Floating and Sinking

Introduction

A force is a push or a pull on an object. Forces are what influence whether an item will float or sink, whether it is in the air or in a liquid. If an object floats, we say that it is 'buoyant' and that it has 'buoyancy'. So why are some objects buoyant, while some objects are not? Read on to find out the answer, plus lots more interesting information about floating and sinking!

Displacement

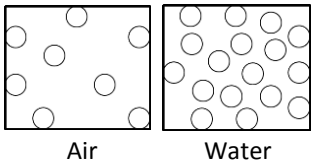
When an object is placed into a liquid or a gas, it displaces some of the liquid or the gas; in other words it pushes aside some of the liquid or the gas. Imagine a group of children standing packed close to each other in a small space, and then another child comes and pushes their way into the group. What would happen to the children who were standing in the new child's way? That's right; they would be pushed out of the way. (Please do not try this, as children are much easier to hurt than water and air!)

Upthrust

Now the children who were pushed out of the way are not very happy about this; therefore they push back against the new child. (Again, no testing this in the playground please!) Well this is also what happens with the liquid or the gas molecules that are displaced (pushed aside) – they push back against the object that displaced them. This force that pushes back against the object is called 'upthrust'. In order for an object to float, the upthrust needs to be equal to the weight of the object.

Density

Density is a measure of the amount of matter (stuff) in an object relative to its size. In other words density is a measure of the amount of mass in an object. If you filled a balloon with air and held it and then filled the same balloon with water and held it, which would be heavier? The balloon would be heavier when it was filled with water because water is denser than air. In geography we say that urban (city) areas have a higher population 'density' than rural (countryside) areas because there are more people packed into each square mile of a city. Different liquids and gases have different densities. For example, salt water is denser than fresh water.



Relative density

Whether an object floats or not depends on the density of the object and the density of the liquid or the gas that it is placed in; in other words, the density of the object 'relative' to the liquid or gas. When the density of an object is *greater* than the density of the liquid or the gas that it is placed in, the object will sink. In contrast, when the density of an object is *less than or equal to* the density of the liquid or the gas that it is placed in, the object will float. For example, an apple will float in water whereas a steel ball will not. This is because the density of the apple is less than or equal to the density of water, whereas the density of the steel ball is greater than the density of the water.

Changing the relative density

So if steel is denser than water, how do ships that are made from steel float? The density of an object can be changed by changing its shape or by changing what is inside it. A ship is hollow, which means it has air inside of it. Remember, air is less dense than water, so the air inside the ship makes it less dense overall; thus allowing it to float. Life jackets are filled with air for the same reason: the air makes the person wearing the life jacket less dense, and therefore less likely to sink. Hot air balloons also work by changing relative density. Because hotter air is less dense than colder air, heating the air in the balloon makes the balloon rise, while allowing the air in the balloon to cool makes the balloon fall. Helium is used in airships / blimps and in balloons you might buy at a fair or theme park. Because helium is less dense than air, the helium makes the airship or the balloon rise.

Archimedes

Incredibly, the Ancient Greeks discovered the basic rules of buoyancy in water over 2,000 years ago! A king asked a man named Archimedes to find out if his new crown was pure gold, without damaging the crown. To test this, Archimedes placed the crown in a bowl of water and measured how much water the crown displaced. He then did the same thing with a piece of pure gold. When the pure gold displaced more water than the crown, Archimedes knew that the crown contained another metal less dense than gold.

Summary

If an object floats, we say that it is buoyant or that it has buoyancy. Objects float when the upthrust that they create when they displace a liquid or a gas is equal to or greater than their weight. Objects that are less dense than (or of equal density to) water or air will float, whereas objects that are more dense than water or air will sink. An Ancient Greek named Archimedes first discovered the basic laws of buoyancy and over time people have discovered ways to reduce the density of objects, such as ships and balloons so that they will float.

References

The Usborne Internet-Linked Library of Science: Energy, Forces and Motion

Eyewitness Science: Forces and Motion