IGCSE PHYSICS • EXERCISE SHEET

1.4 Density

Name: _____ Class: _____ Date: _____ **Total: 25 marks**

KEY WORDS density 密度 • floats 漂浮 • displacement method 排水法 • mass 质量 • measurement 测量

Objective

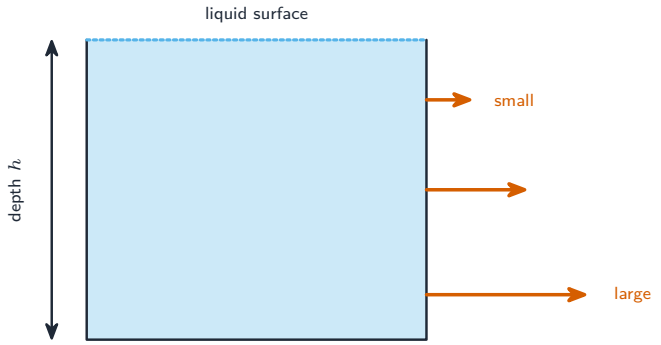
Build the skills to answer exam questions on **density** 密度 — using $\rho = \dfrac{m}{V}$, finding volume (incl. the **displacement method** 排水法), and floating/sinking.

You must be able to:

- use $\rho = \dfrac{m}{V}$ with consistent units
- find the volume of a regular and an irregular solid
- predict floating or sinking from densities

1 Worked examples

■ Density and the displacement method



Density ρ is mass per unit volume; a denser liquid also gives a greater pressure with depth

Stone, mass 54 g, water rises 20 → 40 cm³: volume = 20 cm³; $\rho = \dfrac{54}{20} =$ 2.7 g/cm³.

Float/sink: floats if its density < the liquid's density.

■ Which floats, and finding the density of a liquid

An object **floats** in a liquid when its density is **less** than the liquid's density, and sinks when it is greater. The same rule decides which of two liquids floats on the other, provided they do not mix: the less dense liquid lies on top. Oil ($\approx$ 800 kg/m³) floats on water (1000 kg/m³).

Density of a liquid. Weigh an empty measuring cylinder; pour in the liquid and read its volume; weigh again. The mass of the liquid is the difference between the two readings, and $\rho = \dfrac{m}{V}$.

Worked example. An empty cylinder has a mass of 84.0 g. With 50 cm³ of a liquid it has a mass of 124.0 g. Mass of liquid = 124.0 − 84.0 = 40.0 g, so $\rho = \dfrac{40.0}{50} =$ 0.80 g/cm³. This liquid floats on water, whose density is 1.0 g/cm³.

△ Watch the units: 1 g/cm³ = 1000 kg/m³, because 1 m³ = 10^6 cm³ and 1 kg = 1000 g.

2 Practice

2.1 A block has mass 240 g and volume 30 cm³. 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/cm³. State the order in which they settle, from the top of the container downwards. [2]

2.4 Convert a density of 2.7 g/cm³ into kg/m³. [2]

3 Exam-style questions

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

3.2 A rectangular metal block measures 2.0 cm × 3.0 cm × 5.0 cm and has mass 216 g.

(a) Find its volume. [1]

(b) Find its density. [2]

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]

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]

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

(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]

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

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

Solutions

Each answer shows the steps, then the **result**.

2.1

- $\rho = m/V$

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

2.2

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

2.3

- 0.79, 0.92, 1.00, 1.26 g/cm^3 from the top down
- the least dense liquid floats on top of the denser ones

2.4

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

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

3.1 B

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

3.2

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

(b) $\rho = m/V$

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

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)

3.4

(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

(b) mass of liquid = 140.0 g − 76.0 g = 64.0 g

- $\rho = m/V$

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

(c) volume of the metal = 105 cm^3 − 80 cm^3 = 25 cm^3

- mass of the metal = 337.5 g − 140.0 g = 197.5 g

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

(d) **no**, it sinks

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

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