PAPERCLIPS! FOILED AGAIN!

Background Information for Activity Leaders

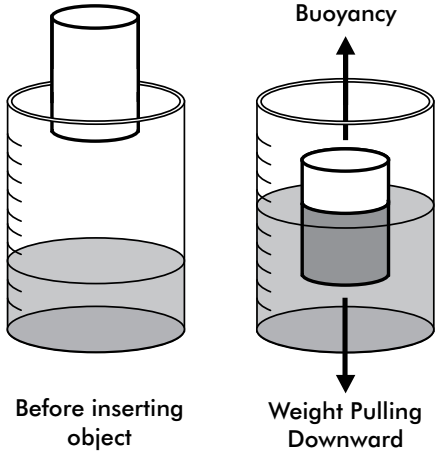
Overview

Children will design an aluminum foil boat as a way to help understand the forces involved in building a boat that will float. By designing models that work, and even models that don't work, children learn to make inferences, refine hypotheses, and draw conclusions about the design and behavior of materials. These steps are a very important part of the scientific inquiry process.

Key Concepts

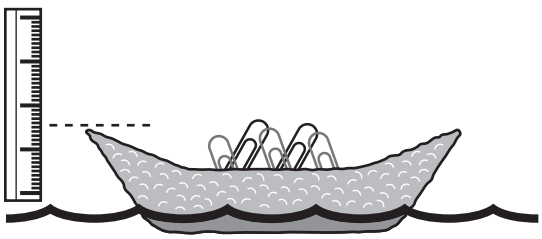
In this activity children will explore the scientific laws required for the design of a boat that floats: **buoyancy** and the **Archimedes' Principle**.

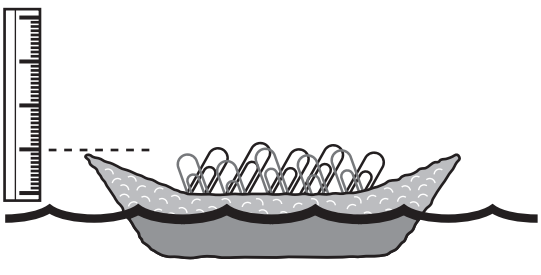
- When an object is placed into a container of water, the object moves, or displaces, some of the water upward. As the object is submerged, the water level in the container goes up. This upward force is what makes some objects float. The ability to float is called buoyancy.
- According to the Archimedes' Principle, if the **weight** of an object is greater than the weight of the displaced fluid, it will sink. If the weight of the object is less than the weight of the displaced fluid, it will float. That is why a very heavy ocean liner can float. It displaces a large amount of water.



What to Expect

- Successful designs will probably resemble a flat-bottomed bowl. This design will hold many paperclips as long as the weight is carefully distributed in the boat. This is a feature of flat-bottomed boats: they require careful balancing of the cargo and passengers, or else they become unstable and may tip and take on water.
- As children add paperclips to their boat, the boat will begin to sink deeper into the water. Unless the boat is wide enough and the sides are high enough to prevent water from leaking into the boat and adding to the weight, the boat will sink. The reason this occurs is that as water enters the boat it increases the weight of the boat. As the weight increases the boat will displace more water and sink deeper. Since the children will only have a 15 cm by 15 cm piece of aluminum foil to work with, keeping water out of the boat will be a challenge.


less weight


more weight

Background Information for Activity Leaders

Common Misconceptions

- *Children may think, "Large objects sink, while small objects float."*

  Size is not the most important factor. If a small object does not displace enough weight in water to match or exceed its weight, then it will not float. For example, if a small solid metal cube and a large hollow metal cube weigh the same, the small solid cube will displace less water than a larger hollow cube. The solid cube will sink, while the hollow cube will float.

- *Children may think, "Objects will sink or float depending on what material they are made of."*

  Children tend to think that metal objects will sink, while wooden objects will float Whether an object will float is not dependent on the material it is made of. It depends on how much water it displaces compared to its weight.

Metal Boat Illustration

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Data Collection Sheet

Name:_____ **Date:**_____

WONDER What shape of boat will float? What shape will carry the heaviest load? Draw the blueprint of your boat below.

