LA COUNTY LIBRARY

DIY Library Program

WHAT FLOATS YOUR BOAT?

LEARNING ABOUT BOUYANCY WITH PAPER BOATS

Recommended for Ages 12 – 17

Did you know that several of the worlds' largest cruise ships weigh over 100,000 tons? Did you ever wonder how they manage to float instead of sinking straight to the bottom? The answer lies in a scientific principle known as **buoyancy** that was discovered over 2000 years ago! Our understanding of the science behind buoyancy is attributed to an Ancient Greek mathematician and inventor named Archimedes, who lived from 287 to 212 B.C.E. Long after his death, this discovery continues to inform our understanding of how objects float on water or in the air.

How does buoyancy work? Buoyancy is the upward force that fluids exert on an object that is less dense than itself. The Principle of Buoyancy, sometimes called Archimedes Principle, states:

The buoyant force acting on an object immersed in or floating on a fluid is equal to the weight of the fluid displaced by the object.[1]

If you think back to the 100,000-ton boat, this means that the weight of the water displaced by the boat must be greater than the weight of the boat itself to make sure it floats on top without sinking. This might be a bit confusing, so let's do a few experiments to test this principle by making our own boats out of paper. We'll test them to make sure our boats float and see how much they can carry!

Questions for Discussion:

- What are the Principles of Buoyancy?
- Who is the scientific figure widely credited with discovering of the Principle of Buoyancy?
- If you put a metal boat in water would it float? What if you put a metal ball with the exact same weight in the water? Discuss possible reasons for any difference between the two.

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[1] Jeryan, Richard A. "Buoyancy, Principle of." The Gale Encyclopedia of Science, edited by K. Lee Lerner and Brenda Wilmoth Lerner, 5th ed., vol. 1, Gale, 2014, pp. 707-709. Gale eBooks, https://link.gale.com/apps/doc/CX3727800398/GVRL?u=down54663&sid=GVRL&xid=9c30e049. Accessed 20 Mar. 2020.

Materials Needed

- Paper
- Scissors
- Tape
- Aluminum foil (optional)
- Plastic wrap (optional)
- Craft sticks (optional)

Activity

Start with paper, scissors, and a pencil to sketch out your design before you begin cutting. Aluminum foil also works well, just be careful not to cut yourself on the serrated edge of the box. Below you will find a few photos of simple designs you can try, or you can start with a design of your own.

Here's a few things to keep in mind as you think about your design:

- *How high should you make the sides of your ship?* A larger hollow inner portion of the will mean more air inside and makes your boat less dense, but once you start loading cargo your boats will become heavier (and if it gets too heavy it will sink).
- *Will the boat be balanced in the water?* Making sure the boat is balanced from both the left to right sides (called port and starboard on a boat) as well as the front to back (or bow and stern) can be important to make sure it doesn't capsize when you fill it with cargo or when the boat is navigating through high waves.
- *Is the boat going to be water-tight?* When boats take on water, they become heavier, denser, and eventually may sink. If you're using paper, you can add tape to the sides to help prevent it from absorbing water. You can also try lining the sides of your boats with plastic wrap or the plastic from a sandwich bag. Anything to make sure that water intrusion doesn't sink your boat!

Find a plastic tub, a large sauce pot from the kitchen, or a bathtub and fill it with water. Try not to overfill your tub as it becomes difficult to move around without spilling. Gently place your boat into the water and observe.

- Is your boat taking on any water? If so, why do you think water is getting into the boat? Do you need to make changes to your design?

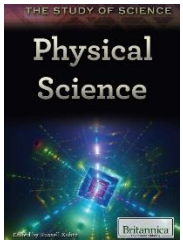
- If your boat is watertight and continues to float well, try attempting to add weight inside and observe the results. You can add weight using coins, paper clips, or small rocks. What happened when you added weight? What happens if you add more weight to one side than another? What happens if the weight is evenly distributed in the boat?
- If your boat is standing up to the water and cargo, do you think it can survive waves? As long as you didn't overfill your container, you should be able to gently give it a shake to produce waves in the water. You can increase the intensity of the waves a bit as you go, just be careful not to spill and make sure you aren't near anything that shouldn't get wet.

After all this extensive testing, you should either have a seaworthy vessel or will have learned a lot about how boats float (and sink), so keep designing to get better! And don't forget to name your boat!

DIGITAL RESOURCES AVAILABLE THROUGH LA COUNTY LIBRARY

eBooks & Audiobooks

LA County Library offers numerous resources that can help you learn more about buoyancy and science. Here are just a few, all of which are available as eBooks on OverDrive and Libby:

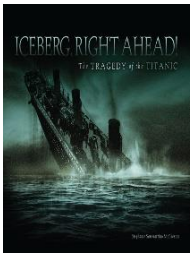


Physical Science: the Study of Science III **by Russell Kuhtz**

Learn about the three major areas of physical science: astronomy, physics, and chemistry. Discover their origins in the ancient world and their applications in our modern age.

