

## Penny Boats

It is essential that the river rafts float while holding passengers and supplies. When a boat is floating there is an upward force from the water that is equal to the weight of the water displaced by the boat. For example, a boat that weighs 500 pounds will sink into the water until it has displaced 500 pounds of water. The boat will sink if it weighs more than the water it displaces.

### Experiment 1

In this activity you will use aluminum foil to make a variety of boats to determine which style will float best while holding the most weight in pennies.

#### Materials:

- 10 pieces of aluminum foil about 8 inches square
- 300 pennies (marbles can be substituted for pennies)
- 1 large bucket filled with water (a sink or bathtub can also be used)

#### Steps for this experiment:

1. Fold each piece of foil into a different boat. Change the boat shapes with high or low sides, various lengths and/or widths, and different bottoms.
2. Measure the length and width of each boat to determine the approximate area of the bottom of the boat using the following formula:  $\text{Length} \times \text{Width} = \text{Area}$
3. Optional: Measure the depth of each boat and determine its volume using the following formula:  $\text{Length} \times \text{Width} \times \text{Depth} = \text{Volume}$ .
4. Based on the results from Steps 2 and 3, guess which boat will hold the largest number of pennies.
5. Set a boat on the water in the bucket and put pennies in the boat one at a time until it starts to sink.
6. Count and record the number of pennies.
7. Repeat this with each of the other nine boats.
8. Create a graph with your results (see sample graph).

#### Questions

- Which boat was best designed to carry the most pennies?
- What is the smallest number of pennies that a boat held? What is the largest number of pennies that a boat held? What were the differences between the two types of boats?
- Is there a relationship between the area (and volume) of a boat and the number of pennies it held?
- Is there a relationship between the depth of a boat and the number of pennies it held?
- Did you create a boat similar to the river rafts in the story? How did this boat do compared to the other boats that you created?
- Did it matter how you placed the pennies in the boat? What was the best way to place the pennies in the boat?
- How would you load passengers and supplies into a river raft?

### Experiment 2

The boats used for river rafting have inflatable sides. In this experiment you will use straws to hold air in your aluminum rafts.

#### Materials:

- 10 pieces of aluminum foil about 10 inches square
- straws
- clay to plug straws
- 300 pennies (marbles can be substituted for pennies)
- 1 large bucket filled with water (a sink or bathtub can also be used)

#### Steps for this experiment:

1. Fold each piece of foil into a different boat as in Experiment 1. This time roll straws into the sides of the boat. The straws should be plugged with the clay to hold air.
2. Measure the length and width of each boat to determine the approximate area of the bottom of the boat.  $L \times W = A$
3. Optional: Measure the depth of the boats and determine the volume of each boat.  $L \times W \times D = V$
4. Based on the results from Steps 2 and 3, guess which boat will hold the largest number of pennies.
5. Set a boat in on the water in the bucket and put pennies in the boat one at a time until it starts to sink.
6. Count and record the number of pennies.
7. Repeat this with each of the other nine boats.
8. Create a graph with your results again.

#### Questions

- How do the results differ from the first experiment?
- If there was a difference, what is a possible explanation?
- Why are the river rafts inflatable?

### Experiment 3

For this experiment you will look at water currents using the best penny boat you created in Experiment 1. Please note this should be done outside in a large tub or small swimming pool.

#### Materials:

- 10 pieces of aluminum foil about 10 inches square
- straws
- clay to plug straws
- 300 pennies (marbles can be substituted for pennies)
- 1 large bucket or pool filled with water
- 1 hose connected to a water source

#### Steps for this experiment:

1. Recreate the boat from Experiment 1 that held the most pennies.
2. Place the boat on the water in the tub.
3. Inside the boat, place 40 fewer pennies than what would sink it.
4. Put a hose under the water yet near the surface and turn it on so that it is obviously creating a current on the surface.
5. Place the boat in current of the hose.
6. Make observations.
7. Turn the water up higher to create a stronger current.
8. Make observations
9. Repeat steps 2 through 8 with other boat designs, including those from Experiment 2.

#### Questions

- What happened when you put the first boat in the water current? Did the boat continue to float? Did water get inside?
- Which boat was best designed for currents? Was it the same as the boat that held the most pennies from the Experiment 1 or 2?
- How does your boat design compare to the river rafts?

### Pennies in Foil Boats

