INNOVATION AT PLAY

TEACHER ACTIVITY

FINDING BALANCE

Have you ever gotten seasick? A boat's movements can be hard to stomach sometimes. But it's all part of keeping it floating and upright!

In this activity, you and a teammate will design your own boat as you explore what exactly helps it stay stable!

STEP 1: CONNECT

Boats come in all shapes and sizes. Have you ever seen or been on a boat before? Describe what you remember. Can you think of anything in particular that may have helped it stay afloat or glide smoothly through the water?

STEP 2: INVESTIGATE

First, check out some of the *many* different types of boats. Scroll through workshopinsider.com/types-of-boats and read more about some of the boats that catch your eye. As you do, look a little closer at how they're designed.

Then, read these two pages about Newton's Laws of Motion. Think about how these laws may relate to boats and jot down any connections you make.

STEP 3: DISCUSS

Share the connections you made as you discuss: *How may Newton's laws relate to a boat's stability?* Think about a boat both in motion and at rest.

Next, think about center of gravity. An object's center of gravity is the point where its weight is even on all sides. Discuss: *How may a boat's center of gravity affect its stability? What boat designs are likely to be more stable? How about less stable?*

Finally, let's talk about buoyancy. When a boat is floating in water, the pressure of the water pushes upward on the boat, creating what is called a buoyant force. Net buoyant force is the difference between the force of gravity pushing down on the boat and the force of the water pushing up on the boat. When the net buoyant force is zero, the boat floats. When the net buoyant force is positive, the boat rises, and when the net buoyant force is negative, the boat sinks.

Discuss: *What types of boat designs or special features may increase a boat's buoyancy?*

THE UNIVERSE LIKES STABILITY!

Stability doesn't just relate to physics… It can apply to chemistry, too. Le Chatelier's principal states that if a chemical system at equilibrium has a change in temperature, concentration, or pressure, the equilibrium will shift to minimize the change.

STEP 4: MATERIALS

Let's build your own sailboat so you can keep experimenting with the forces that affect a boat's stability! You'll need:

- A variety of materials that can be used as building supplies, such as:
    - Corks
    - Egg cartons
    - Foil
    - Straws
    - Popsicle sticks
    - Paper
    - Craft foam
    - String
    - Rubber bands
    - Hot glue
- A container filled with water (for testing)
- Optional:
    - Hairdryer
    - Small weights to fit inside your boat (marbles, coins, etc.)

DID YOU KNOW?

Boats are more buoyant in ocean water than in lakes or rivers. The salt in ocean water makes saltwater denser than freshwater. This increases the mass of ocean water, which in turn increases the pressure pushing upwards on the boat. Everything—even humans—floats more easily in salt water!

STEP 5: THE CHALLENGE

Your challenge is to create not just a regular boat, but a sailboat that:

1. is as narrow as possible.
2. has as big of a sail as possible… all while floating in wavy, windy conditions without tipping over!

Review the materials you have available and consider what you know about the forces that keep a boat stable. Then get your hands wet and start testing to see what works best.

Once you're confident with your boat design, place it back in the water container. This time, create waves and see if the boat can maintain its stability. If possible, test with the wind of a hairdryer too! Just be careful… If your sail isn't waterproof, you may need to replace it every time your boat tips over!

WANT TO MAKE THE CHALLENGE EVEN TRICKIER?

Add small weights to your boat! As you choose where they should go, think about stability and the effect they may have on your boat's center of gravity.

While it may still seem easy to stay balanced and afloat when the water is flat, beware of the waves. If your weights can move around, things may get tricky when the waves roll in!

STEP 6: SHARE

Once you're confident that your sailboat has what it takes to survive on a rough day at sea, create a quick video that shows off how your boat fares in windy, wavy conditions. As it sails, describe your design decisions—including the position of your boat's center of gravity. Post your video so others can learn from you too!

NGSS STANDARDS

- HS-PS1-6 Matter and its Interactions
    - Cross-Cutting Concept: Stability and Change: Much of science deals with constructing explanations of how things change and how they remain stable.
- HS-PS2-2 Motion and Stability: Forces and Interactions
    - Disciplinary Core Idea: PS2.A: Forces and Motion: If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.

COMMON CORE ELA STANDARDS

- CCSS.ELA-LITERACY.CCRA.SL.4: Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.