IGCSE PHYSICS 0625 · CHAPTER 2 NOTES · ~7 MIN READ

Mass, weight & density

The most mixed-up pair in physics — mass and weight — plus density, floating and the experiments you must be able to describe.

Mass vs weight | Gravitational field strength | Density | Measuring density | Floating & sinking

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No tag = **Core** (everyone) EXTENDED Extended only highlight = comes up again and again

Test yourself at the end

IN 30 SECONDS

- **Mass** (kg) = how much matter. It never changes. **Weight** (N) = the pull of gravity on that mass. It changes with g.
- **W = m × g**, with g = 9.8 N/kg on Earth and 1.6 N/kg on the Moon.
- **Density = mass ÷ volume** — how tightly the matter is packed. Water = 1.0 g/cm³.
- An object **floats** if its density is less than the density of the liquid.

BY THE END YOU CAN

- State the difference between mass and weight and calculate each.
- Use ρ = m ÷ V, converting between g/cm³ and kg/m³.
- Describe how to find the density of a liquid, a regular solid and an irregular solid.
- Predict whether something floats or sinks from density data.

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1 Mass and weight

Mass is not weight

	Mass	Weight
What it is	amount of matter in an object	gravitational force on the object
Unit	kilogram (kg)	newton (N)
Changes between places?	**No**	**Yes** (depends on g)
Measured with	balance	newton-meter (spring balance)
Type	scalar	vector (points down)

$$W = m\,g$$

weight (N) = mass (kg) × gravitational field strength (N/kg)

Gravitational field strength (g) — the weight of each kilogram: $g = \frac{W}{m}$. On Earth g = 9.8 N/kg, which is also the free-fall acceleration in m/s².

PICTURE IT

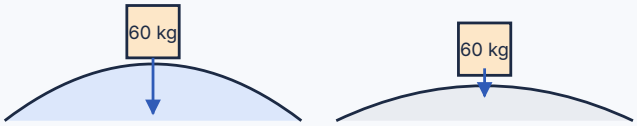
g tells you how many newtons each kilogram weighs. On Earth every kilogram is pulled with 9.8 N; on the Moon only 1.6 N, so you could jump much higher there.

same 60 kg person, different weight

mass never changes — weight depends on g

EARTH g = 9.8 N/kg
W = 60 × 9.8 = 588 N

MOON g = 1.6 N/kg
W = 60 × 1.6 = 96 N



Same 60 kg person. The mass stays the same; the weight changes with the gravitational field strength.

WORKED EXAMPLE

An astronaut has mass 80 kg. Find the weight on Earth (g = 9.8 N/kg) and on the Moon (g = 1.6 N/kg).

1. Earth: W = mg = 80 × 9.8 = **784 N**
2. Moon: W = 80 × 1.6 = **128 N**
3. **The mass is still 80 kg on both**

EXAM TIP

Many questions say "take g = 10 N/kg". Use whichever value the question gives you.

COMMON MISTAKE

"My weight is 60 kg." kg is the unit of mass. Weight is in newtons.

- A balance compares masses, so it gives the same reading on the Moon. A spring balance measures weight, so its reading would change.
- EXT Weight is the effect of a gravitational field on a mass.

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2 Density

Density

Density — the mass of each unit volume of a material. Dense materials pack lots of matter into a small space.

$$\rho = \frac{m}{V}$$

ρ (rho) in kg/m³ or g/cm³ · m in kg or g · V in m³ or cm³

- Rearranged: **m = ρV** and **V = m ÷ ρ**. Use a triangle with m on top and ρ, V underneath.
- Keep units matching: g with cm³ gives g/cm³; kg with m³ gives kg/m³. **1 g/cm³ = 1000 kg/m³**.

Material	Density (g/cm³)
air	0.0012
oil	about 0.8
ice	0.92
water	1.0
aluminium	2.7
iron / steel	7.9
copper	8.9
lead	11.3

WORKED EXAMPLE

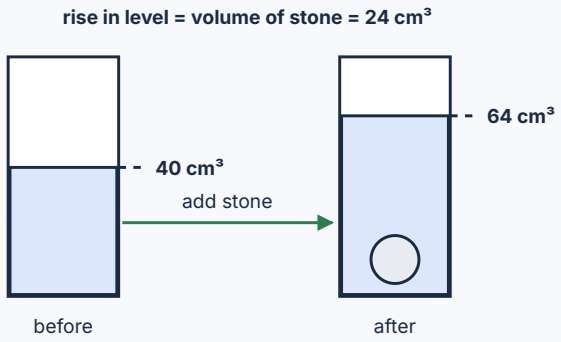
A metal block measures 4.0 cm × 3.0 cm × 2.5 cm and has a mass of 237 g. Find its density. What metal could it be?

