LESSON 9

Measuring the Buoyant Force

Overview and Objectives

In Lessons 1 through 8, students explored the concept of buoyancy by focusing on the effects of weight, design, and size on an object's ability to float. In the previous lesson, they also felt the upward force, or buoyant force, of water on an object. Students now focus on the buoyant force itself by measuring and comparing the force needed to pull three different fishing bobbers completely under water. They discover that the larger the bobber, the greater the upward force of the water.

- Students predict the amount of buoyant force on fishing bobbers of three different sizes.
- Students test their predictions by using a spring scale to measure the buoyant force on the three fishing bobbers.
- Students discuss and compare their observations and conclusions.

Background

When an object is placed in water, the water exerts an upward push, or buoyant force, on it. Therefore, students can obtain a measure of buoyant force by measuring the force needed to pull floating objects under water.

The buoyant force is exerted on all objects in water, regardless of whether they sink or float. An object will float if the buoyant force on it is equal to or greater than the downward force of gravity. An object will sink if the upward buoyant force on it is less than the downward force of gravity.

For example, the buoyant force on a huge oil tanker can be very great—great enough to hold many tons of the ship and its cargo above the surface of the water. On the other hand, although the buoyant force on a rock at the bottom of a pond makes it easier to lift the rock off the bottom, it is not great enough to cause the rock to float.

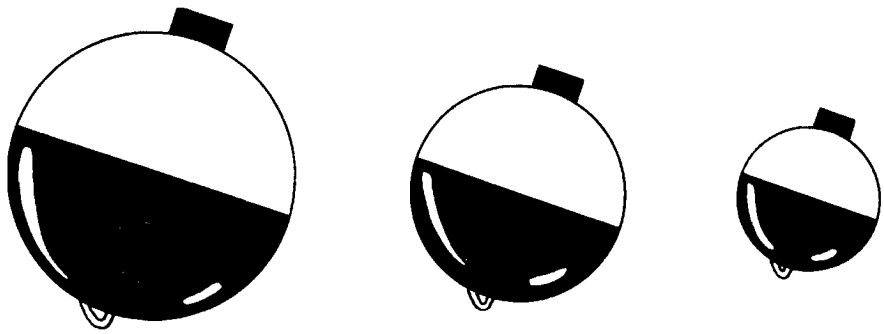
The activities in this lesson provide students with a chance to measure the buoyant force directly by using a spring scale and a string to submerge a fishing bobber. What they are really measuring with the spring scale is the upward buoyant force minus the downward force of gravity (the weight of the bobber itself). But the bobber's weight is small relative to the buoyant force, so what students measure is nearly equal to the buoyant force. The major effect that students will notice is the relationship between the magnitude of the buoyant force and the size of the bobbers.

This experience will give students more practice making predictions and then investigating and analyzing the results. Encouraging students to ask questions and then seek answers for themselves is a productive way for students to develop an increased understanding of buoyancy. Questions such as the following, which they can investigate on their own, may help students begin to explore additional topics that interest them.

- How much do you think each bobber weighs?
- How much do you think each bobber will weigh in the water?
- How hard will the water push up on each of the bobbers when you submerge them?

Figure 9-1

Three sizes of fishing bobbers



Materials

For each student

- 1 science notebook
- 1 copy of **Record Sheet 9-A: Working with Fishing Bobbers**
- 1 copy of **Record Sheet 9-B: Measuring the Forces on the Fishing Bobbers—Weight and Buoyancy**

For every two students

- 1 fishing bobber, 32 mm (1¼″)
- 1 fishing bobber, 38 mm (1½″)
- 1 fishing bobber, 45 mm (1¾″)
- 1 spring scale
- 1 piece of braided nylon cord, 60 cm (24″)
- 1 piece of cardboard, 8 cm (3″) square
- 1 small suction cup with hook
- 1 plastic tank with 2 liters (2 qt) of water
- 1 plastic plate
- 1 towel

Preparation

1. Make one copy of **Record Sheets 9-A** and **9-B** for each student.
2. Prepare a piece of braided nylon cord for each pair of students. Directions for preparation can be found on pg. 83.

