



HOW DO HUGE SHIPS STAY FLOAT?

Topic suggested by Diana Beck

There are many ships over 100,000 tonnes, and some even weigh more than 600,000 tonnes—but they all still float on the water! How does this happen?

The answer was given to us by the Greek philosopher Archimedes (287-212BC). The story goes that he was lying in the bath, wondering how to tell real gold from adulterated gold (as one does!), when the idea came to him. Forgetting to put on his clothes, he leapt out of the bath and ran down the street, shouting “Eureka”! This may not be entirely true, but it makes a good story, and as a result we still remember him, over 2,200 years later!

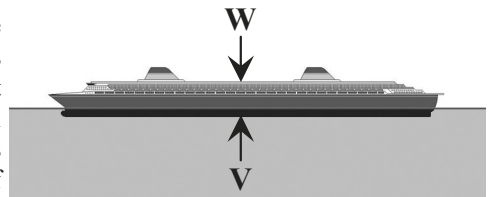
‘Archimedes Principle’ states that when a solid object is immersed in a liquid, it pushes some of the liquid out of the way (which is obvious, when you think about it). The volume of liquid it pushes away (displaces) is equal to the volume of the object—again obvious. However, what may not be entirely obvious is that the liquid which has been pushed away pushes upwards on the object, making it appear to weigh less.

Let’s get away from ‘liquids’ and ‘objects’, to talk about water and ships. If a typical cruise ship, weighing 100,000 tonnes, is lowered into the water, it will displace more and more water until it has displaced 100,000 tonnes. At that point, the upward force of the water will equal the weight of the ship, and it will no longer move downwards; the ship will be ‘floating’!

So, why don’t bricks float in the same way that ships do? The answer lies in how big an object is (its volume) in relation to its weight. A brick will displace water, but the weight of the water it displaces is less than the weight of the brick, so it will still sink. Ships are very big, but (relatively) light, so they displace enough water to equal their own weight.

The relationship between weight and volume is known as ‘density’. Pure water has a density of 1.0 (one cubic metre of water weighs one tonne). Sea water is slightly more dense, but the difference needn’t worry us here. If an object is more dense than water, it will sink (eg a brick); if it is less dense, it will float (eg a ship). The reason ships are less dense than water is that they are full of air. If a ship fills up with water (eg the Titanic), it becomes denser than water, and sinks. Archimedes realised that an object (in this case a crown) weighs less when immersed in water, enabling you to find its density (and whether it is made of pure or adulterated gold).

So, that is the answer—it doesn’t matter how heavy a ship is, so long as its volume is large enough to give it a density of less than one. A 100,000 tonne ship will float, so long as its volume, below the waterline, is 100,000 cubic metres.



*W: the weight of the ship
V: the volume of the ship below the waterline*

©2011 Mike Whittle