1. Volume = 4.0 × 3.0 × 2.5 = 30 cm³
2. ρ = m ÷ V = 237 ÷ 30
3. **= 7.9 g/cm³ — iron or steel**

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Measuring density

- **Regular solid:** measure length, width, height with a ruler → V = l × w × h. Find the mass on a balance. Then ρ = m ÷ V.
- **Irregular solid that sinks:** use **displacement**. The rise in water level equals the volume of the object.
- **Liquid:** mass of the cylinder + liquid, minus the mass of the empty cylinder, gives the mass of the liquid. Read its volume on the scale.



Tie the stone to a thread and lower it into the water. The level rises from 40 to 64 cm³, so the stone's volume is 24 cm³.

WORKED EXAMPLE

A stone has mass 60 g. It raises the water level from 40 cm³ to 64 cm³. Find the density.

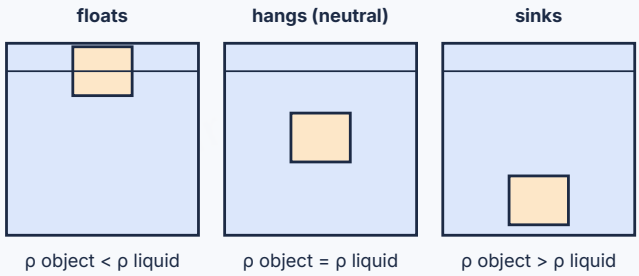
1. Volume of stone = 64 − 40 = 24 cm³
2. ρ = 60 ÷ 24
3. **= 2.5 g/cm³**

COMMON MISTAKE

Forgetting to subtract the mass of the empty container when finding the mass of a liquid.

3 Floating and sinking

Floating and sinking



Compare the density of the object with the density of the liquid.

- **Floats** if ρ object < ρ liquid. **Sinks** if ρ object > ρ liquid. Equal densities: hangs in the liquid.
- A steel ship floats because it is mostly air inside — its **average** density is less than water.
- EXT Immiscible liquids (liquids that do not mix) layer by density: oil (0.8 g/cm³) floats on water (1.0 g/cm³); mercury (13.6 g/cm³) sinks below water.

PICTURE IT

Think of a crowd: dense materials are like people squeezed close together — they push down through lighter, more open material and sink beneath it.

4 Test yourself

Test yourself — cover the answers first

QUICK CHECK

1. What is the weight of a 5.0 kg object on Earth (g = 9.8 N/kg)?
2. Find the density of 12 g of a material with volume 3.0 cm³.
3. Convert 2.7 g/cm³ to kg/m³.
4. Will an object of density 0.80 g/cm³ float in water?
5. Which measuring instrument gives a different reading on the Moon: a balance or a spring balance?

EXAM-STYLE

6. An empty measuring cylinder has mass 62.0 g. With 40.0 cm³ of a liquid it has mass 94.0 g. Calculate the density of the liquid and say whether it floats on water.
7. Describe how to find the density of a small irregular stone. [4]
8. The Moon has g = 1.6 N/kg. A bag of sugar has mass 2.5 kg on Earth. Find its mass and weight on the Moon.

Show answers

1. 5.0 × 9.8 = 49 N
2. 12 ÷ 3.0 = 4.0 g/cm³
3. 2.7 × 1000 = 2700 kg/m³
4. Yes — its density is less than water (1.0 g/cm³).
5. The spring balance (it measures weight).
6. mass of liquid = 94.0 − 62.0 = 32.0 g
   ρ = 32.0 ÷ 40.0 = 0.80 g/cm³
   it is less than 1.0 g/cm³, so it floats on water
7. Find its mass on a balance
   Half-fill a measuring cylinder with water and record the volume
   Lower the stone in on a thread and record the new volume
   volume of stone = new reading − old reading, then ρ = m ÷ V
8. mass = 2.5 kg (it does not change)
   weight = mg = 2.5 × 1.6 = 4.0 N

Stuck on a question?

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