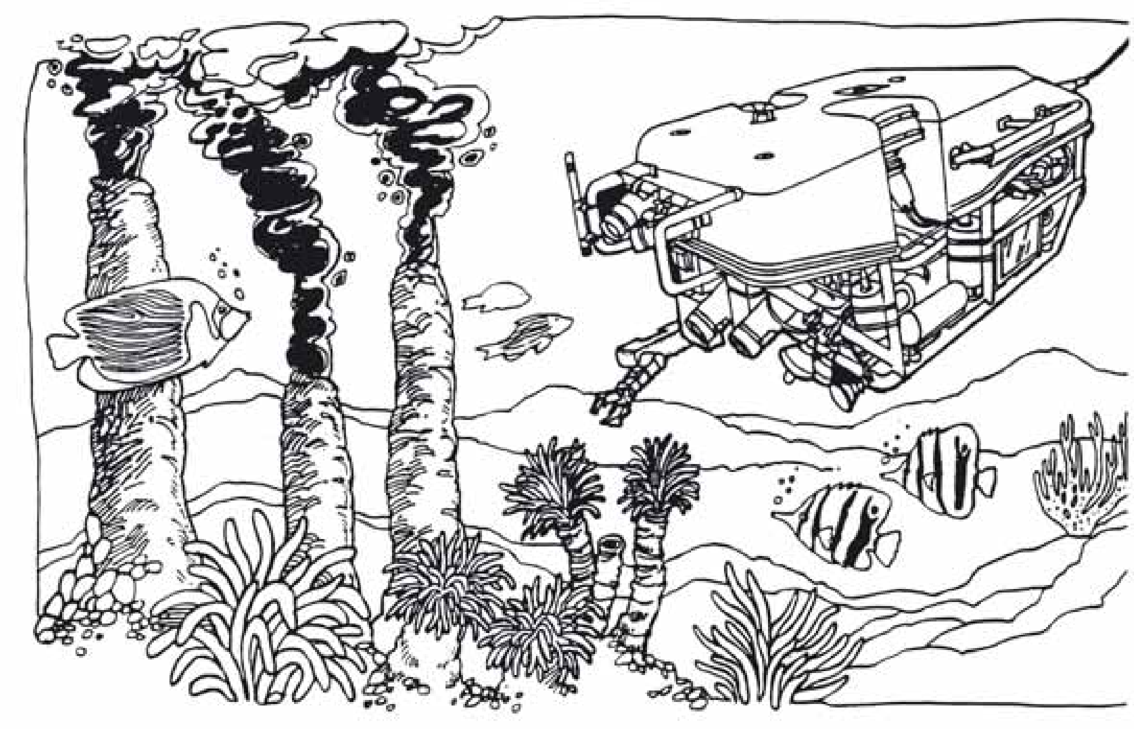


Technology of the Deep: Energy-Efficient Vehicles

Introduction

In 1985, explorer Dr. Robert Ballard achieved what many before him failed to do. Using state-of-the-art technology Ballard discovered the RMS Titanic which had sunk 73 years before after running into an iceberg in the North Atlantic. A year later, he used the underwater robotic vehicle JASON, Jr., to explore and photograph the ship's interior, bringing the world its first pictures of this longtime underwater mystery

Ballard designed both JASON, Jr., and its larger brother JASON, and after he found the Titanic he started the JASON Project to bring the thrills of underwater discovery to students across North America. In the first JASON Project, he and JASON discovered hydrothermal vents in the Mediterranean Sea and then, on the way home he found the German battleship Bismarck. JASON also explored and mapped sunken War of 1812 battleships in Lake Ontario, and other submersibles looked at underwater volcanoes in the mysterious Galapagos Islands. More information about the JASON Project, and an upcoming expedition, is at the end of this activity.

Ballard and his team designed his submersibles to be neutrally buoyant: they neither sink nor float but hover. This design allows them to remain at a constant depth without expending energy.

Designing vehicles and machines to be energy-efficient also the work of engineers

Grade Level

6th - 8th grades with adaptation for lower grades

Objectives

Upon completion of this lesson students will be able to:

1. Predict and observe the behavior of regular and diet soft drink cans when immersed in water.

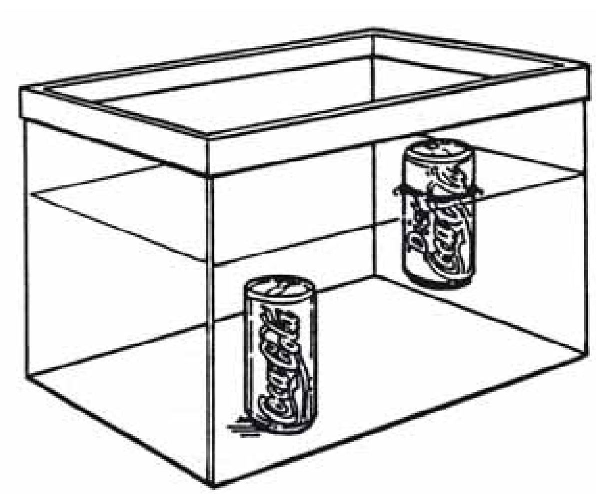
2. Calculate the density of solutions using mass-volume data.

3. Design and construct a neutrally buoyant vessel.

4. Relate density to neutral buoyancy.

Materials

Balance
Aquarium or other large deep, straight-sided container filled with water
One sealed can each of regular and diet soda (same brand) at room temperature (Coke and Diet Coke and Seven-Up and Diet 7-Up are recommended. Same other brands may not exhibit significant differences between regular and diet versions.)
One empty can of each type of soda
Paper towels
Pencils and paper for student data tables
Ice (optional)
Plastic foam (cups, blocks, strips or poly puff "packing worms")
Finishing nails or metal washers, several sizes
Tape, preferably water resistant
Scissors



Procedure

(This activity takes one class period or less, depending on how much of it you decide to do.)

