CRUISING

A view through the porthole

More than you ever wanted to know
about taking a cruise!

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What Floats Your Boat?

Good morning, class. Welcome to **Physics 101** where today we will study how boats float. First, let's conduct an experiment. **We are going to see if a metal object will float.** For this experiment we will need the following:

- A body of water - I have filled the kitchen sink with water.
- A metal object - I have gotten out a 5-ounce can of tuna fish from the pantry.
- A can opener, a spoon, a glass of water, and a hammer - I have put all four items out on the counter by the sink.

Place the object (the unopened tuna fish can) in the body of water. **You will notice that it immediately sinks.** Now use the can opener to open the can and then spoon out all of the contents. Wash out the can so it is clean. Place the empty tuna fish can on top of the water. What does it do now? **It floats.** Now slowly pour some water into the tuna fish can. What is it doing now? It is floating, but it is sitting lower in the water than before. Keep adding water to the can. What happens? The can sits lower and lower in the water until it finally sinks. Now take it out of the water and flatten the can with the hammer. Place it on the water. What happens? **The flattened tuna fish can sinks.**

What have we learned from the experiment? **We have learned that metal objects, under certain conditions, can float!** And using scientific reasoning, we may infer that large boats made out of metal, under certain conditions, can also float. In simplified terms, **this is because any object will float when its density is less than the density of the fluid it is put into.** Archimedes (287 BC – 212 BC), the famous Greek physicist and mathematician, discovered this concept (as well as related principles about displacement, buoyancy, etc.) as he was taking a bath. Remember the story? Upon making his discovery, he was so excited that he jumped out of the tub and ran naked through the streets of Syracuse yelling "Eureka!" meaning "I have found it!" When we say the density of an object, **we mean the average density of the entire object taken as a whole,** not just the density of the outer surface or skin of the object**.**

Density is expressed as mass per unit of volume. Water has a density of about **62 pounds per cubic foot.** Seawater, which is a little bit denser than regular water, has a density of about **64 pounds per cubic foot.** We say "about" because the density of water changes with temperature. Warm water is less dense than cold water.

In terms of the tuna fish can, when it was unopened and full of tuna, its average density was greater than 62 pounds per cubic foot, so it sank. The can without the food floated because the average density of the object (the empty metal can and the air inside the can) was less than 62 pounds per foot. When we then took the air out of the can by flattening it, it sank because the density of the metal by itself was greater than 62 pounds per foot.

When we talk about the density of a large ship, **we mean the average density of the entire ship – the metal hull, the decks, the cabins, the passengers, the luggage, the cargo, the great quantities of food on board, and the air in the ship.** All of this added together makes for an object that is less dense on average than the water the ship is sailing in. **So it floats – just like the empty tuna fish can floated.** This, of course, is because a good portion of the interior volume of the ship is air which is significantly less dense than seawater. So in designing a ship, what engineers need to do to make it float is to shape the metal skin of the vessel (i.e. the hull) **wide enough, long enough, and deep enough** so that the interior of the ship will contain sufficient space and air to allow the ship to float.

Now let's think about some applications of this principle. **Why do life jackets keep people afloat?** Because with a life jacket on, a person's average density has been decreased and the object (the object in this case is the person and the life jacket) has a lower average density than water. **Why do helium balloons float in air?** Because the density of the balloon with helium in it makes the total object (the blown-up rubber balloon plus the helium) less dense on average than the surrounding air. **And why does Ivory Soap float?** Because during the manufacturing process they add air to the mixture as a machine whips up the soap's ingredients. The resulting bar of soap is less dense than water, so it floats.

An interesting part of the principle of flotation as it applies to cruising is that **you can build ships out of non-buoyant materials (such as aluminum, steel, or perhaps even concrete)** so long as you design them with enough interior volume so that their average density is less than the density of water. **Being less dense than water is what floats your boat.**

Thanks, class. Should we now have a test on the material?

Nautical Term

Pipe Down

To pipe down means to be quiet and to stop talking. On sailing ships, the **bosun** had the responsibility to give signals to the crew by blowing his bosun's pipe, a pipe that gave out a shrill whistle. (A bosun was sometimes called a boatswain. He was selected by the captain to help supervise the sailors up on deck.) At the end of each day the bosun would give the last piping signal of the day – **the pipe down signal**. This signal meant that it was time for those up on the deck who didn't have night duties **to go down below and to be quiet for the night.**