

Density

Printable revision sheet — Galaxscia

LEVEL 1

Mass

Mass is a physical quantity that tells you how much matter there is in an object. It is written **m** and is usually expressed in grams (g) or kilograms (kg). These units can of course be converted if needed.

To measure it, we use a **balance**.

Measuring mass



Instrument: the balance

Mass is measured in grams (g) or kilograms (kg).

Be careful not to confuse mass and weight: Mass always stays the same, whatever planet you are on. Weight, on the other hand, depends on the force of attraction exerted by that planet. So an astronaut with a mass of 70 kg on Earth still has a mass of 70 kg on the Moon... but will "weigh" far less there!

Key points — revision questions

What is the unit of mass?

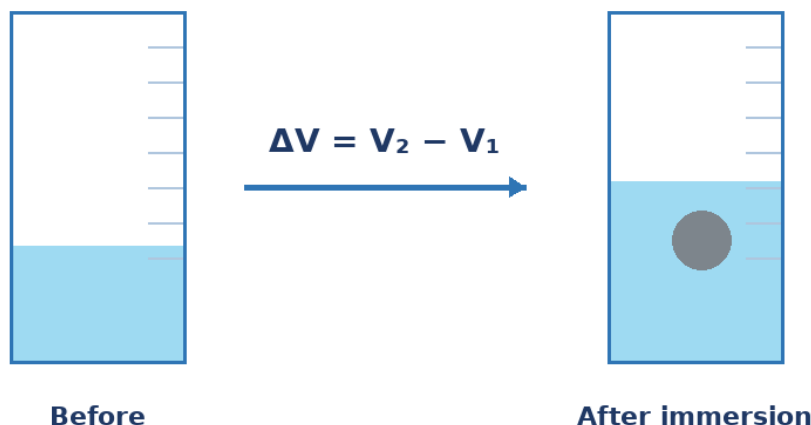
Which instrument is used to measure mass?

Does your mass change if you go to Mars?

LEVEL 2

Volume

Measuring volume



Volume is the space taken up by an object or a substance, whether it is a solid, a liquid or a gas. It is written **V** and is expressed in litres (L), cubic metres (m³) or cubic centimetres (cm³).

For simple shapes (cube, sphere...), the volume can be calculated using geometric formulas. For irregular shapes, it has to be measured directly, for example with a **measuring cylinder** or by the water displacement method.

Key points — revision questions

What are the common units of volume?

How do you measure the volume of a liquid?

How do you measure the volume of an irregular object such as a stone?

LEVEL 3

Density: the link between mass and volume

Density tells you how much mass a given volume of a material contains. You could call it "heaviness per unit of volume". For example, pure water has a density of *1000 g/L*, which means that **1 litre of water** has a mass of **1000 g** (or 1 kg). For the same volume, a heavier object therefore has a higher density.

Density

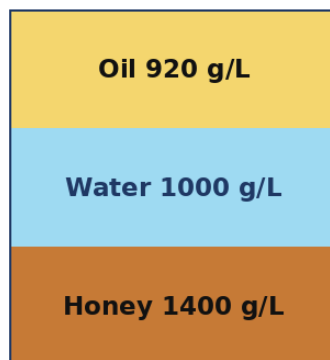
$$\rho = m / V$$

m: mass V: volume

Example: 150 g / 0.2 L = 750 g/L

This idea also explains why some liquids sit in layers when they do not mix (we say they are *immiscible*). The liquid with the lowest density always sits on top, and the one with the highest density sinks to the bottom. That is why oil floats on water, and why honey sinks below water.

Immiscible liquids: layer order



The liquid with the lowest density stays on top.

This property is useful in cooking to make layered drinks or desserts, in chemistry to separate liquids by settling, and in environmental work to recover oil floating on the surface of the water after an oil spill.

Key points — revision questions

What is density?

Why does oil float on water?

In what order do water (1000 g/L), oil (920 g/L) and honey (1400 g/L) sit in layers?

Give a concrete example of a use of differences in density.

LEVEL 4

Calculating and using density

Density is written with the Greek letter ρ (rho). The key relation is:

$$\rho = m/V$$

where: ρ is the density, m the mass of the object, V its volume.

The units must match: if the mass is in grams and the volume in litres, the density will be in g/L. If the mass is in kilograms and the volume in cubic metres, it will be in kg/m³.

Density reference values

Substance	Density
Helium	0.18 kg/m ³
Air	1.20 kg/m ³
Oil	920 kg/m ³
Water	1000 kg/m ³
Aluminum	2700 kg/m ³
Iron	7870 kg/m ³

Example: a 150 g sample takes up a volume of 0.2 L. Applying the formula:

$$\rho = 150/0.2 = 750 \text{ g/L}$$

This is, for instance, the density of petrol.

Every substance has its own density, which makes it a kind of "identity card".

In the laboratory or in everyday life, measuring the density of a material makes it possible to identify an unknown substance or to check how pure it is. For example, pure water at 4 °C is exactly 1000 g/L; if a different value is found, it means there are impurities (such as salt in seawater).

Key points — revision questions

What is the formula for density?

Work out the density of a 200 g sample taking up 0.25 L.

How can an unknown substance be identified from its density?

Why is the density of seawater higher than that of fresh water?