

Exercise walk-through

1.4

Density

IGCSE Physics

Mass, weight and density

- mass (kg) – amount of **matter** ,
same everywhere
- weight (N) – gravity's pull, $W = mg$
- **density** $\rho = \frac{m}{V}$

Floats if its density $<$ the liquid's.

Stone 54 g, **water** 20 $\rightarrow$ 40 cm³

$$V = 20 \text{ cm}^3, \rho = \frac{54}{20} = 2.7 \text{ g/cm}^3$$

Mass, weight, and the units they use

Gravitational field strength

Weight is $W = mg$, where g is the **gravitational field strength**: 9.8 N/kg on Earth. Mass is the same everywhere; weight is not.

Magnitude

A scalar has **magnitude** only; a vector has magnitude *and* direction.

Named units

The **joule** (J) for energy and **work done**; the **watt** (W) for power, one joule per second; the **pascal** (Pa) for pressure, one newton per square metre.

Hooke's law

On a **load–extension graph** the straight part obeys Hooke's law, and the gradient is the spring constant.

Every named unit is a shorthand for a combination of the base units. Knowing which combination is often the whole question.

Measuring length, mass and density

a ruler

read the scale with your eye **straight in front** of the mark, to avoid a parallax error

small measurements

measure many together and divide – 100 sheets of paper, or 20 swings of a pendulum

mass and weight

mass in kg is the amount of matter; weight in N is the force of gravity, $W = mg$

g

about 9.8 N/kg – the same number as the **acceleration of free fall**

density

$\rho = \frac{m}{V}$, in kg/m³ or g/cm³ – ρ is the Greek letter “rho”

finding V

a **regular solid** : measure the sides and calculate. An irregular one: displacement in a measuring cylinder

Mass is compared with a balance, weight with a newtonmeter. A balance gives the same reading on the Moon; a newtonmeter does not.

Density



An iceberg floats with most of its volume hidden: ice is slightly less dense than water

Mass and weight



A laboratory balance measures mass; weight is the gravitational force on that mass

Exercises 2.1-2.3

2.1 A block has mass 240 g and volume 30 cm^3 . Find its density.

[2]

2.2 State how to find the volume of a small irregular stone.

[1]

2.3 Four liquids that do not mix have densities 0.79, 1.00, 1.26 and 0.92 g/cm^3 . State the order in which they settle, from the top of the container downwards.

[2]

Exercises 2.1·2.3

2.1 A block has mass 240 g and volume 30 cm³. Find its density.

[2]

2.1

- $\rho = m/V$

$$\rho = \frac{m}{V} = \frac{240 \text{ g}}{30 \text{ cm}^3} = \mathbf{8.0 \text{ g/cm}^3}$$

2.2 State how to find the volume of a small irregular stone.

[1]

2.2

- lower it into water in a measuring cylinder; the rise in water level is its volume

2.3 Four liquids that do not mix have densities 0.79, 1.00, 1.26 and 0.92 g/cm³. State the order in which they settle, from the top of the container downwards.

[2]

2.3

- 0.79, 0.92, 1.00, 1.26 g/cm³ from the top down
- the least dense liquid floats on top of the denser ones

Exercises 2.4·3.1

2.4 Convert a density of 2.7 g/cm^3 into kg/m^3 . [2]

3.1 An object floats on water (density 1.0 g/cm^3) if its density is: [1]

- ☐ **A** greater than 1.0 g/cm^3
B less than 1.0 g/cm^3
C exactly 1.0 g/cm^3 only
D any value

Exercises 2.4·3.1

2.4 Convert a density of 2.7 g/cm^3 into kg/m^3 . [2]

2.4

- $\times 1000$ to convert g/cm^3 to kg/m^3

$$2.7 \text{ g/cm}^3 \times 1000 = \mathbf{2700} \text{ kg/m}^3$$

3.1 An object floats on water (density 1.0 g/cm^3) if its density is: [1]

- ☐ A greater than 1.0 g/cm^3
B less than 1.0 g/cm^3
C exactly 1.0 g/cm^3 only
D any value

3.1 B

- it floats if its density is less than that of water

Exercise 3.2 (a)

3.2 A rectangular metal block measures $2.0 \text{ cm} \times 3.0 \text{ cm} \times 5.0 \text{ cm}$ and has mass 216 g .

(a) Find its volume.

