LESSON 3

Density Predictions

How could your knowledge of density be used to help clean up this oil spill?

INTRODUCTION

Why is it useful to know about density? You have already discussed how density, because it is a characteristic property of matter, can be used as one way to help identify a substance. You can also use the density of an object or substance to predict how it may behave under different conditions. For example, have you ever done experiments that involved investigating whether objects float or sink in water? Apart from guessing, how can you tell whether an object will float or sink? Are there some measurements that can be used to predict floating and sinking? In this lesson, you will use the data you have already collected on density and relate it to floating and sinking. You will then use density to predict how solids and liquids behave in a density column.

OBJECTIVES FOR THIS LESSON

Predict whether an object will float or sink on the basis of how it feels.

Use density to predict whether a substance will float or sink in water.

Determine the density of different liquids.

Build a density column.

Use density to predict how solids will behave when they are placed in a density column.

Getting Started

1. Collect the plastic box of materials for your group. Check its contents against the materials list. During this lesson, you will use an electronic balance. Your teacher will assign an electronic balance to your group. Other groups will be sharing the balance with you.

2. Take the blocks of aluminum, wax, and white and transparent plastic out of the plastic box. As a group, predict whether each object will float or sink in water and explain how you reached your prediction.

3. Your teacher will list the predictions for each group and may ask you to explain your predictions to the rest of the class.

4. Your teacher will ask some of you to test your predictions. Use the results of these tests and the data you collected in Lesson 2 to fill in Table 1 on Student Sheet 3.1.

5. Answer the following question on the student sheet: Is there a relationship between density and floating and sinking in water? If so, describe what this relationship is.

MATERIALS FOR LESSON 3

For you

1 copy of Student Sheet 3.1: Using Density To Make Predictions
1 copy of Student Sheet 3: Homework for Lesson 3

For you and your lab partner

2 100-mL graduated cylinders
1 250-mL beaker containing colored water
1 copper cylinder
1 nylon spacer
1 test tube brush

For your group

1 aluminum block
1 transparent plastic block
1 wax block
1 white plastic block
1 bottle of vegetable oil
1 bottle of corn syrup

For the class

Access to an electronic balance
Access to water
1 container for collecting vegetable oil waste
1 container for collecting corn syrup and water waste
Paper towels
Detergent

Inquiry 3.1
Building a Density Column

PROCEDURE

1. In this inquiry, you will work in pairs and share the bottles of oil and syrup with other members of your group.

2. Look carefully at Table 2 on Student Sheet 3.1. You need to determine the density of three liquids. You already have some of this information.

3. Spend a few minutes carefully reviewing the procedure you used in Inquiry 2.1 to determine the density of water.

4. Use the same procedure to find out the density of corn syrup and vegetable oil. Use 25 mL of each substance. Use a different graduated cylinder for each substance. The graduated cylinders may have different masses. Be sure to check the mass of each. *Do not empty the cylinders; you will need both of the liquids later in this inquiry.*

5. Use the data you collected to fill in Table 2 on Student Sheet 3.1.

6. Look carefully at the densities you have calculated. Answer the following question on the student sheet: What do you predict will happen when you mix together the vegetable oil, corn syrup, and water? Explain your prediction. Fill in the diagram of the prediction cylinder on the student sheet.

7. Pour the 25 mL of vegetable oil into the cylinder containing the corn syrup. Add an additional 25 mL of colored water from the beaker. (The colored water has the same density as water.) Allow the contents of the cylinder to settle.

8. Fill in and label the diagram of the observation cylinder on the student sheet.

9. Answer the following questions on the student sheet: Do the liquids mix together (miscible) or form distinct layers (immiscible)? What is the relationship between the density of the liquid and its position in the graduated cylinder?

10. Use information you obtained in Inquiry 2.1 to predict what will happen when you drop the copper cylinder into your density column and when you drop the nylon spacer into the column. Discuss your ideas with your partner.

11. Drop the copper cylinder, followed by the nylon spacer, into the column. Observe what happens. Record your results in the diagram of the observation cylinder on the student sheet. Label each object and write down its density.

12. Carefully pour the vegetable oil into the container provided for this purpose; do the same with the syrup and water.

13. Using the test tube brush, thoroughly wash all the graduated cylinders and objects in a detergent solution.

14. Dry the objects with a paper towel. Stand the graduated cylinders upside down in a sink or on newspaper to allow them to drain.

15. If you have spilled any substances, wipe off your table.

REFLECTING ON WHAT YOU'VE DONE

1. Write a short paragraph in your science notebook explaining your observations. Make sure you include the words "density" and "immiscible" in your description. Be prepared to read your paragraph to the rest of the class.

