^{3}$$

Prefix	Symbol	Factor
nano	n	10^{-9}
micro	µ	10^{-6}
milli	m	10^{-3}
centi	c	10^{-2}
kilo	k	10^{3}
mega	M	10^{6}

Derived units and dimensional checks

Derived quantities combine base quantities. Speed uses m/s, acceleration uses $\mathrm{m/s^2}$, density uses $\mathrm{kg/m^3}$, and force uses the newton: $\mathrm{N} = \mathrm{kg \cdot m/s^2}$.

Dimensional analysis checks whether both sides of an equation describe the same kind of quantity. It can reject an impossible formula before numbers are substituted.

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speed = distance / time
density = mass / volume
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Worked example - convert 72 km/h to m/s

Convert by multiplying by conversion factors equal to one.

01 72 km/h·(1000 m / 1 km)·(1 h / 3600 s)

02 Cancel km and h, leaving m/s.

03 72 × 1000 / 3600 = 20.

72 km/h = 20 m/s

Before you close the file

Formula recap

PREFIXES AND POWERS OF TEN

1 km = 10^3 m
1 cm^2 = $(10^{-2}\ m)^2$ = $10^{-4}\ m^2$
1 cm^3 = $(10^{-2}\ m)^3$ = $10^{-6}\ m^3$

DERIVED UNITS AND DIMENSIONAL CHECKS

speed = distance / time
density = mass / volume

In the exam

The habits this lesson is drilling. Marks are lost here more often than on the algebra.

- Record the number, unit, and uncertainty when it is known.
- Keep units beside every value during a calculation.
- Give the final answer in a unit appropriate to the physical quantity.

Check yourself

- [ ] Did I write a number and a unit?
- [ ] Did I apply the prefix factor in the correct direction?
- [ ] Did I square or cube the factor when the unit is squared or cubed?
- [ ] Do the final dimensions match the requested quantity?

Keep going online

Scan for this lesson's interactive version: the model you can drive, the graph that redraws, and a check that marks itself.

`giophysics.com/chapter-1/units/`