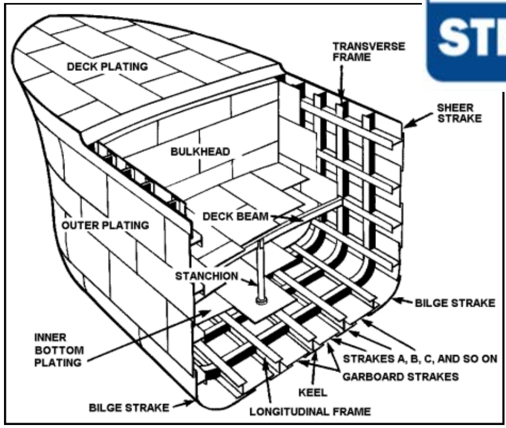
Hull Integrity

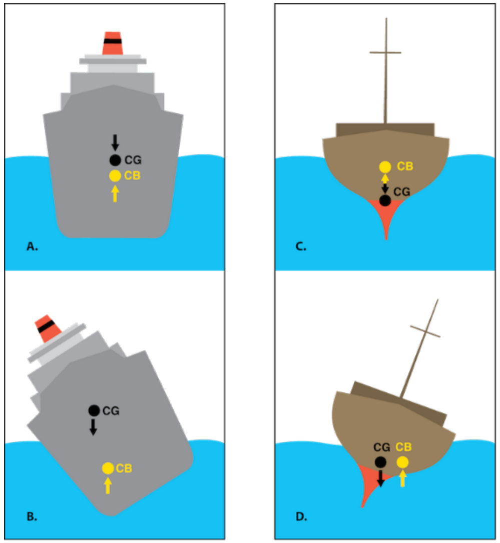
1. **Using** a limited amount of aluminum foil and straws, design a ship hull that will hold the maximum number of crew members.
2. **Place** the empty ship in the water and use a Sharpie to trace the waterline *(the line where the hull meets the water surface)* on the outside of the hull.
3. **How** does the waterline change as you fill your ship with passengers?
4. **Maximize** the number of passengers your ship can hold by redesigning and reinforcing the hull.



Water, water everywhere...

The **hull** is the watertight body of a ship. The main centerline structural part of the hull is the **keel**, which serves as the "backbone" of the ship. **Frames** are fastened to the keel, which are the "ribs" of the ship and give shape and strength to the hull. **Deck beams** and **bulkheads** support the decks of the ship and provide additional strength.

The **center of buoyancy (CB),** an imaginary focus of all the vertical buoyant forces that keep the ship afloat, is the geometric center of the underwater form. Therefore, the shape of the hull determines the CB, and the CB is not fixed and will move around in response to loading and wave motion. If the ship is to float in equilibrium, the **center of gravity (CG)** must be in line vertically with the center of buoyancy.



A) A stable ship in calm water, B) An unstable ship that cannot right itself, C) A ship with a weighted hull in calm water, D) An unstable ship with a weighted hull that cannot right itself.

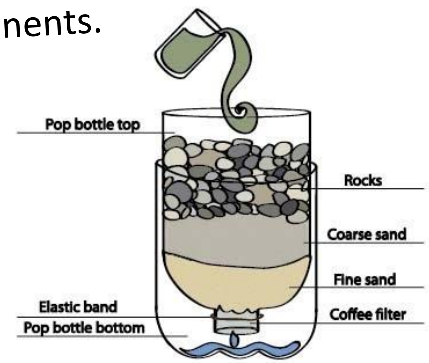
NAVY NOTES

Navy ships have bulkheads or walls designed to reinforce the hull's structure and to create watertight compartments that can contain water in case of a hull breach.

This activity is a product of Naval collaboration observed at the April 2016 ONR Best Practices in STEM Workshop

Filter Face Off

1. **Construct** a water filter using a plastic water bottle and layered materials in any order: gravel, sand, charcoal, cotton balls, coffee filter paper, gauze, etc.
2. **Create** dirty water by mixing sand, food coloring, paper pieces, glitter, and/or vegetable oil with tap water.
3. **Pour** the “polluted” water through your filter.
4. **How** does the filtered water compare to the dirty water?
5. **Investigate** which layers removed dirty water components.
6. **Try** putting materials in a different sequence.
7. **Compete** with another team to see who’s filter cleaned dirty water the most!



Water filters remove impurities from water using a physical barrier, chemical process, or biological means. Filters cleanse water to different extents depending on the purpose such as irrigation, human consumption, or swimming pools.