Procedure

1. Review with students what they learned in Lesson 8, when they investigated how many marbles the aluminum foil boats could keep afloat. Ask students to discuss their ideas about the effect that the size of the boat has on how many marbles it will keep afloat.
2. Explain that in this lesson students will have a chance to investigate a floating object—a fishing bobber. First, ask students to estimate the weight of each bobber by holding it in their hands. Then ask them to investigate the buoyant force on each bobber by pushing it under water.

Figure 9-2

Submerging the fishing bobbers

3. Distribute the fishing bobbers and water. Students can begin the activity.
4. After students have had a chance to work with the fishing bobbers, ask them to make two predictions about them. Ask students the following questions:
   - Which fishing bobber do you think weighs the most?
   - Which fishing bobber do you think will have the greatest buoyant force pushing against it?

   Have students put the materials aside for a moment and record their predictions on **Record Sheet 9-A.** Ask them to discuss their ideas with their partners. Remind them to include the reasons for their predictions on Record Sheet 9-A.
5. Distribute the remaining materials. Ask students to weigh each of the fishing bobbers and record the weight on **Record Sheet 9-B.**
6. Ask students to use the directions on pg. 27 in the Student Activity Book to measure the buoyant force on each of the bobbers. These directions can also be found on pg. 84 of the Teacher's Guide.

Final Activities

1. After students finish measuring the buoyant force on each of the bobbers, have them return their materials to the storage area.
2. Ask students to discuss their results. You may want to ask questions such as the following:
   - What effect do you think size has on the amount of buoyant force?
   - What are some possible reasons that the fishing bobbers float so well?

Extensions

SCIENCE

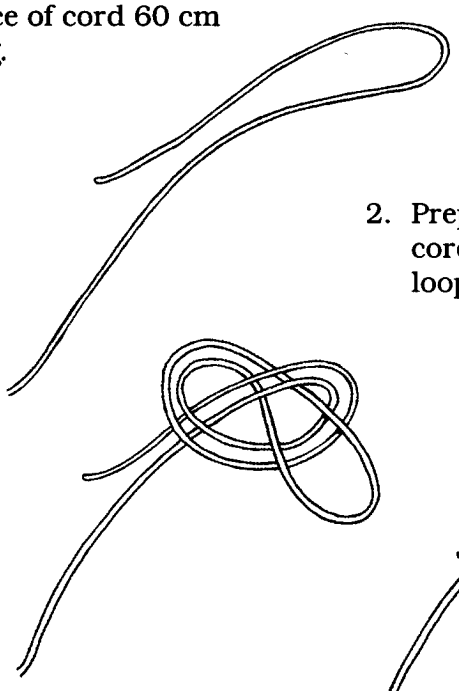
1. Encourage students to devise ways to measure the buoyant force on other objects. Students may be interested in finding out the buoyant force on clay boats or on the assortment of objects from Lessons 2 and 3.

SOCIAL STUDIES LANGUAGE ARTS

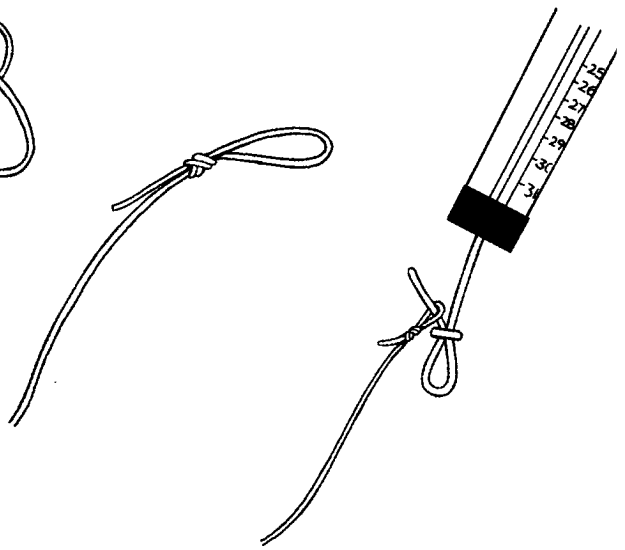
2. Ask students to write and illustrate an advertisement for fishing bobbers. You may want to ask students to design a special fishing bobber that is needed to catch a very large fish.