2. Your teacher will show the bottle containing two liquids that you used in Inquiry 1.6. Use your knowledge of immiscible liquids and density to explain (in your notebook) the appearance and behavior of the liquids in the bottle.

3. Oil is less dense than water. Discuss with other members of your group how this information can be applied to cleaning up a spill from an oil tanker.

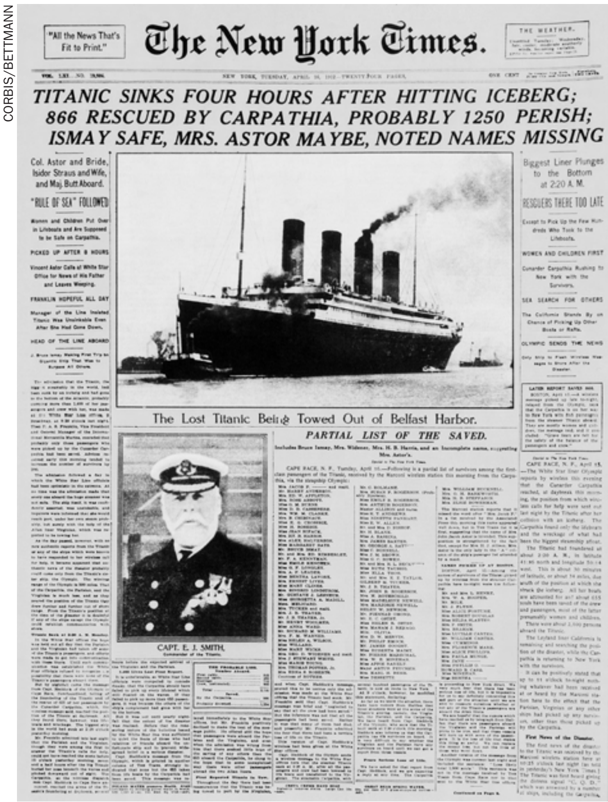
Why Did the *Titanic* Float?

On April 10, 1912, the luxury liner *Titanic* left England for New York and sailed straight into the annals of history. Why is the name *Titanic* so well known? At that time, she was considered the safest ship ever built; some people even considered her unsinkable. The *Titanic* became famous when she struck an iceberg and sank on her first voyage. About 1500 people drowned or froze to death in the ice-cold Atlantic water.

People often ask, "Why did the *Titanic* sink?" Perhaps a better question would be, "Why did the ship float?" She was, after all, made mainly from iron and steel. Her anchors alone weighed 28 metric tons. (That's almost 62,000 pounds!) Steel has a density about eight times that of water, so you would expect a ship made of steel to sink.

However, if you were to look at a plan of the *Titanic*, you would discover that most of her volume was occupied by air. Air has a density of about one-thousandth that of water. Therefore, the average density of the ship was less than the density of water. That's why she floated.

CORBIS/BETTMANN


"All the News That's Fit to Print."

The New York Times.

TITANIC SINKS FOUR HOURS AFTER HITTING ICEBERG; 866 RESCUED BY CARPATHIA, PROBABLY 1250 PERISH; ISMAY SAFE, MRS. ASTOR MAYBE, NOTED NAMES MISSING

Col. Astor and Bride, Isidor Straus and Wife, and Maj. Butt Aboard.

"RULE OF SEA" FOLLOWED

Biggest Liner Plunges to the Bottom at 2:20 A. M.

RESCUERS THERE TOO LATE

The Lost Titanic Being Towed Out of Belfast Harbor.

PARTIAL LIST OF THE SAVED.

CAPT. E. J. SMITH.

This newspaper article reported on the disastrous maiden voyage of the Titanic. *Why was this voyage a disaster? What role did density play in the tragedy?*

AP/WIDE WORLD PHOTOS

The Titanic *now lies under 12,500 feet of water. It was made mainly from steel, which is denser than water. How did it manage to float at all?*

USCG PHOTO BY BRANDON BREWER, ATLANTIC AREA PUBLIC AFFAIRS

Icebergs float in water. What does this tell us about their density?

Why did she sink? When the *Titanic* hit the iceberg, water rushed into the ship's hull and displaced the air. The average density of the water and the steel ship was greater than the density of water. The result of this change? The *Titanic* sank to the bottom of the Atlantic. □

QUESTIONS

Unfortunately, life vests, or personal flotation devices (PFDs), were not enough to save the lives of many of the *Titanic's* passengers. However, they save hundreds of lives every year.

1. If you were designing a PFD, what factors would you need to take into account?
2. Draw a diagram of a PFD of your own design. Label it, explaining the role of each of its parts, and be sure to include the word "density" somewhere in your explanation.