The Secret Science of Magic **by Melissa Keil**

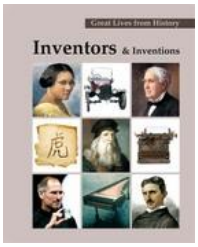
Mix a former child prodigy/math genius with a highly intelligent amateur magician and you get this heartwarming tale of unconventional romance, perfect timing, and finding your own magic.



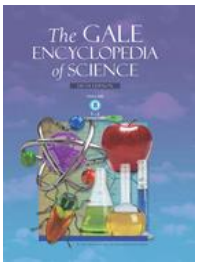
Iceberg, Right Ahead!: the Tragedy of the Titanic **by Stephanie Sammartino McPherson**

McPherson brings the reader through the history of the Titanic, stories from survivors, as well as the politics and intrigue still surrounding the wreck—including what modern science can reveal about what really happened to the ship and who was at fault.

Digital Reference Library



Inventors & Inventions
Provides in-depth critical essays on important men and women inventors of all time, from around the world.



The Gale Encyclopedia of Science
This encyclopedia covers all major areas of science, engineering, technology, as well as mathematics and the medical and health sciences, while providing a comprehensive overview of current scientific knowledge and technology. Entries typically describe scientific concepts, provide overviews of scientific areas and, in some cases, define terms.

Online Learning

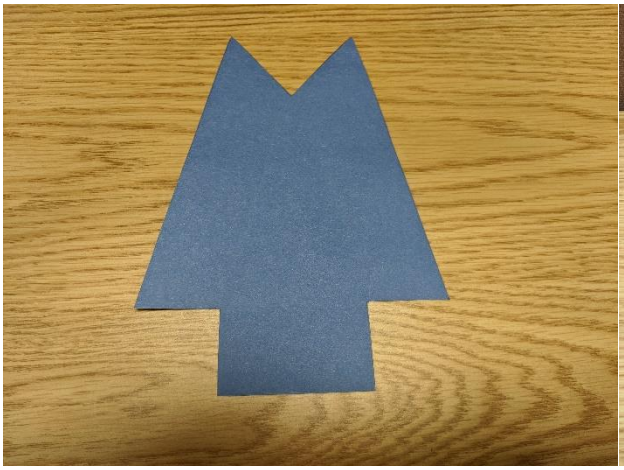
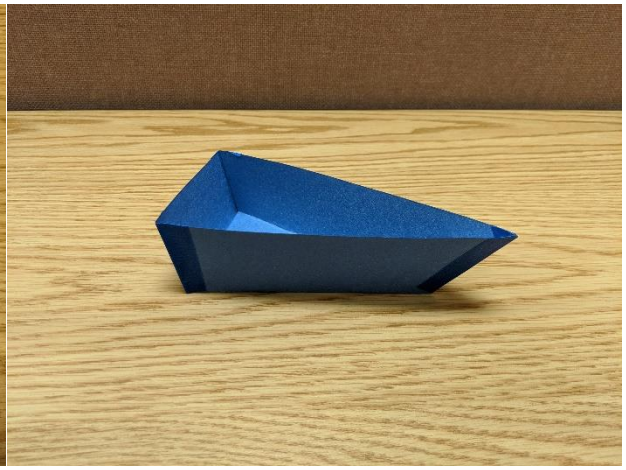
Want an even more detailed scientific explanation of buoyant forces at work? Check out the resources available at Khan Academy. www.khanacademy.org

Interested in learning about other scientific subjects? Take a course online from Universal Class to learn about biology, astronomy, chemistry, and more! colapublib.universalclass.com

