Buoyancy

Name: _____ **Date:** _____

Read and Learn

Buoyant force, also called **upthrust**, is the upward force a fluid exerts on an object partly or completely immersed in it. Both liquids and gases are fluids.

Fluids exert pressure on an object's surfaces. **Pressure increases with depth**, so the bottom of an immersed object experiences greater pressure than the top. This pressure difference produces a net upward force.

Archimedes' principle: The buoyant force on an object equals the weight of the fluid it displaces.

Buoyant force depends on:

- **Fluid density:** A denser fluid produces a greater buoyant force for the same displaced volume.
- **Volume of fluid displaced:** Displacing more fluid produces a greater buoyant force.
- **Gravitational field strength:** Stronger gravity increases the weight of the displaced fluid.

An object floating at rest has balanced forces: **buoyant force = weight**.

Multiple Choice

Circle the correct answer.

1. In which direction does buoyant force act?

A. Downward
B. Upward
C. In the direction of motion
D. Toward the nearest wall

2. Why does an immersed object experience an upward buoyant force?

A. Fluid pressure is greater at the bottom than at the top.
B. Fluid pressure acts only upward.
C. The object loses its weight in the fluid.
D. The fluid removes gravity.

3. Two objects are completely immersed in the same water. Object X displaces twice as much water as object Y. How do their buoyant forces compare?

A. X experiences half the buoyant force of Y.
B. They experience equal buoyant forces.
C. X experiences twice the buoyant force of Y.
D. Y experiences no buoyant force.

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4. The same object is completely immersed first in fresh water and then in denser salt water. Where is its buoyant force greater?

A. In fresh water
B. In salt water
C. It must be equal in both.
D. It depends only on the object's mass.

Complete the Sentences

Word bank: upward • pressure • volume • weight

1. Buoyant force acts _____ on an immersed object.
2. Fluid _____ increases with depth.
3. Buoyant force equals the _____ of the displaced fluid.
4. In the same fluid, a larger displaced _____ produces a greater buoyant force.

True or False?

Write **T** or **F**. Correct each false statement.

1. Only objects that float experience buoyant force. _____

2. Water pushes on the sides as well as the top and bottom of an immersed object. _____

3. Two objects of equal volume, both completely immersed in the same water, experience equal buoyant forces even if their masses differ. _____

Compare and Explain

1. A steel ball and a plastic ball have the same external volume. Both are held completely underwater without touching the container. Compare their buoyant forces and explain your answer.

2. A sealed, rigid block is completely underwater. It is moved deeper into water of the same density.

a. What happens to the pressure on its top and bottom surfaces?

b. Does its buoyant force increase, decrease, or stay the same? Explain.

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Apply Your Understanding

1. A boat floats at rest. Its weight is 800 N. What is the buoyant force acting on it?

Buoyant force: _____ N

2. Cargo is added to the boat, and it settles lower in the water before floating at rest again. Explain why its buoyant force increases.

3. Draw a box representing an object underwater. Add two labelled vertical arrows to show its weight and buoyant force. Make the arrows equal in length if the forces are balanced.

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Buoyancy — Answer Key

Multiple Choice

1. **B** — Upward
2. **A** — Fluid pressure is greater at the bottom than at the top.
3. **C** — X experiences twice the buoyant force of Y.
4. **B** — In salt water

Complete the Sentences

1. **upward**
2. **pressure**
3. **weight**
4. **volume**

True or False?

1. **False.** Both floating and sinking objects experience buoyant force when immersed in a fluid.
2. **True.**
3. **True.** They displace equal volumes of the same fluid, so they experience equal buoyant forces.

Compare and Explain

1. Steel ball and plastic ball

They experience **equal buoyant forces**. Both are completely immersed and have the same external volume, so they displace the same volume—and therefore the same weight—of water. Their different masses do not change their buoyant forces.

2. Moving a sealed, rigid block deeper

a. Pressure **increases on both the top and bottom surfaces**.

b. The buoyant force **stays the same**. The block displaces the same volume of water of the same density. The pressure difference between its bottom and top remains unchanged.

Apply Your Understanding

1. Floating boat

Buoyant force = **800 N upward**

The boat floats at rest, so its buoyant force balances its weight.

2. Adding cargo

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The cargo increases the boat's weight. The boat settles lower and displaces more water, increasing the buoyant force. It floats at rest again when the buoyant force equals its new total weight.

3. Force diagram

Students should draw a box with:

- An **upward arrow** labelled **buoyant force** or **upthrust**.
- A **downward arrow** labelled **weight** or **gravitational force**.
- **Equal-length arrows** if the forces are balanced.

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