RECORD How well did your boat float? Describe and draw any changes you made to the boat's design?

_____

_____

_____

EXPAND

Data Table

number of paperclips	initial height	10	20	40
height from the surface of the water to the top of the boat				

How did adding the paperclips affect your boat?

_____

CONCLUDE What factors are important when you design a metal boat?

_____

_____

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Activity Leader's Guide

Group Size: 2 children
Time: 20 - 40 minutes

Set Up the Expedition

Materials:

For the activity leader:
- (1) large basin or bowl
- (1) 15 cm by 15 cm piece of aluminum foil
- (1) metal boat illustration

For each group:
- ***Paperclips! Foiled Again!*** Learning Cards
- (1) large basin or bowl filled with tap water
- (1) roll of heavy duty aluminum foil
- (40) paperclips
- (1) ruler
- paper towels for clean up

For each child:
- (1) ***Paperclips! Foiled Again!*** Data Collection Sheet

Prepare the demonstration:
1. Fill the clear plastic pan with water for the demonstration.
2. Cut out a 15 cm by 15 cm piece of aluminum foil.

Prepare the exploration:
1. Cut four 15 cm by 15 cm pieces of aluminum foil per every two children.
2. Place the large container with water where children can gather around and test their metal boats.
3. Provide every two children with one sheet of 15 cm by 15 cm aluminum foil, 20 paperclips.

Engage

1. Gather the children together. Place a piece of aluminum foil where all the children can see. Aluminum is a light-weight metal that is easy to shape and manipulate.

   Ask:
   "What material is this object made of?"

2. **Ask:**
   "Aluminum is a metal. Do metal objects float or sink?" Allow children time to contribute their ideas.

   Say:
   "Let's find out." Shape the aluminum foil to make a wide bowl. Place the aluminum foil flat on the surface of the water in the large container of water.

3. **Ask:**
   "Did you expect that the metal would float?" Allow children time to contribute their ideas. Remove the foil from the water and dry it using a paper towel. Fold the foil into a small square so that no air pockets are left inside. Drop the foil into the bowl of water.

4. **Ask:**
   "Why did the aluminum foil sink this time?" The shape of the aluminum foil influences whether it will float or sink. During the EXPAND section of their Learning Card, children will get an opportunity to experiment with boat design.

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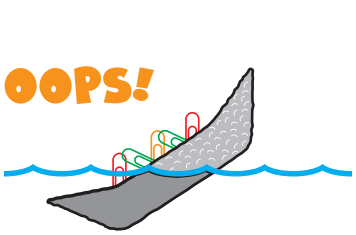
Explore/Expand

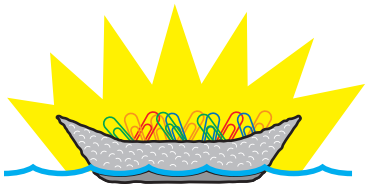
5 Divide the children into pairs. Distribute the Data Collection Sheets and the Learning Cards.

Say:
"Follow the directions on the Learning Card to investigate what factors are important to consider when you design a metal boat."

Explain:
"You will have four challenges to meet. First, your boat must be able to float. Next your boat must support ten paperclips, then twenty paperclips, and finally forty paperclips!"

6 Allow children enough time to complete the WONDER, EXPLORE, RECORD and EXPAND sections of their Learning Card.





Conclude

7 Gather the children together to complete the lesson and ask the following questions:

"While doing this activity what did you discover about designing metal boats?"

"What characteristics must a boat have to float?"

"Does the shape matter? How about the size?"

"Why do you think that even though the boat is made of metal, it floats?"

Display the illustration of a metal boat. Encourage children to discuss how what they have discovered might be applied to the boat in the picture.

8 **Say:**
"Congratulations! You have earned your 'Ask Me About Design and Construction' stamp. You are ready to tell people about design and construction."

