**Eureka!**

**Objective:**

To build a boat to carry a cargo of pennies and investigate Archimedes principle.

**Background:**

The Greek Mathematician, Archimedes, is said to have exclaimed, “eureka, eureka” upon noticing how his body displaced water when submerging himself in a bathtub. Archimedes principle explains how ships float. It states that the buoyant force on an object is equal to the weight of the fluid displaced by the object. The buoyant force is an upward force that acts on submerged objects. It occurs because water pressure increases with depth and explains why objects feel lighter when you lift them under water. An object will float as long as its buoyant force is greater than its weight. Boats are designed to displace water so that they float. The more water that is displaced, the larger and heavier the boat can be. Your goal is to build a boat to carry a cargo of pennies. The bigger the boat, the more pennies (weight) it can hold. Water is much heavier than air. Keep the water off, as long as possible. You don’t need to use all of the materials.

 **Guiding Questions:**

1. What is Archimedes principle?
2. What is buoyant force?

**Vocabulary:**

1. Fluid- any substance that flows. A liquid or gas.
2. Buoyant Force- The upward force exerted by a fluid on a submerged object.
3. Archimedes Principle- The buoyant force on an object is equal to the weight of the fluid displaced by the object.

**Materials:**

1. Aluminum foil
2. 2 craft sticks
3. 2 wood splints
4. 2 straws
5. 10 cm masking tape
6. 10 cm scotch tape
7. Paper
8. Scissors
9. Metric ruler
10. Calculator
11. Digital Balance
12. Tub with water
13. Pennies

**Procedures:**

1. Measure and cut out 2 squares of aluminum foil 10 cm by 10 cm.
2. Measure and cut 10 cm of masking tape and 10 cm of scotch tape.
3. Brainstorm with your partner about how you want to build your boat.
4. Build your boat according to your design making any necessary changes and modifications that you agree upon.
5. Determine the mass of your boat before you put it in water. Record on your data table.
6. Float your boat and add pennies. Pennies will be placed, one at a time, on the boat by you and/or your partner. The instructor will count as you add them. You will get credit for the number of pennies your boat holds which will be one less than what it sinks on.
7. Retrieve the pennies that your boat held (minus one), dry them and find the mass of them using a digital balance. Record on your data table.
8. Add the mass of the boat (dry) to the mass of the pennies that it held. Convert this to Kg, multiply by 9.8 m/s2 to convert to Newton’s. This is the buoyant force. Record on your data table.
9. Repeat steps 1-8 and make a second boat. You may change your design.

**Observations:**

Make a simple sketch of your boats below. Use two views if needed.

Boat 1-

Boat 2-

**Data:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | 1Mass of boatdry, prior to adding pennies(grams) | 2Mass of pennies your boat held (grams) | 3Total mass of boat and pennies converted to kilograms(kilograms) | 4Total mass multiplied by 9.8 m/s2 (Buoyant Force)(Newtons-N) | 5Weight of water displaced by your boat and pennies (N) |
| Boat 1 |  |  |  |  |  |
| Boat 2  |  |  |  |  |  |

 **Questions:**

1. What is the relationship between the buoyant force and the weight of water that is displaced?
2. When will an object float? Answer in terms of buoyant force and weight
3. When will an object sink? Answer in terms of buoyant force and weight.
4. What did you do differently when you made your second boat?