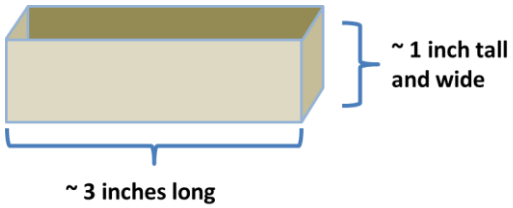
# DIY Air Force Activities:

# Float your Boat


**Materials:**

- aluminum foil
- tape
- dry rice
- measuring cup
- paper and pen/pencil
- water
- corn oil
- large mixing bowl
- dry pennies
- calculator

**Suggested boat dimensions for Part A:**





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. So how does a ship made of steel float? If you drop a steel ball in water, it sinks. Ships, however, are not solid steel! 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. That fluid could be a liquid or even air! Whether or not an object is buoyant depends mostly on two factors: the amount of fluid an object displaces and the densities of the object and fluid. This law of physics is known as Archimedes' Principle. For a review of density check out a few other WOW! DIY activities - Density Diversions and Rainbow Density. As we add cargo, or mass, to the volume of our ship 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 experiments you will design ships and test how much cargo they can carry before they sink. We will begin by exploring different liquids.

**Directions Part A:**

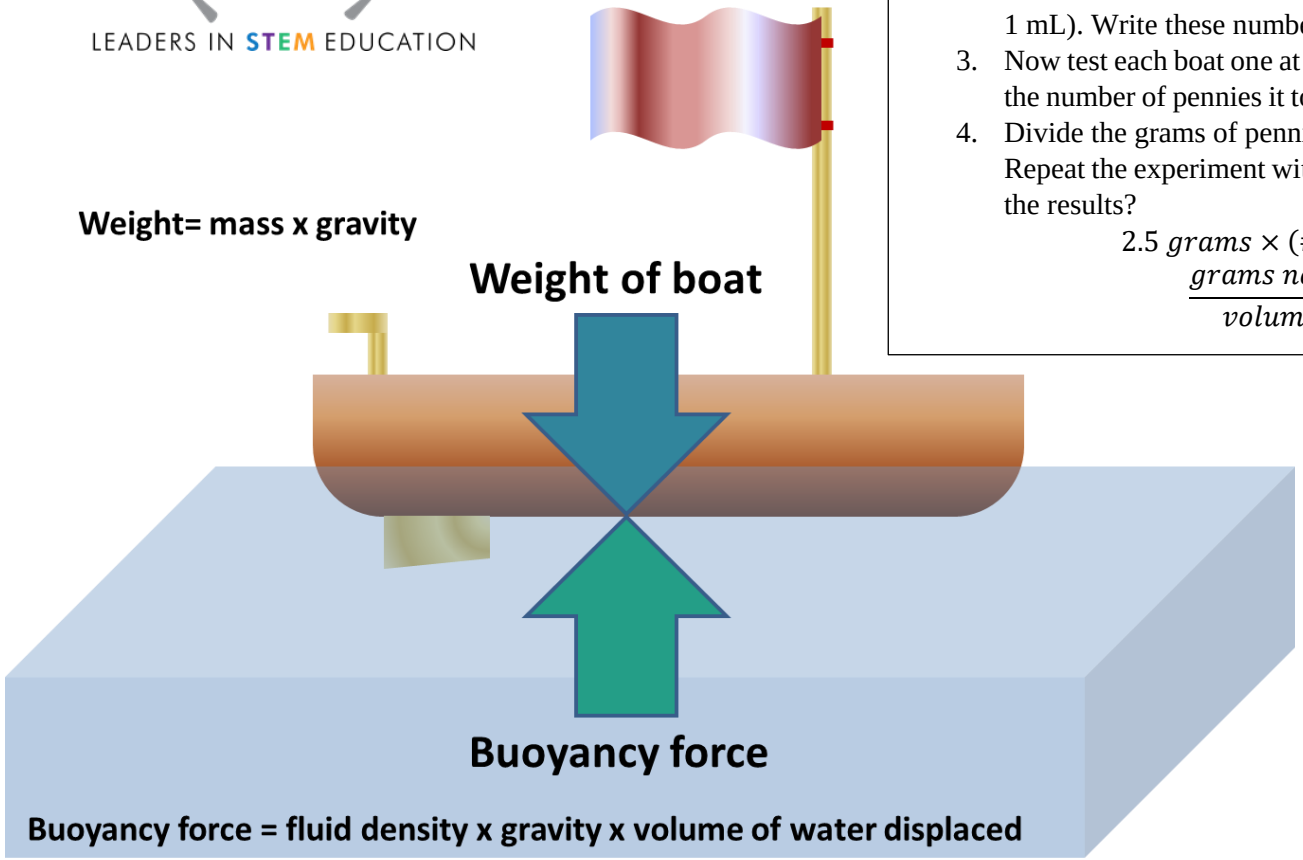
1. Use the aluminum foil and tape to create a boat. Make the boat about 1 inch tall and wide by 3 inches long with a flat bottom. It must be small enough to float and sink in your bowl!
2. Fill your boat with dry rice so that the rice is level with the edge of the boat. Transfer this amount of rice into a measuring cup to estimate the volume of your boat in mL (1 $cm^3$ = 1 mL). Write this number down.
3. Fill your large mixing bowl about halfway with water (the water should be deeper than about twice the height of your boat).
4. Place the boat in the bowl. Add pennies one at a time. Make observations. Continue to add pennies until your boat sinks.
5. Dump the water in the sink and dry off your boat, bowl, and pennies. Be careful not to change the size and shape of your boat!
6. Fill the bowl with corn oil, repeat step 4. Did you need more or less pennies to sink the boat? What does this tell you about the densities of the two liquids?

**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.

WIZARDS of WRIGHT

LEADERS IN STEM EDUCATION




***For students that want to take this a step further!***

**Directions part B:**

1. Create a few boats that are different sizes and shapes. Your ship may be any shape, use your imagination or test some of the templates on this sheet. Just make sure they are stable enough to float!
2. As in Part A, fill each boat with rice until it is level with the edge of your boats and then transfer the rice into a measuring cup to estimate their volumes in mL (1 $cm^3$ = 1 mL). Write these numbers down.
3. Now test each boat one at a time! Add pennies to your boat until it sinks. Write down the number of pennies it took and multiply that by 2.5 g (average weight of a penny).
4. Divide the grams of pennies by the volume of the rice. Note this number.
   Repeat the experiment with different size and shape boats. What do you notice about the results?

$$2.5\ grams \times (\#\ of\ pennies) = grams\ needed\ to\ sink\ boat$$

$$\frac{grams\ needed\ to\ sink\ boat}{volume\ of\ rice\ in\ cm^3} = ?\ \frac{g}{cm^3} = density!$$

**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.

$$\mathbf{F_b = \rho g V_f}$$

$F_b$ = buoyancy force (in Newtons (N))

$\rho$ = 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

**Results:**

In **Part A** did you notice it was harder to sink the boat in water than it was in the oil? This is because water is more dense than oil, giving water a larger buoyancy force!

In **Part B** did you notice that all your numbers were fairly close? This is because you are actually estimating the density of the water! To make your answer more accurate try using sand instead of rice to estimate the volume. Try weighing the dry pennies used to get a more exact weight in grams! Repeat this experiment with the oil and compare the results!