CONSTRUCTING AN ALUMINUM FOIL BOAT

Name: ______________________________
Date: ______________________________
Period: ___________ Page: ________

Objective: Given the provided materials, design and construct a boat that will hold the most amount of pennies and still float.

Rules: Using the aluminum foil and tape, you need to construct a boat that will float on water and hold a load of pennies. You do not have to use all the materials, but you may not use any more than listed. The boat that holds the most pennies wins, and the penny that causes the boat to sink does not count.

Required Materials:

- Pencil
- 5 squares of Aluminum Foil (13 cm X 13 cm)
- Scotch Tape (30 cm)
- Container Filled w/ Water
- Pennies (100)
- Electronic Scale
- Graduated Cylinder (100 mL)

Pre-lab Questions: Answer questions in a complete sentence

1. What is buoyancy?

2. What is the cause of the buoyant force?

3. What does Archimedes Principle state?

4. When an object is placed in a fluid such as water, what happens to some of the water? Explain why.

5. What is…

   a. Positive Buoyancy?

   b. Negative Buoyancy?

   c. Neutral Buoyancy?

6. In terms of density…
   a. When will an object float above the surface of a liquid?

   b. When will an object sink to the bottom of a liquid?

   c. When will an object neither float nor sink?

Procedure/ Data & Results:

Part A:

1. Crumble up one sheet of aluminum foil into a ball and drop it into the container of water.
   a. Describe what happens?

   b. How does the density of the aluminum foil ball compare to the density of the water based on what you observed?

2. Now, lay a flat piece of aluminum foil on the surface of the water.
   a. Describe what happens?

   b. How does the density of the aluminum foil ball compare to the density of the water based on what you observed?

   a. Explain what the unusual occurrence was, and why this is significant.

Part B: Find the mass, volume, and density of each of the objects/ substances in each of the tables below and record these values.

Density of Water:

3. Find the mass of an empty graduated cylinder. Record the mass in grams in the chart on the activity sheet.
4. Pour 50 mL of water into the graduated cylinder. Try to be as accurate as possible by checking that the meniscus is right at the 50 mL mark. Use a dropper to add or remove small amounts of water.

5. Weigh the graduated cylinder with the water in it. Record the mass in grams.
6. Find the mass of only the water by subtracting the mass of the empty graduated cylinder. Record the mass of 50 mL of water in the chart.
7. Use the mass and volume of the water to calculate density. Record the density in g/cm^3 in the chart.

Object/ Substance	Mass of Filled Graduated Cylinder (g)	Mass of Empty Graduated Cylinder (g)	Mass of Water (g)	Volume of Water (mL)	Density of Water (g/mL)
Water	-	=		50 mL	

Density of Pennies

8. Pour enough water from your cup into the graduated cylinder to reach a height that will cover the sample. Read and record the volume.

9. Slightly tilt the graduated cylinder and carefully place the sample into the water.

10. Place the gradated cylinder upright on the table and look at the level of the water. If the sample floats, use a pencil to gently push the top of the sample just under the surface of the water. Record the number of milliliters for this final water level.

11. Find the amount of water displaced by subtracting the initial level of the water from the final level. This volume equals the volume of the cylinder in cm^3.

12. Record this volume in the chart on the activity sheet.

13. Remove the sample by pouring the water back into your cup and taking the sample out of your graduated cylinder.

Object/ Substance	Mass (g)	Volume of Displacement			Density (g/mL)
		Ending Volume (mL)	Starting Volume (mL)	Volume of Pennies (mL)	
1 Penny		-	=		
5 Pennies		-	=		

Density of Aluminum Foil:

14. Using an electronic scale, mass a piece of aluminum foil. Record the mass in the table below.

15. Calculate the volume of the aluminum foil. For our purposes the volume of the aluminum foil cannot be measured directly because it is extremely thin, so it will need to be calculated. To find the volume of the aluminum foil, you will need to find it by dividing its mass by its density.

To find volume of aluminum foil: **Volume = mass ÷ density**

Object/ Substance	**Mass of Aluminum Foil (g)**	**Volume of Aluminum Foil (V = m / d) (cm3)**	**Density (g/mL)**
Aluminum Foil			2.71 g / cm3

<u>Part C:</u>

16. Sketch out 3 possible designs that you could use to construct a boat that you feel can carry a load of 100 pennies without sinking.

17. Predict the number of pennies that each of your boat designs will hold before sinking, and write this number in the spaces below.

18. Once you are satisfied with your designs, construct your foil boat and test it by placing one penny at a time into the boat (Note: Spread your pennies out evenly so that not all the weight is on one side of the boat, which will cause it to sink.). Remember, you do not have to use all the materials, but you may not use any more than listed. If your boat sinks prematurely, make adjustments to your existing design and retest.

19. Continue to make adjustments until your boat holds the most amounts of pennies possible.

Boat 1 Design:

	How many pennies do you think your aluminum boat will hold?
	How many pennies did you aluminum boat hold when testing in the water tub?

Boat 2 Design:

<table>
<tr><td rowspan="4"></td><td>How many pennies do you think your aluminum boat will hold?</td></tr>
<tr><td></td></tr>
<tr><td>How many pennies did you aluminum boat hold when testing in the water tub?</td></tr>
<tr><td></td></tr>
</table>

Boat 3 Design:

<table>
<tr><td rowspan="4"></td><td>How many pennies do you think your aluminum boat will hold?</td></tr>
<tr><td></td></tr>
<tr><td>How many pennies did you aluminum boat hold when testing in the water tub?</td></tr>
<tr><td></td></tr>
</table>

Conclusion Questions: Answer questions in a complete sentence

1. Which of the substances used in this exploration (water, copper, or aluminum) had the highest density? Explain what is meant by high density.

2. How many pennies went into your best aluminum foil boat before it sank?

3. What can you now say about how a boat should be designed to float as much weight as possible?

4. What changes could you make in your boat design so that the boat would hold more pennies?

5. What besides the design of a boat affects how many pennies it can hold?

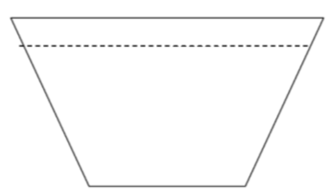
6. Steel is almost eight times denser than water, and yet huge steel ships can float with ease, even while carrying enormous loads. How is this possible? (Note: Please be thorough and specific when writing your response to this question.)

7. What 2 factors determine how heavy an object can be and still float?

8. An object with a mass of 10 g and a volume of 5 cm^3 was placed into a container of water.

   a. What is the density of the object? Show all work in the space below.

   b. Where would this object be located if it were placed into the container of water shown below? (Please draw a rectangle to represent the solid object.)



   c. Is the object positively buoyant, negatively buoyant, or neutrally buoyant? Explain why?

9. A barge filled with sand approaches a bridge over a river and cannot pass underneath it. Should sand be added or removed from the barge to get it under the bridge? Explain.