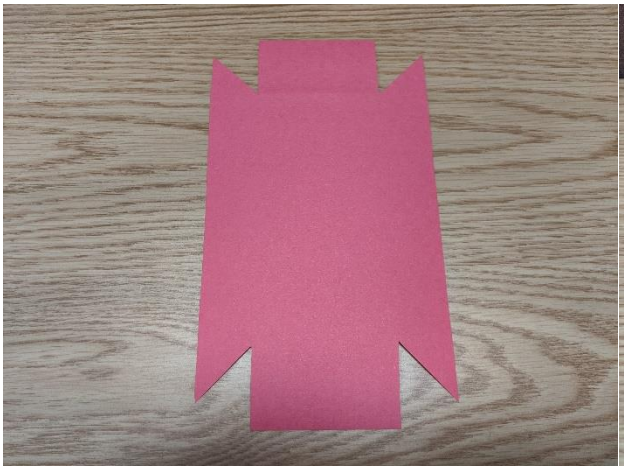
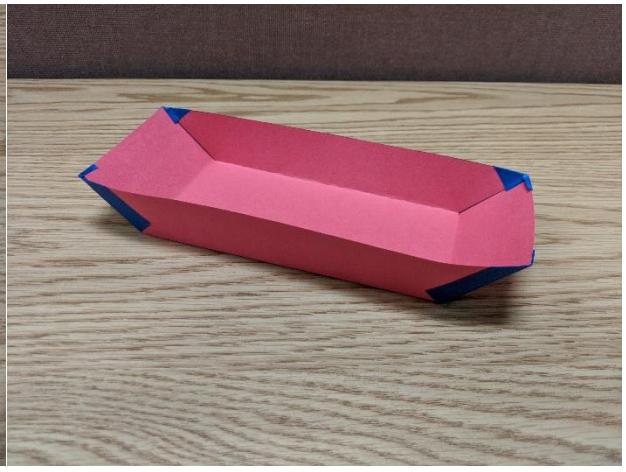
EXAMPLES

Below you'll find a few examples of boat designs along with a photograph of what the finished boat should look like. There are no measurements indicated because we wanted you to be able to create them in any size that you wanted. Helpful tip: edges which will be joined together with tape should ideally be measured to be the same length.

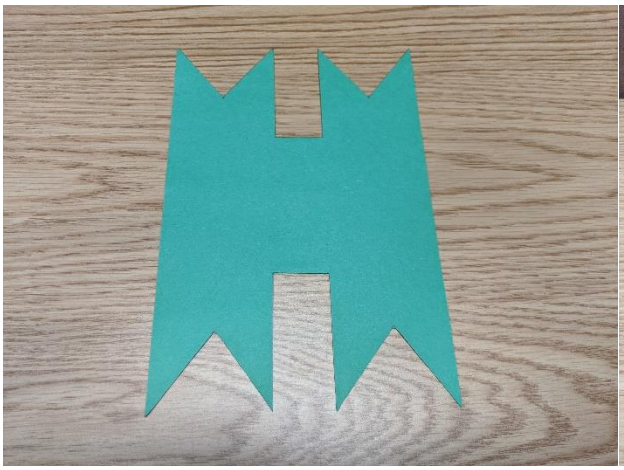
A-Frame Boat

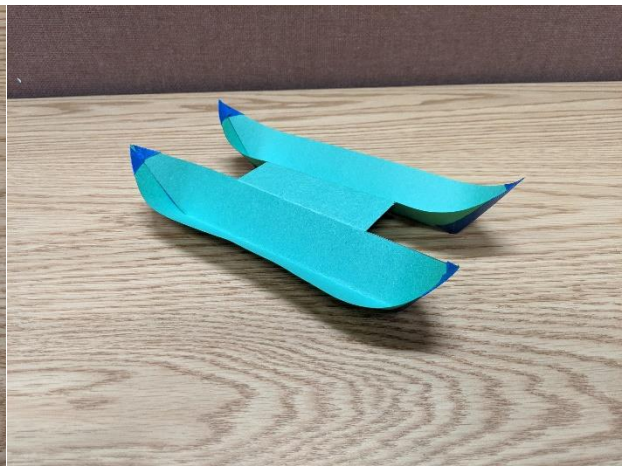



Flat Bottom Boat

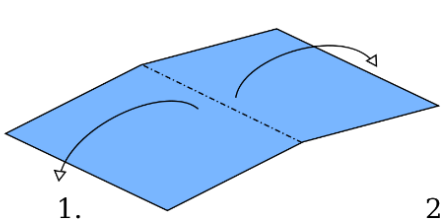
Catamaran Boat





Origami Sailboat

You might also give this foldable sailboat a try if you enjoy doing origami!



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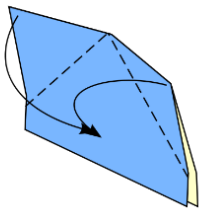

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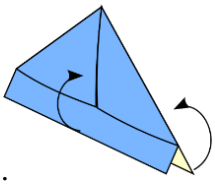

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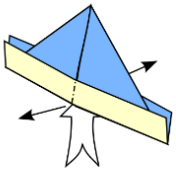

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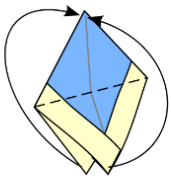

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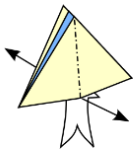

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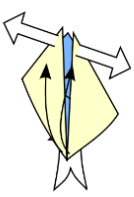

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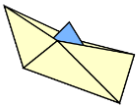

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