

8.3 Fluids and Newton's Laws

Name: _____ Class: _____ Date: _____

Total: 10 marks**KEY WORDS** buoyant force 浮力 • archimedes' principle 阿基米德原理 • density 密度 • fluid 流体

Objective

Build the skills to answer exam questions on **fluids and Newton's laws**.**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

1 Worked examples

Study these first. Each one shows the method for a question type used later.

■ Archimedes' principle

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

■ Float or sink

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

■ Example

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

2 Practice

2.1 State Archimedes' principle. [2]

2.2 An object weighs 8.0 N in air and displaces fluid weighing 5.0 N when submerged. Find the buoyant force on it. [1]

2.3 State the condition, in terms of density, for an object to float. [1]

3 Exam-style questions

3.1 The buoyant force on a submerged object equals the weight of the [1]

- **A** object
 - **B** displaced fluid
 - **C** container
 - **D** air above it
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3.2 An object floats when its density is [1]

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

(a) Find the buoyant force on it. [2]

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

[2]

Solutions

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

2.2 5.0 N (equal to the weight of displaced fluid).

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

3.1 B.

3.2 C.

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