NAVY NOTES

To produce drinkable, clean water at sea, U.S. Navy submarines have distillation devices that take in seawater and produce freshwater. The distillation plant heats seawater to water vapor, which removes the salts, and then cools the water vapor into a collecting tank of freshwater. This process can produce up to 10,000 to 40,000 gallons of freshwater a day.

This activity is a product of Naval collaboration observed at the 2015 ONR Best Practices in STEM Workshop

(inspired by PBS Kids ZOOM: http://pbskids.org/zoom/activities/sci/waterfilter.html)

ZOOM into Engineering

Flinker

What's a Flinker? It's something that doesn't float or sink but just "flinks" in the middle.

What You Need

- foam packing peanuts
- paper clips
- clear container that will hold water (like a soda bottle with the top cut off)

1 **Fill** a clear container with water.

2 **Place** a foam packing peanut in the water. **What happens?**

3 What can you do to make the peanut **flink** (neither float nor sink)? Here are some ideas: **Attach** paper clips to your peanut. Or **change the shape** of the peanut.

4 **Experiment!** Keep changing the design of your Flinker until it **flinks** for 10 seconds.

Engineering Scoop

When you put a foam peanut in water, the water "**pushes up**" on the peanut. (This is called a **buoyant force**.) At the same time, the weight of the peanut "**pushes down**" on the water. If the "pushing down" force of the peanut is **less** than the "pushing up" force of the water, the peanut **floats.** If the "pushing down" force of the peanut is **more** than the "pushing up" force of the water, the peanut **sinks**. If both forces are exactly **equal**, the peanut **flinks**! (It doesn't rise or sink in water.)

Sent in by Sarah P. of Maribel, WI

ZOOM on

Try making a **different object**, like a small sponge or a penny, flink. **Predict** what you think will happen. Then **test it** and **send** your results to ZOOM.

ZOOM INTO ENGINEERING is a partnership of WGBH and National Engineers Week. National Engineers Week 2002 chairs: DuPont and the American Society of Civil Engineers. ZOOM is produced by WGBH Boston. Funding for ZOOM is provided by the National Science Foundation, the Corporation for Public Broadcasting, the Arthur Vining Davis Foundations, and public television viewers. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

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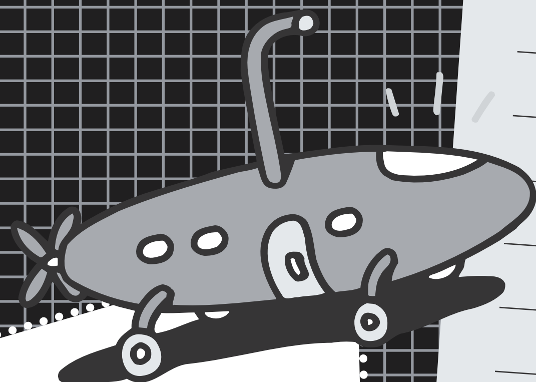
Flinker

Engineer's Notebook

My Prediction

What Happened



Engineers Wanted!

Did you know that most of the Earth is covered by water? As land becomes more crowded, people may someday **live under the ocean**. Underwater vehicles will be needed to build these communities. People will also need ways to travel between their underwater homes and the land. These vehicles will need to float, sink, and "flink." Engineers like **you** could design flinkers of the future!

Send It to ZOOM™!
Tell us about your results at
pbskids.org/zoom/sendit

ZOOM into Engineering

Hoop Glider

What You Need

- paper
- ruler
- scissors
- pencil
- nonbendable, plastic drinking straw
- tape

Engineering Scoop

If you throw a **plain straw**, it doesn't go very far. But when you add **paper hoops**, the straw glides through the air. That's because the hoops act like **wings**. Things that **fly**—like insects, birds, and airplanes—all have wings. But wings are not all the same **shape** and **size**. Different wings can be better for different kinds of flight. For example, an eagle has **long**, **wide wings** that help it glide. An airplane has **wings with small flaps** that move up and down to turn the plane. Try **changing** the wings on your glider. How does it **fly** with different wings?

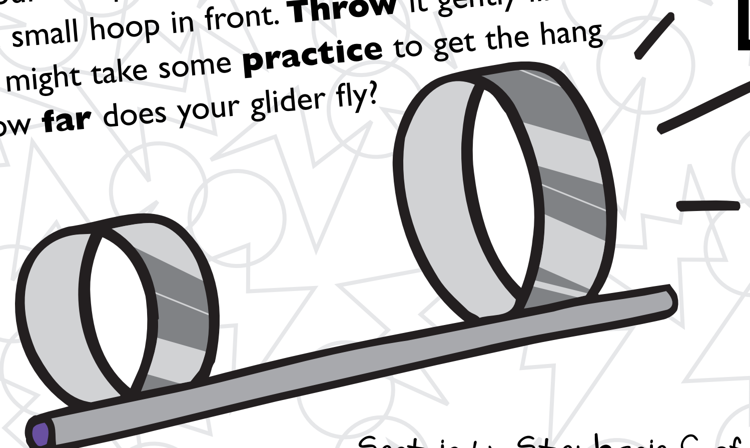
1 Cut two strips of paper. Make one strip **1 inch wide and 5 inches long.** Make the second strip **1 inch wide and 10 inches long.**

