

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

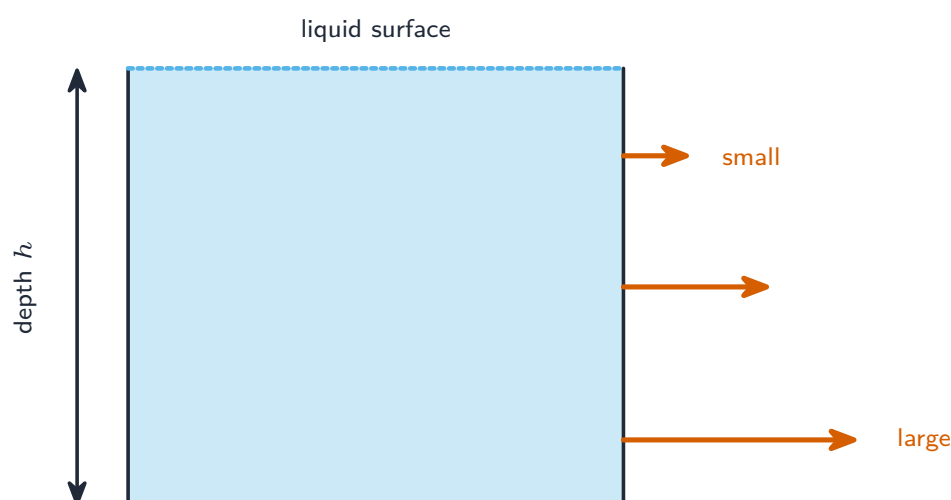
Build the skills to answer exam questions on **density** 密度 — using $\rho = \frac{m}{V}$, finding volume (incl. the **displacement method** 排水法), and floating/sinking.

You must be able to:

- use $\rho = \frac{m}{V}$ 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 $\rightarrow$ 40 cm³: volume = 20 cm³; $\rho = \frac{54}{20} =$

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 ($\approx 800 \text{ kg/m}^3$) 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 $\rho = \frac{m}{V}$.

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 = $124.0 - 84.0 = 40.0 \text{ g}$, so $\rho = \frac{40.0}{50} = 0.80 \text{ g/cm}^3$. This liquid floats on water, whose density is 1.0 g/cm^3 .

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

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/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	B
C	D

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 $2.0 \text{ cm} \times 3.0 \text{ cm} \times 5.0 \text{ cm}$ 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]
