Cloverbud Investigators: Career Detectives

June

Make it Float: Junk Boats

Background:
Have you ever driven by a large river, lake or even the ocean and seen the many boats, barges or large ships floating around? Have you ever wondered how they can be so heavy but still stay afloat? Do you think their design might be important to helping them float? Archimedes (Ark-i'-meed-eez), a Greek scientist who lived way back in 281 BC, also wondered about these things. He was the first recorded person to study the reasons behind why things float. In this lesson, we will learn about Archimedes' Principle and even try our own experiments, exploring how and why boats float, the important parts of a boat, and how to design your own boat.

Brainstorming:
Let's start by exploring things that float. Make a list of things that float and things that sink. Now let's compare these items and ask the following questions: Why does this float? Why did that sink? What makes this different from something else the same size that sinks? Would the objects weight or size have anything to do with it? Does density play a role in sinking or floating?

Local Career Connections: Careers to discuss

- Boat Captain/ Crew
- Boat Mechanic
- Civil Engineer
- Industrial Engineer
- Boat Builder
- Aircraft Engine Specialist

June's Mystery: How do heavy boats float while loaded?

Gather objects that float, and that sink (ex: blocks of wood, pieces of plastic, coins, washers)
*****Basically anything from your "junk drawer"**
Supplies needed:

- **Clay**
- **Aluminum foil**
- **Craft (popsicle) sticks**
- **Toothpicks**
- **Straws**
- **Tape**
- **Glue**
- **Small masses (ex: coins, washers, nails, beans)**
- **Pool or large tub to hold water**
- **Rulers**
- **Newspaper**
- **Card board**
- **Wood**
- **Styrofoam**
- **Boat coloring sheet with labeled parts**

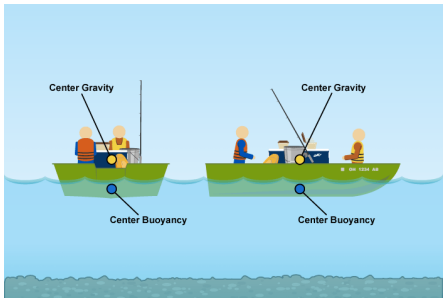
Last Updated by T. Winters 1/2019

Science Behind It:

It is natural to think that something that is heavy would sink, right? While the weight of an object does play an important role in if it will sink or float, it is not the only factor. We also need to look at its *density* (how much a certain volume of an object weighs). If the object is denser than water, like a rock, it will usually sink. If it is less dense, like plastic, it will float. However, some very dense things, like a metal ship, can be made to float, using Archimedes' Principal.

The ability of an object to float is described as *buoyancy*, which is an upward force exerted by a fluid that opposes the weight of an object. When an object floats (the upward force is greater than the weight of the object) in water it is said to be positively buoyant. When an object sinks (the weight of the object is greater than the upward force of the liquid) in water, it is said to be negatively buoyant.

When designing boats and ships, engineers must determine the total amount of water which will be displaced by the weight of the boat, when the boat is placed into the water. A good example of water displacement to use with kids, is the example of sitting in a bathtub full of water. The water starts at one level but when you get into the tub and sit down, the mass of your body displaces some of the water and the water level will rise. If the tub is too full, sometimes the water will go right over the side of the tub. That is because your body "displaced" some of the water in the tub and it had to go somewhere. The key to an object floating, is that it must displace an amount of water which is equal to its own weight. Think about it this way, if you are swimming and you lay your body out flat on the water so that your body covers (or displaces) more of the surface of the water, (you have more upward forces hitting your body), it is easier to float on the water than if you were trying to stand up vertically in the water, which reduces your body to water surface ratio.