[1]

Exercise 3.2 (a)

3.2 A rectangular metal block measures $2.0 \text{ cm} \times 3.0 \text{ cm} \times 5.0 \text{ cm}$ and has mass 216 g .

(a) Find its volume. [1]

(a) $V = 2.0 \times 3.0 \times 5.0 = \mathbf{30} \text{ cm}^3$

Exercise 3.2 (b)

3.2 A rectangular metal block measures $2.0 \text{ cm} \times 3.0 \text{ cm} \times 5.0 \text{ cm}$ and has mass 216 g.

(b) Find its density.

[2]

Exercise 3.2 (b)

3.2 A rectangular metal block measures $2.0 \text{ cm} \times 3.0 \text{ cm} \times 5.0 \text{ cm}$ and has mass 216 g .

(b) Find its density.

[2]

(b) $\rho = m/V$

$$\rho = \frac{m}{V} = \frac{216 \text{ g}}{30 \text{ cm}^3} = \mathbf{7.2 \text{ g/cm}^3}$$

Exercise 3.3

3.3 A liquid of density 0.80 g/cm^3 is poured onto water. State, with a reason, which liquid floats on top. [2]

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3.3

- the liquid of density 0.80 g/cm^3 floats
- because its density is less than that of water (1.0 g/cm^3)

Exercise 3.4 (a)

3.4 A student finds the density of a liquid and of an irregular metal object.

(a) Describe how she finds the density of the liquid, naming her measurements. [3]

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(a) measure the mass of the empty measuring cylinder

- pour in the liquid and read its volume from the scale, at the bottom of the meniscus with the eye level
- measure the mass again and subtract to get the mass of the liquid, then divide mass by volume

Exercise 3.4 (b)

3.4 A student finds the density of a liquid and of an irregular metal object.

(b) Her empty measuring cylinder has a mass of 76.0 g. With 80 cm³ of the liquid it has a mass of 140.0 g. Calculate the density of the liquid. [3]

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(b) mass of liquid $m = m_{\text{full}} - m_{\text{empty}} = 140.0 \text{ g} - 76.0 \text{ g} = 64.0 \text{ g}$

- $\rho = m/V$

$$\rho = \frac{m}{V} = \frac{64.0 \text{ g}}{80 \text{ cm}^3} = \mathbf{0.80 \text{ g/cm}^3}$$

Exercise 3.4 (c)

3.4 A student finds the density of a liquid and of an irregular metal object.

(c) She lowers the metal object into the cylinder. The level rises from 80 cm^3 to 105 cm^3 and the balance now reads 337.5 g . Calculate the density of the metal. [3]

Exercise 3.4 (c)

3.4 A student finds the density of a liquid and of an irregular metal object.

(c) She lowers the metal object into the cylinder. The level rises from 80 cm^3 to 105 cm^3 and the balance now reads 337.5 g . Calculate the density of the metal. [3]

(c) volume of the metal $V = V_2 - V_1 = 105 \text{ cm}^3 - 80 \text{ cm}^3 = 25 \text{ cm}^3$

- mass of the metal $m = m_2 - m_1 = 337.5 \text{ g} - 140.0 \text{ g} = 197.5 \text{ g}$

$$\rho = \frac{m}{V} = \frac{197.5 \text{ g}}{25 \text{ cm}^3} = \mathbf{7.9 \text{ g/cm}^3}$$

Exercise 3.4 (d)

3.4 A student finds the density of a liquid and of an irregular metal object.

(d) State, with a reason, whether the metal would float in the liquid.

[2]

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3.4 A student finds the density of a liquid and of an irregular metal object.

(d) State, with a reason, whether the metal would float in the liquid. [2]

(d) **no**, it sinks

- its density of 7.9 g/cm^3 is far greater than the liquid's 0.80 g/cm^3

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(e) Explain why the displacement method could not be used for a small cube of sugar.[1]

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(e) Explain why the displacement method could not be used for a small cube of sugar.[1]

(e) sugar dissolves in the liquid, so the level would not give its volume