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PAPERCLIPS! FOILED AGAIN

Expedition Learning Card

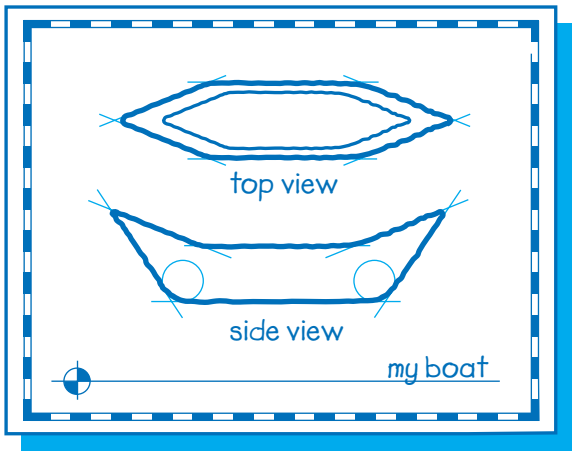
Can you design a boat that floats while carrying a load of paperclips?

float
buoyancy
blueprint

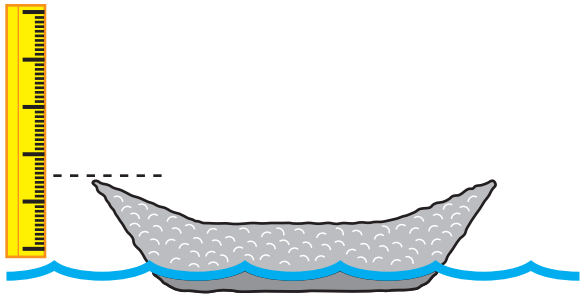
Explore ways to design a boat that floats.

1 WONDER What boat shape will float? What shape will carry the heaviest load?

Plan with your partner ways to use aluminum foil to build a boat that floats. Draw your plan in your data collection sheet. Architects call detailed drawings blueprints.



2 EXPLORE Build the boat and test it in the container of water. The ability to float is called buoyancy.



3 RECORD

Record on your Data Collection Sheet how well your boat floats. Measure the height from the surface of the water to the top of the boat. What would you change in your design? Record your design changes on your Data Collection Sheet.

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Expedition Learning Card

4 **EXPAND** Once you adjust the design of the boat to get it to float, measure the initial height of the boat in the water. Place ten paperclips in your boat. Did the height of the boat in the water change?

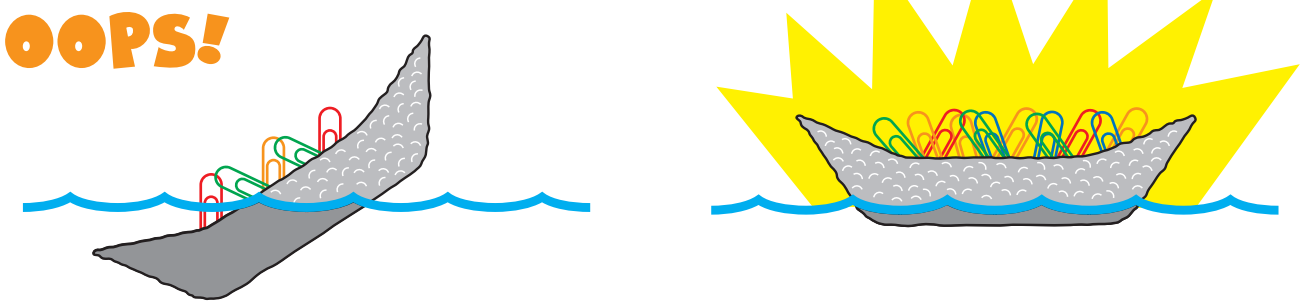
Record the results on your Data Table.

If the boat was not able to float with ten paperclips inside, experiment with your design. TRY IT AGAIN!

Repeat until the boat is able to hold 10, 20, and even 40 paper clips.

Record the results on your Data Table.

5 **CONCLUDE** What factors are important when you design a metal boat?



Discovery

Why did we do that?

- Different factors determine whether a boat floats.
- Through experimentation we can discover what makes boats float.
- A problem may have more than one solution.

Congratulations!

You have earned your "Ask Me About Design and Construction" stamp! Now you are ready to tell people about design and construction!

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