

8 Buoyancy and flowing fluids – Part 2

Name: _____ Class: _____ Date: _____

Vocabulary

Write each word three times.

English

Write it 3 times (English)

buoyant force

Archimedes' prin-
ciple

continuity

Bernoulli's

Recall

In Part A you met density and pressure. Now two more fluid ideas you have already half-noticed:

- A ball pushed underwater pops back up – water pushes objects up.
- Squeeze a hose and the water shoots out faster.

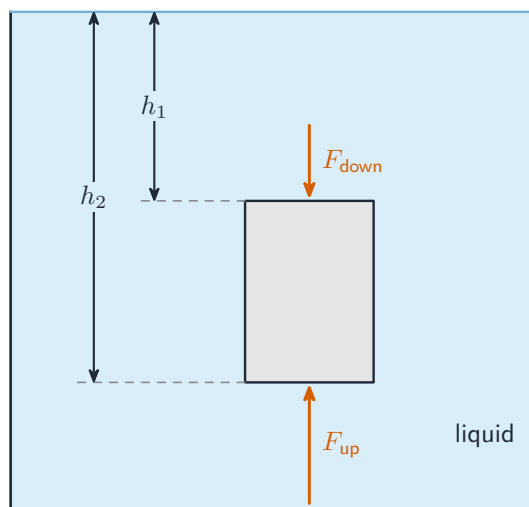
Each idea has a worked example before the Practice.

New ideas

■ 1 The buoyant force

A fluid pushes up on anything in it with a **buoyant force** equal to the weight of the fluid the object pushes aside – **Archimedes' principle** :

$$F_b = \rho_{\text{fluid}} g V_{\text{displaced}}.$$



■ 2 Float or sink

Compare the buoyant force with the weight:

- floats when buoyancy balances weight,
- sinks when the weight wins.

Worked example. A block of density 600 kg/m^3 floats in water (1000 kg/m^3). The fraction below the surface is $\frac{\rho_{\text{object}}}{\rho_{\text{fluid}}} = \frac{600}{1000} = 0.60$ – so 60% sits underwater, the same reason most of an iceberg is hidden.

■ 3 Flowing fluids – continuity

When a fluid flows through a pipe, the same volume must pass every second. So where the pipe is **narrow**, the fluid must flow **faster** – this is **continuity** :

$$A_1 v_1 = A_2 v_2.$$

Worked example. Water flows at 2.0 m/s in a pipe of area 0.010 m^2 , then reaches a narrow section of 0.0040 m^2 : $v_2 = \frac{A_1 v_1}{A_2} = \frac{0.010 \times 2.0}{0.0040} = 5.0 \text{ m/s}$.

■ 4 Fast flow, low pressure

Where a fluid flows faster, its pressure **drops** – **Bernoulli's** idea. This is why a fast stream of air over a wing lifts a plane, and why shower curtains get sucked inward.

Watch out: a floating object does not have “no weight” – its weight is exactly balanced by the buoyant force pushing up. The two forces are equal, not absent.

Practice

Try these in order. The methods are all above.

2.1 State the direction of the buoyant force on an object in water, and what it equals (in words). [2]

2.2 An object of density 800 kg/m^3 floats in water (1000 kg/m^3). Find the fraction that sits below the surface. [2]

2.3 Water flows at 3.0 m/s in a pipe of area 0.020 m^2 . Find its speed where the pipe narrows to 0.0060 m^2 . [3]

2.4 Explain why water speeds up when a pipe becomes narrower. [2]

2.5 A ball is held underwater and released. Explain, in terms of forces, why it rises. [2]
