Engineering & Robotics - Archimedes' Boat: An Engineering Puzzle

Legacy SeaPerch Resource www.seaperch.org

Grade Level: 5th – 12th grade

Length of Lesson: 1-2 class periods

Goals:

- Understand that friction slows moving objects, but also allows them to be controlled
- Predict characteristics of surfaces that might influence the amount of friction
- Create a hovercraft and understand how it moves and why it hovers

National Science Standards:

- PS2.A: Forces and Motion
- ETS1.A: Defining and Delimiting an Engineering Problem
- ETS1.B: Developing Possible Solutions
- ETS1.C: Optimizing the Design Solution

Materials:

- Aluminum foil
- Marbles (at least 30)
- 6"x12" cardstock (1-2 per team)
- Scissors
- Scotch tape
- At least one container, 10" wide x 15" long x 10" dee (or larger)
- Rulers (optional)

Background:

From the simplest of rafts to the most complex ocean liners, all boats share a common function, which is to transport people or other goods and materials safely from one point to another on some body of water. It may be across an ocean, lake, or down a river, depending upon the particular destination. Boats may be powered by man, wind, a mechanical power source, or just drift with the currents and tides.

There are many engineering and scientific principles involved with boats, but perhaps the most basic one is the principle of buoyancy. As the story goes, Archimedes, a Greek mathematician, was taking a bath. When he stepped into the bath, he noticed that the water spilled over as he immersed himself. He recognized that he had displaced a volume of water, which turned out to be equal to the volume of his body. From this start, the Archimedes Principle was developed.

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Simply stated, the principle declares that "a body immersed or floating in water is pushed up with a force equal to the weight of the water displaced." This principle explains why some objects float, while others sink. An immersed object weighs less in water than in air by an amount equal to the weight of the water displaced by the object. If this water weighs as much as or more than the object, the object floats. If the displaced water weighs less than the object, the object sinks.

Lesson: LAUNCH

1. Tell students the story behind the Archimedes Principle (in the Background section). Ask students to explain why boats can float, even though most boats are made of steel, and steel is more dense than water.
2. Have students begin to brainstorm about what shape of boat would be the most buoyant, i.e. which shape would be able to hold the most cargo.

Lesson: INVESTIGATE

1. Put the students into teams of two. In their teams, let students come up with several (3-5) boat shapes that can be made out of a single sheet of 6"x12" cardstock.
2. Give each team several pieces of aluminum foil. Students should test their designs by folding or molding the foil into the desired boat shape, and then placing it in the container of water. They should add marbles one at a time until the boat sinks, recording the number of marbles for each trial.
3. After students have tested their designs, have them come up with a final design. Distribute the cardstock (1 piece per team for the final boat, and another optional piece in case of mistakes), the scissors, and the scotch tape. Allow students to build the final design for their boats.
4. Once all final designs have been created, test each boat as a class, recording the maximum number of marbles each boat can hold. You may want to distribute small prizes to the team or teams whose boat(s) held the most marbles.

Lesson: PRACTICE

1. Ask students to write a 1-2 paragraph explanation why the winning boat was able to hold the most marbles. They may wish to measure the boats using the rulers. Students should use Archimedes' Principle in their explanation.
2. If time, discuss the explanations as a class, and come up with a final class answer to the question.

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