

What is Buoyancy?



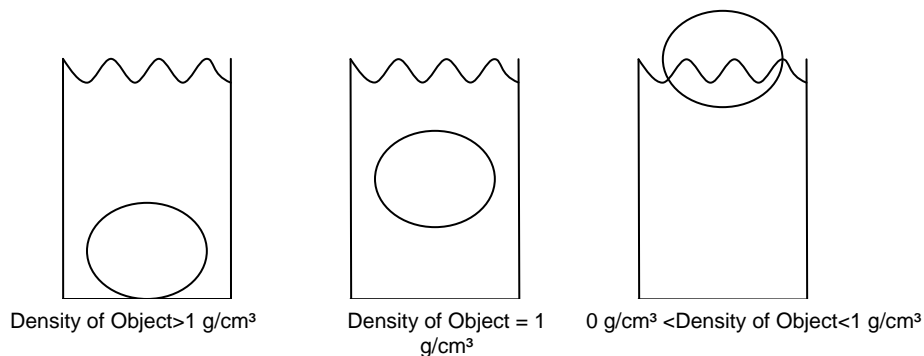
Have you ever wondered why massive boats and ships weighing hundreds of tons float while small objects like rocks sink? Have you ever wondered why when you inhale in a pool you float and when you exhale you sink to the bottom even though you weigh the same? This phenomenon can be explained by the scientific principle called **buoyancy**.

Buoyancy is the upward force that an object feels from the water and when compared to the weight of the object, it is what makes an object float, sink, or remain **neutrally buoyant** in the water.

When an object floats, the upward buoyant force exerted by the water is greater than the downward force of the weight of the object. You can also understand this concept with numbers. If an object's density is less than water's density (1 g/cm^3), it will float.

When an object sinks, the weight of the object is greater than the upward buoyant force exerted by the water and its density is greater than 1 g/cm^3 . When an object is neutrally buoyant, meaning it neither sinks nor floats, then the weight of the object is equal to the upward buoyant force exerted by the water.

When neutrally buoyant in water, the object also has the same density as water. Neutral buoyancy is a very important principle in the sea perch competition. Just like a real submarine, you will want your sea perch to be able to submerge below the surface of the water without just sinking to the floor.



When you start to build your sea perch, you will want to consider this principle. We can calculate just how much buoyancy your sea perch will need in order to be neutrally buoyant if we understand **Archimedes' Principle**.

Archimedes' said that the upward buoyant force is equal to the weight of the displaced volume of liquid. So,

$$\text{Buoyant Force} = \text{Weight of Displaced Fluid}$$

This can be explained by Newton's second law which states that every action has an equal and opposite reaction.

Stability

A body is stable when it is in a stable state of equilibrium which is when a body is in a state of balance between opposing forces. Stability is a property that enables the object to develop forces that restore the object back to its original condition. Your sea perch's stability also depends on its buoyancy. The buoyant force on an object acts through the *center of buoyancy*, which is the same as the centroid of the displaced volume of liquid. This is because the force of gravity on the object acts through the object's center of gravity. Since these actions must be equal and opposite, the buoyant force must be beneath the center of gravity. The weight of the sea perch also acts through its *center of gravity*. If these two points don't line up vertically, then your sea perch will rotate and not maintain stability.



On submarines, buoyancy is controlled using ballast tanks. Ballast tanks are used to allow the vessel to submerge. The mass of the water taken in by the ballasts alters the vessels buoyancy and allows the vessel to dive. Similarly, the water pushed out of these tanks by compressed air allows the buoyant force to increase and the submarine to rise. The tanks are also used to maintain stability. If the water pushed out and taken in is not equal along the ship then it will be unbalanced and begin to tip in a certain direction. If there is more weight in one end of a ship then more air can be kept there to increase the buoyant force holding that side up.