1. Ask students for examples of objects or substances that will

   • sink in water

   • float in water

   • hover in water

2. Explain the concepts of buoyant force and weight. Buoyant force is a force that acts upon an object causing it to float. An object will float when the buoyant force is greater than its weight. An object will sink when its weight is greater than the buoyant force. When the buoyant force and weight are equal, the object will be neutrally buoyant.

3. Explain that engineers must design machines to be energy efficient. When it comes to exploring in water, an object that is neutrally buoyant will not have to use energy to remain at constant depth. Explain that Bob Ballard and his crew use vehicles, like JASON, that arc neutrally buoyant.

4. Perform this demonstration:

A. Show students unopened cans of regular and diet soda. Ask how they can tell the difference between the two cans. Write or summarize their responses on the board.

B. Ask the class to predict what would happen if the cans were placed in water.

C. Fully immerse the can of regular soda in water (it should sink and stay sunk), then the can of diet soda (it should rise to the surface and float). Compare observations with predictions. (Before the experiment, test several cans of sodas to be sure the desired results are obtained. Despite their labels, cans in a six-pack may have slightly different volumes, and this will affect their buoyancy If the expected result does not occur at room temperature; try ice cold cans in ice water.)

D. Ask students to offer probable explanations for their observations. Refer them to the list of ingredients on the side of each can. Do the different solutions contain anything that might make them more or less dense? Discuss. (Regular soft drinks are sweetened with dissolved sugar and/or high fructose corn syrup. A great quantity of this relatively heavy substance is required to sweeten regular soft drinks. The artificial sweeteners in so-called diet drinks are many times sweeter than sugar and so they are required in smaller quantities. Therefore, regular soft drinks are more dense than water and diet drinks are less dense.)

E. Distribute plastic foam and nails or washers. Give these directions for a student experiment:
1. Set up a data table for recording mass, volume, and density.
2. Determine the mass of an empty, dry, regular drink can and a diet drink can. Determine the mass of a full, unopened can of each solution and record. Read the volume of solution from the side of the can. Record this information in your data table.

3. Determine the overall volume of your unopened cans by water displacement. How do these volumes compare with the volume of the contents indicated on the side of the can?

4. Calculate the density of the unopened cans by dividing the mass by the volume of each can. ($M \div V = D$)

5. Modify your cans to make them hover in the middle of the container of water. Use plastic foam materials and metal nails or washers to raise or lower the cans.

Use these questions as the basis for a class discussion:

How do the densities of the regular and diet drink solutions compare to the density of water, which we will assume to be 1 g/ml? (Actually at room temperature, the density of water is slightly less than this. The regular drink should have a density greater than that of water while the diet drink's density should be less.)

Do the densities explain what students observed when the drink cans were placed in water? (Yes)

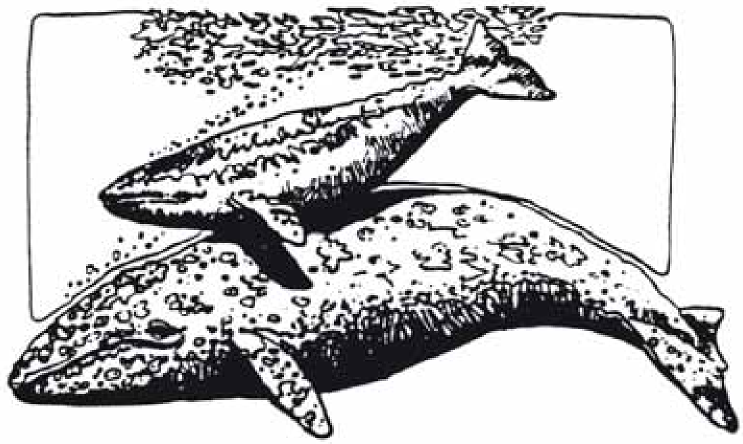
How does the density of something that will sink compare to that of the fluid surrounding it? What about the density of something that floats? Something that hovers?

Explain why modifications to the originally sinking and floating cans caused them to hover. Why would an object that hovers be easier to maneuver than one that sinks or floats? (Extra equipment to control sinking and floating is unnecessary. it is more maneuverable because the operator does not have to spend time getting it up from the bottom or down from the surface.)

Adaptations

If you would like to try this activity with younger students, you may want to limit the lesson to a demonstration and discussion of the drinks in, water.

Do not include the concept of density with its calculations and graphs if the students are not ready to grasp this mathematical concept.



Sponsor

Information for this National Engineers Week activity was provided courtesy of the National Science Teachers Association and the JASON Foundation for Education.

The Next Adventure

On March 1-13, 1993, Dr. Ballard and his crew will travel to Mexico's Baja California There they will use the underwater robot JASON to explore hydrothermal vents at the bottom of the Gulf of California and the weird, eerie life forms that thrive on them. Students and teachers who have participated in "Creatures of the Deep" should be encouraged to look for news of the JASON Project expedition in their local newspapers. The expedition will be broadcast live to more than 25 sites in the US, Canada, and England. Through advanced satellite technology and two-way audio students can ask the JASON Project scientists questions about what they are seeing as they are seeing it.

If you would like more information on participating in the JASON Project, contact the JASON Foundation for Education,
395 Totten Pond Road,
Waltham, Massachusetts 02154;
(617) 487-9995.

JASON PROJECT

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