Wright-Patterson AFB Educational Outreach

K-12 STEM

WPAFBSTEM.com

DIY Air Force Activities:

Float your Boat

WOW DIY

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Materials:

- aluminum foil
- tape
- calculator
- dry rice
- dry pennies
- measuring cup
- paper and pen/pencil
- water
- bucket, tub, sink, or dishpan (somewhere to float your boat!)

What floats your boat? Physics! More specifically density; the density of an object vs the density of the liquid determines whether an object will float. Yet in our density demo we saw that a steel ball sinks, so how does a ship made of steel float? The steel of the hull is dense, but the hull encloses a large volume of air, making the ship as a whole less dense than the water it is floating on! Buoyancy is the ability or tendency to float, and results from the upward force exerted by a fluid when it opposes the weight of an immersed object. This law of physics is known as Archimedes' Principle. As we add mass, or cargo, to that volume though, the density increases. If too much cargo is added the ship will sink! The buoyant force is no longer great enough to resist the force of the boat's weight (mass x gravity) and hold it up. In the following experiment you will design a ship and test how much cargo it can carry before it sinks. Your ship may be any shape, use your imagination or test some of the templates on the back of this sheet. For a review of density check out our Density Diversions and Rainbow Density activities.

Directions:

1. Use the aluminum foil and tape to create 2 different boats with the same shape but of a different size.
2. Fill your boat with dry rice so that the rice is level with the edge of the boat. Transfer this amount of rice into a measuring cup to estimate the volume in mL (1 cm^3 = 1 mL). Write this number down.
3. Fill your chosen container a little over halfway with water (the water should be deeper than about twice the height of your boat).
4. Place the boat in the water. Add pennies one at a time. Make observations. Continue to add pennies until your boat sinks. Write down the number of pennies it took and multiply that by 2.5 g (average weight of a penny)
5. Divide the grams of pennies by the volume of the rice. Note this number.
6. Repeat the experiment with different size and shape boats. What do you notice about the results?

Air Force Associations:

When you think of the Air Force you think of airplanes, but did you know they also have their own fleet of ships? The Afloat Pre-positioned Fleet consists of four freighter-style ships that sail around the world loaded with various types of ammunition. In addition, drone recovery vessels operate out of Tyndall Air Force base. They are used to recover wrecks form the Air Force's "Combat Archer" aerial target practice training area.

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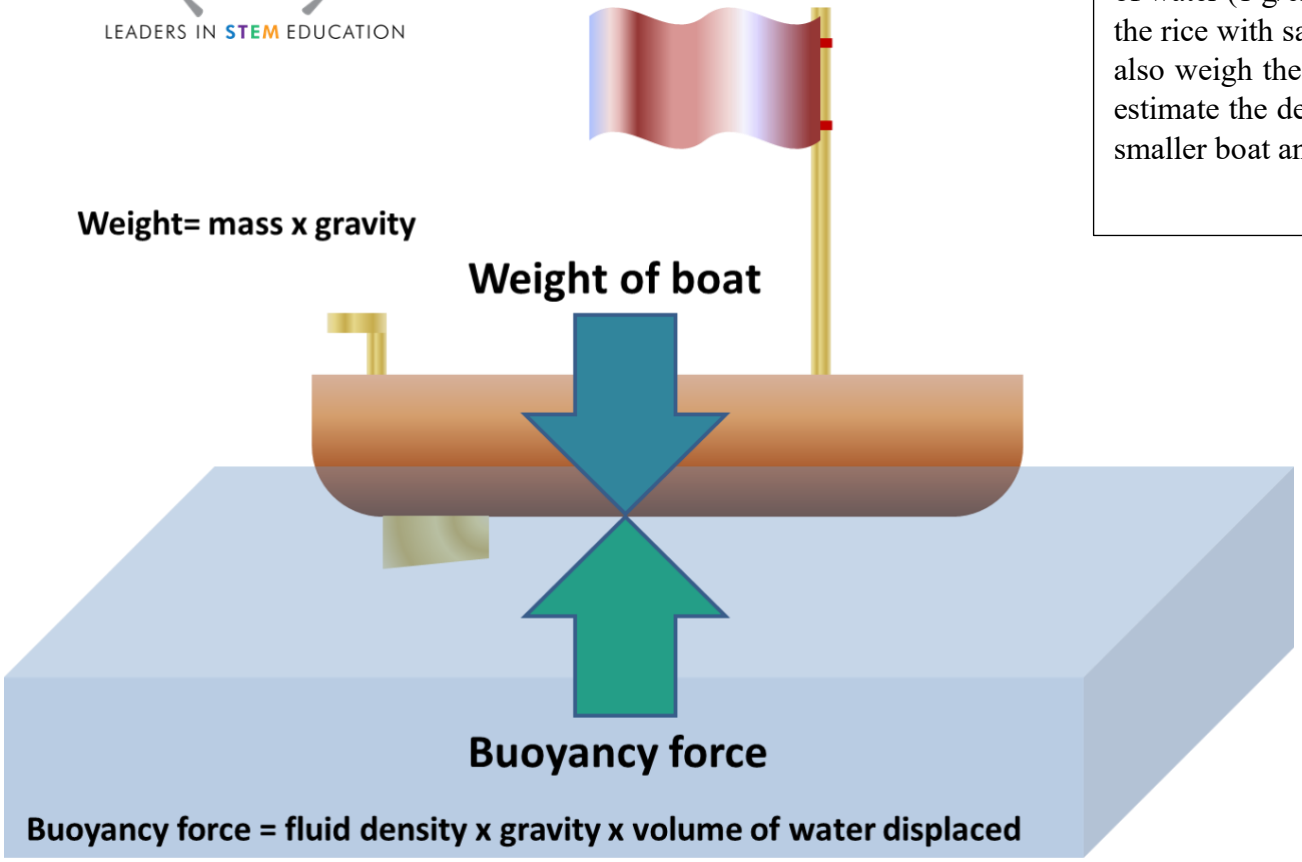
You should have noticed that all the results were fairly similar (within +/- 1). Size and shape do not matter, although some designs are likely to be more stable than others. You have actually estimated the density of water (1 g/cm^3)! If you want a more accurate answer, try replacing the rice with sand (smaller grains) to estimate the volume. You could also weigh the dry pennies rather than estimate their mass. Can you estimate the densities of other liquids? Repeat the experiment with a smaller boat and container and test other fluids like milk or oil!



Archemedes' Principle states that the upward buoyant force exerted by the fluid is equal to the weight of the fluid that the floating object displaces.

$$F_b = \rho g V_f$$

F_b = buoyancy force (in Newtons (N))

ρ = fluid density (kg/m^3)

g = standard gravity (9.806 m/s^2)

V_f = volume of the fluid displaced (kg/m^3)

Suggestions for shape of boat