Instructions for Preparing a Braided Nylon Cord

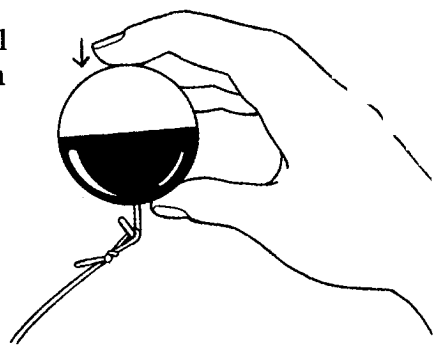
1. Cut a piece of cord 60 cm (24″) long.

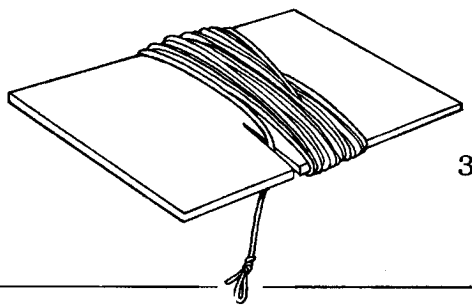


2. Prepare a small nonslip loop on each end of the cord by tying a loop knot as shown here. One loop will be hooked on to the spring scale.



The other loop will be used to attach the fishing bobber to the cord. This loop should be as small as possible to prevent the knot from snagging on the hook on the suction cup.



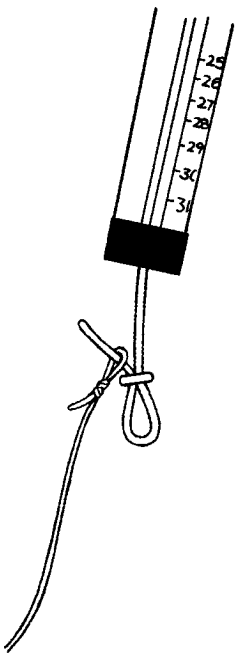


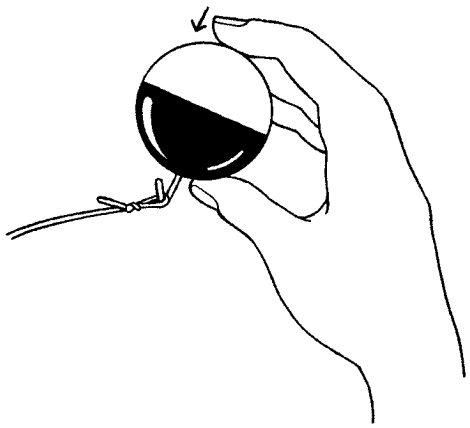
3. To prevent tangling, wrap each cord around a piece of cardboard. Use a slit in the cardboard to secure the cord.

Student Instructions for Measuring the Buoyant Force

1. Thread the string through the hook in the suction cup.

2. Attach one end of the string to the spring scale.





3. Attach the other end to the fishing bobber. Push on the top of the bobber to make the hook on the bottom come out.

4. Attach the suction cup to the bottom of the tank.

5. Use the spring scale to pull the bobber slowly under water. Read the force of the scale after the bobber is completely under water.

6. Repeat Step 5 several times for each bobber. Record your results on **Record Sheet 9-B.**

Record Sheet 9-A

Name: _____

Date: _____

Working with Fishing Bobbers

Prediction: Which fishing bobber do you think weighs the most?

Prediction: Which fishing bobber do you think has the greatest buoyant force?

Reasons: What are some reasons for your predictions?

Use **Record Sheet 9-B** to record the weight of each fishing bobber and the force that it takes to sink each one.