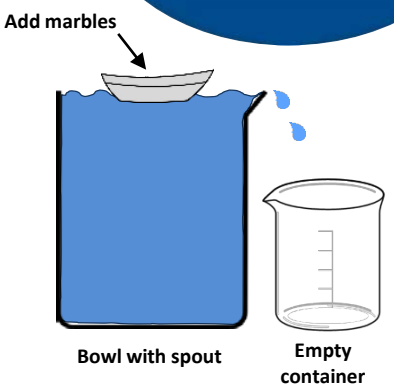
Float Your Boat

1. **Choose** a boat design to provide structural integrity.
2. **Build** a hull with a piece of aluminum foil or another material of choice.
3. **Add** 20 marbles to your boat and weigh it while dry on a scale ($\mathbf{W_{Boat}}$). Record this value.
4. **Fill** a large bowl or tank with a spout up to the brim with water.
5. **Record** the weight of an empty container and set it under the spout of the bowl.
6. **Place** your boat on the water and arrange the 20 marbles inside carefully for balance. Water that spills over will be captured by the adjacent container.
7. **Once** the spilling stops, weigh the container with the displaced water and record.
8. **Calculate** the weight of the displaced water alone by subtracting the weight of the container. This value is called the ***displacement*** (**Δ**).
   - How does **Δ** compare to $\mathbf{W_{Boat}}$?
9. **Use** the formula to calculate the ***submerged volume of the boat*** (**V**).
10. **Repeat** the experiment using different hull designs or numbers of marbles.
    - What is the relationship between **Δ** and $\mathbf{W_{Boat}}$?
    - What is the relationship between **V** and **Δ**?
    - What is the maximum displacement ($\mathbf{\Delta_{max}}$) you can achieve without sinking your boat?



$$F_B = \Delta = \rho g V$$

Archimedes Principle is described mathematically using the formula above. F_B is the *buoyant force*, Δ is the *displacement* of water in lbs, ρ is the *density of water* in lb-s^2/ft^4, g is the *acceleration due to gravity* in ft/s^2, and V is the *submerged volume of the ship* in ft^3. On earth, g = 32 ft/s^2 and in freshwater, ρ = 1.94 lb-s^2/ft^4. This formula can also be rewritten as **V = Δ/(ρg)**. As you load your boat with more marbles, the dry weight of the boat increases, the submerged volume of the boat increases, and more water is displaced.

Archimedes Principle

How does a boat float?

When you put a boat in water, the weight of the boat (W_{Boat}) **pushes down** on the water and **displaces** it. The water **pushes up** on the boat with a **buoyant force (F_B)** equal to the weight of the water displaced (**Δ**). If the weight of the displaced water (**Δ**) equals the dry weight of the boat (W_{Boat}), the boat will **float**!

NAVY NOTES

Most Naval surface ships are supported on the water **hydrostatically**. In other words, they float by displacing their own weight in water, as described by Archimedes Principle. A Nimitz Class aircraft carrier displaces about 97,000 tons of seawater when full (Navy Fact File, 2016).

Float Your Boat

$$F_B = \Delta = \rho g V$$

$$V = \frac{\Delta}{\rho g}$$

Acceleration due to gravity (g) is 32 ft/s^2

Density of freshwater (ρ) is 1.94 lb-s^2/ft^4

	Boat 1	Boat 2	Boat 3
Weight of boat with marbles, W_{Boat} (lbs)			
Weight of empty container (lbs)			
Weight of displaced water and container (lbs)			
Weight of displaced water (a.k.a. displacement), Δ (lbs)			
Magnitude of buoyant force, F_B (lb)			
Submerged volume of boat, V (ft^3)			