

Lesson Plan: What Boats sink AND float?



Illustration© John Joyce, 2006

WHAT BOATS SINK AND FLOAT?

Aim / Description:

The aim of the lesson is to demonstrate which boats can sink AND float. By introducing a history lesson about John Phillip Holland's influence in designing submarines and making a DIY submarine, students can learn how they sink and float.

Background:

John Phillip Holland (1841 – 1914)

In the Beginning:

- John Phillip Holland was born on February 29th 1841 in Liscannor Co. Clare.
- He gained a love of the sea while his father John Phillip Holland Sr., who patrolled the west coast of Ireland. As a member of the Coast Guard, it was his father's duty to watch out for attempts of invasion by the French.

The First Plans:

- In 1853, Mr Holland senior and his family moved to Limerick and John soon was influenced by the teachings of Brother Dominic Burke - being a science teacher, greatly encouraged John Holland in his ideas.
- John had drawn out plans for his first submarine by the end of the 1850s.



Lesson Plan: What Boats sink AND float?

HOLLAND I:

- In 1873, John immigrated to America where he would reform warfare by creating brilliant machine designs.
- After working as a schoolteacher in Paterson, New Jersey, he began designing submarines.
- He built the Holland I, a tiny two-ton, petrol-driven sub in 1877.

What was Holland's Secret?

- Before Holland, submarines dived by flooding water tanks that were contained inside the same space that the crewmembers lived and worked.
- These tanks took up a lot of space inside the hull and sometimes leaked, with disastrous results.
- Holland's design was to have a single watertight "pressure hull" in which the men lived and the delicate machinery of the submarine was contained, with the floodable "ballast tanks" OUTSIDE the pressure hull.
- This made Holland's designs much more efficient and far safer. The principle of the ballast tank is still used in the design of modern nuclear submarines.

How does a submarine sink and float?

Ballast tanks are used to make a submarine sink and float. The tanks sit on either side of the pressure hull like saddlebags on a horse. They have openings at the top, which can be closed by valves. They also have openings at the bottom, which stay open all the time. On the surface, the tanks are pumped full of air from high-pressure air tanks (making the whole submarine lighter than the water in which it sits) and the submarine floats.

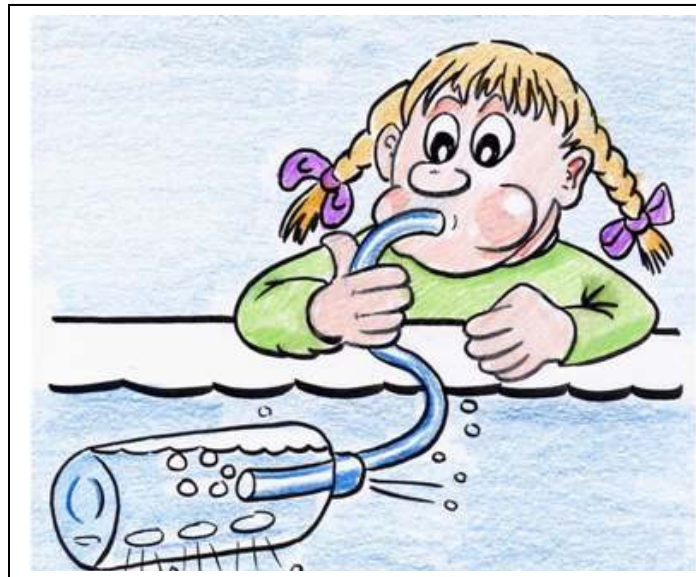
To dive, the valves on top of the ballast tank are opened, the air flows out and the submarine sinks. Once the required depth is reached, a specially trained crew member (called the "Diving Master") changes the amount of water and air in the ballast tanks until the submarine is the same weight as the water and neither floats or sinks.

At this point, special fins called hydroplanes can be used to "fly" the submarine underwater, just as the wings of an aircraft are used to fly the plane in air as it moves forward.

When the Captain wishes to surface, high-pressured air from tanks is blown back into the ballast tanks, the submarine becomes lighter than the water and it rises to the surface.

See the Illustration of What Boats sink and Float.

Lesson Plan: What Boats sink AND float?



Illustration© John Joyce, 2006

Materials:

- A deep basin of water
- Plasticine
- A small plastic drink bottle
- A bendy straw or bendy plastic tube
- Scissors

Activity: A DIY Submarine

Step 1. CAREFULLY – make a straight line of holes along the edge of a plastic bottle from the top to the bottom. (Take the lid off the bottle before cutting to release the air pressure inside it - otherwise it will be difficult to cut into the bottle).

Safety note: It is recommended that teachers cut the holes in the bottle before the class.

Step 2. Mould a piece of plasticine around the bendy part of the straw to use to seal out the water.

Step 3. Place the shorter end of the plastic drinking straw through the top of the bottle, bending it so that it sticks up like a periscope. Press the seal in place.

Step 4. Submerge the bottle in the water with the holes upwards so that the bottle fills with water and sinks (this is like a submarine diving). A little bit of force may be required to force the air out of the bottle so it sinks. Now turn the bottle the other way around so that the holes are facing downwards (this is like the Captain shutting the top vents on the ballast tanks).

Step 5. Gently blow into the straw. Students are now “blowing ballast” – i.e. blowing in air and forcing water out of the bottle. The bottle “submarine” will then rise to the surface.

Explorer Education Programme



Lesson Plan: What Boats sink AND float?

Outcome:

Students will have learned about

- the invention of the submarine

Students will have developed skills:

- understanding the language associated with buoyancy.
- understanding the science of buoyancy by analysing, making inferences and coming up with conclusions.

Also, see lesson plans on the physics of buoyancy “The Cartesian Diver Experiment”