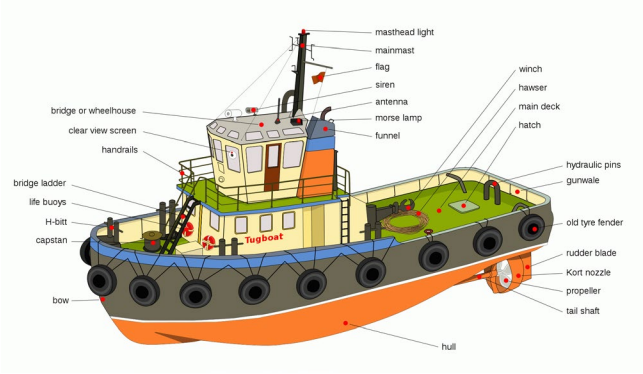
Now that we understand why boats float, what else do we need to think about before designing a boat? What about holding people or cargo without tipping over? Ask the students if they have ever been in a canoe, kayak or other small boat. Were they told not to stand up or lean over the side? That's because the movement of their body weight can cause these small boats to tip or even flip over. "Stability" is important in boat design. Stability means that your boat has been designed not to tip over. Most boats are designed to have a low center of gravity in the center of the boat. However, if you step onto the side of the boat, or you stand up in the boat, your body weight can physically move the center of gravity and cause the boat to rotate toward you (the new center of gravity), which means it will tip or lean and could sink low enough for water to come over the sides. So to compensate for this, small boats are designed to carry their weight low and in the center as the picture above shows.

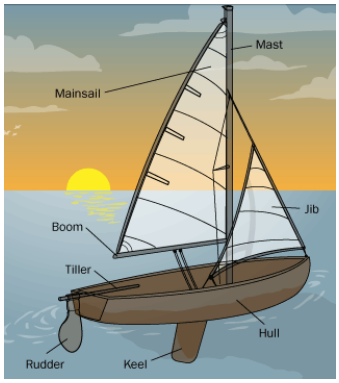
Last Updated by T. Winters 1/2019

In this lesson, investigators are going to design and construct a boat out of "junk". The boats will then be tested by floating them in a small pool of water. To test the boat further, we will add weight to find the boat's "displacement capacity", which is the amount of weight it can carry before it begins to sink. Investigators will be able to redesign and make improvements to their boats as they will explore different shapes, sizes and materials to see how each will perform in the water.

What to do:

Help your investigators learn the parts of a ship. This can be done with coloring sheets that label the ship's parts or by placing labels on model ships. For an additional challenge, they can be asked to label or include the parts on their ships that they design and build.





Take the suggested materials from the supply list and challenge students to build their own boat, using the *Engineering Design Process*:

Define the problem

- On a piece of paper, start by drawing your design of your boat. Think about all the parts a boat should have.

Brainstorm possible solutions or designs
Compare possible design solutions

- The first step is to find a base or "hull" for your boat. Try to find a piece large enough that you think will hold all the pieces of a boat.
- Next, you will want to pick a piece to make your "mast". This is a piece that will help balance your hull.
- The next pieces you will want to find and construct on your boat are the rudder, center board, boom, and main sail.

Build and test a prototype (A prototype is a first attempt at a design.)

- Now that you have all your pieces, attach them to your boat. Once your prototype is built you can start to test it in the water.

Last Updated by T. Winters 1/2019

Redesign based on test findings

- Redesign, what works, what doesn't, what needs to be improved on your boat for the final test? Try it again in the water.
- Re-test your prototype and make final adjustments.

Testing displacement - Add marbles to the hull see how much weight your boat can hold without sinking.

- Add weights
- Share what you learn with others, what worked, what didn't, how did you change it.

Go Over Findings:

What is displacement?

Why do boats float?

What are the major parts of your boat?

What careers can you think of using what you learned today?

Investigate, Create, & Take: Investigators can take with them:

- ✓ Your "junk boat"
- ✓ Coloring page

Sources:

Boat Safe Kids "How does a heavy boat float?" http://boatsafe.com/kids/021598kidsques.htm

Additional Links:

How do ships float? Buoyancy! https://www.youtube.com/watch?v=xniW3_afO-0
https://www.bing.com/images/search?q=coloring+page+parts+of+a+pirate+ship

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