2 Curl each paper strip into a hoop. **Tape** the ends together. Now you have a big hoop and a small hoop.

3 Tape the small hoop to one end of the straw.

4 Tape the big hoop on the other end of the straw. Make sure the big hoop **lines up** with the small hoop.

5 Hold your Hoop Glider in the middle of the straw, with the small hoop in front. **Throw** it gently like a spear. It might take some **practice** to get the hang of it. How **far** does your glider fly?



Sent in by Stephanie C. of Milton, NH

ZOOM on

Change your glider so that it flies the longest possible distance. What happens if you make the **straw smaller?** What happens if you change the **size of the hoops?** Or, what happens if you add a **third hoop?** Choose one thing to change (that's the **variable**), and make a **prediction.** Then **test it** and **send** your results to ZOOM.

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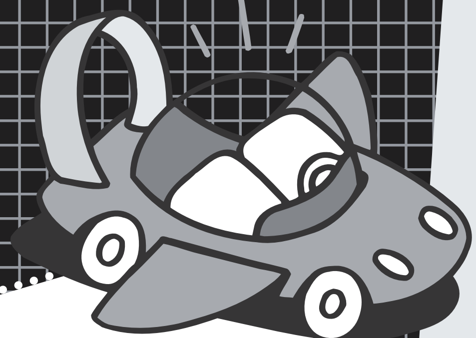
pbskids.org/zoom

Hoop Glider

Engineer's Notebook

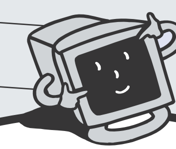
My Prediction

What Happened



Engineers Wanted!

Imagine going to school in a car that travels through the air! Some day you might see "air-cars" everywhere. **Air-cars** will have wings that can change shape, depending on how fast you are flying. That's because you need one kind of wing shape when traveling at low speeds, and you need a different wing shape for high speeds. Engineers are designing new materials to make these self-bending wings. Engineers like **you** could design the first air-schoolbus of the future!



Send It to ZOOM™!

Tell us about your results at

pbskids.org/zoom/sendit

ZOOMsci™

Hovercraft

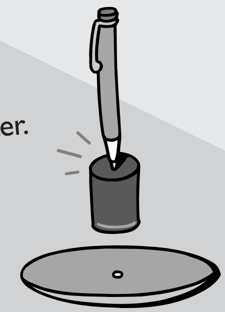
What You Need

- ballpoint pen
- large plastic plate
- film canister
- 12" round balloon
- poster putty (sold in office supply stores)

1 Use the **point** of the pen to **poke** a small **hole** in the center of the plate.

2 **Poke** another hole in the **bottom** of the film canister.

3 **Put** some poster putty around the **bottom** of the film canister. Make sure you **don't cover** the hole.



4 **Stick** the film canister to the **middle** of the plate. Try to **line up** the **holes** in the plate and the film canister.

5 **Blow** up the balloon. **Twist** the end and **pinch** it shut.

6 Work with a friend to **put** the balloon on the film canister. One person can **hold** the neck of the balloon so no air escapes. The other person can **stretch** the end of the balloon over the film canister.

7 **Place** your hovercraft on a smooth surface, like a table or the floor.

8 **Let go** of the balloon. Then **gently tap** the side of the plate. **What happens**?

Engineering Scoop

Put a **plain plate** on a table and **gently tap** the side of the plate. It doesn't move very far, does it? That's because of **friction** between the bottom of the plate and the table. Friction is a **dragging force** that happens when objects slide against each other. Why does your hovercraft **glide** more easily? Because it's **resting** on a cushion of air! When you let go of the balloon, the air **flows** under the plate. The **layer of air** under the plate **takes up space** and keeps the plate and table from rubbing together. When a plate slides on top of air, there is **less friction** than when it slides on the table.

Redesign It!

Change the design of your hovercraft. How can you make the hovercraft travel a **long distance** in one tap? How can you make one that **lasts a long time** before the air runs out? Can you think of a way to **steer** your hovercraft? Choose **one thing** to change, like the size of the plate or the hole in the film canister. Then **test it** and **send** your results to ZOOM.

Sent in by Dene D. of Woodbridge, VA

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