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

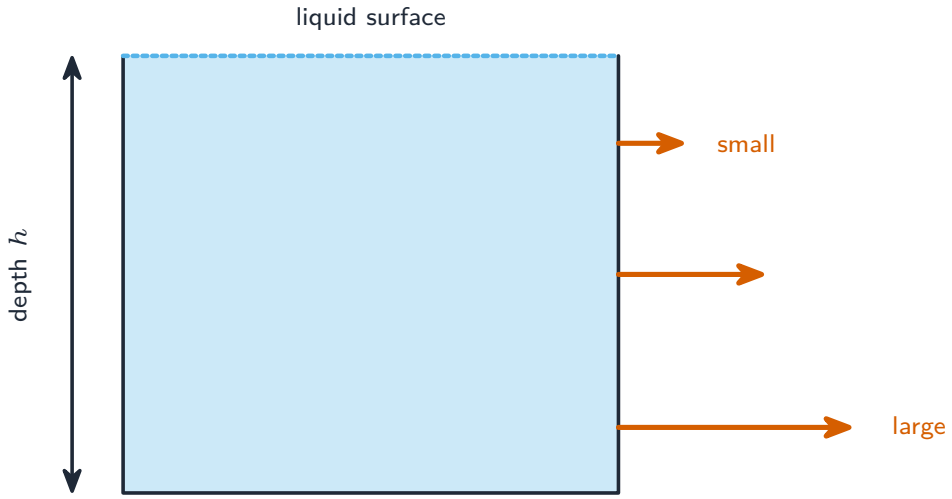
Build the skills to answer exam questions on **density** 密度 — using $\rho = \dfrac{m}{V}$, finding volume (incl. the **displacement method** 排水法), and floating/sinking.

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 (≈ 800 kg/m^3) floats on water (1000 kg/m^3).

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 cm^3 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/cm^3. This liquid floats on water, whose density is 1.0 g/cm^3.

△ Watch the units: 1 g/cm^3 = 1000 kg/m^3, because 1 m^3 = 10^6 cm^3 and 1 kg = 1000 g.

2 Practice

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]

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

3.3 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

2.1 $\rho = \dfrac{m}{V} = \dfrac{240}{30} = 8.0$ g/cm^3.

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

3.1 B. It floats if its density is less than that of water.

3.2 (a) $V = 2.0 \times 3.0 \times 5.0 = 30$ cm^3.
(b) $\rho = \dfrac{216}{30} = 7.2$ g/cm^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).

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 2.7 g/cm^3 $\times$ 1000 = 2700 kg/m^3.

3.3 (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 − 76.0 = 64.0 g; $\rho = \dfrac{64.0}{80} = 0.80$ g/cm^3.
(c) Volume of the metal = 105−80 = 25 cm^3; mass of the metal = 337.5−140.0 = 197.5 g; $\rho = \dfrac{197.5}{25} = 7.9$ g/cm^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.