Exercise walk-through

Fluids and Newton's Laws ▪ 8.3

eXercise

You must be able to

- treat **buoyancy 浮力** as a net upward force from a fluid
- state **Archimedes' principle 阿基米德原理**: the buoyant force equals the weight of the displaced fluid
- explain floating and sinking by comparing an object's weight with the buoyant force

Method — Archimedes' principle

The **buoyant force** equals the weight of the fluid displaced: $F_b = \rho_{fluid}\, g\, V_{displaced}$.

Method — Float or sink

Compare weight and buoyant force. Float if $F_b \geq$ weight — equivalently, if the object's density is less than the fluid's.

Method — Example

An object of weight 10 N displacing fluid of weight 12 N feels a net upward force $\rightarrow$ it floats up.

Practice 2.1 ▪ 2 marks

State Archimedes' principle.

Solution 2.1

Method: Archimedes' principle

Worked steps

the buoyant force on an object equals the weight of the fluid it displaces B1 B1.

Practice 2.2 ▪ 1 mark

An object weighs 8.0 N in air and displaces fluid weighing 5.0 N when submerged. Find the buoyant force on it.

Solution 2.2

Worked steps

5.0 N (equal to the weight of displaced fluid) **B1**.

Practice 2.3 ▪ 1 mark

State the condition, in terms of density, for an object to float.

Solution 2.3

Method: Float or sink

Worked steps

the object's density must be less than (or equal to) the fluid's density B1.

Exam-style 3.1 ▪ 1 mark

The buoyant force on a submerged object equals the weight of the

A object

B displaced fluid

C container

D air above it

Solution 3.1

A object

B displaced fluid ✓

C container

D air above it

Worked steps

B.

Exam-style 3.2 ▪ 1 mark

An object floats when its density is

A greater than the fluid's

B exactly equal to the fluid's

C less than or equal to the fluid's

D unrelated to the fluid's

Solution 3.2

A greater than the fluid's

B exactly equal to the fluid's

C less than or equal to the fluid's ✓

D unrelated to the fluid's

Worked steps

C.

Exam-style 3.3 ▪ 2 marks

A 2.0 kg block of volume 1.0×10^{-3} m^3 is fully submerged in water ($\rho = 1000$ kg m^{-3}, $g = 10$ m s^{-2}).

(a) Find the buoyant force on it.

(b) State whether it sinks or rises, with a reason.

Solution 3.3

Worked steps

(a) $F_b = \rho g V = 1000 \times 10 \times 1.0 \times 10^{-3} = 10$ N **M1** **A1**. (b) weight $= mg = 20$ N > 10 N, so it sinks — the buoyant force cannot support it **M1** **A1**.