8.1 Weight, Mass, and Volume

weight: the force of gravity acting on an object

mass: the amount of matter that makes up an object or substance

Figure 1 This astronaut is able to manipulate huge pieces of equipment because of their minimal weight in space.

volume: the amount of space an object or substance takes up

Would you weigh the same on the Moon as you do on Earth? Your **weight** is a measure of how strongly gravity pulls on you. Therefore, weight will change depending on where it is measured. You would weigh much less on the Moon because the force of gravity is not as strong as on Earth. **Mass**, however, is a measure of the amount of matter in an object or substance. If you went to the Moon, your weight would change, but your mass would not (Figure 1).

Which do you think has greater mass: a kilogram of gold or a kilogram of polystyrene foam? Since mass measures the amount of matter in a substance, their mass is the same—1 kg. However, you need a lot more foam than gold to make up a kilogram. So, although the mass is the same, the volume of foam will be greater. **Volume** is a measure of how much space an object occupies.

You can find the volume of a regular solid by multiplying its three dimensions together:

$$\text{volume} = \text{length} \times \text{width} \times \text{height}$$

This gives a measurement in cubic units (m^3, cm^3, and so on). Gases are often measured in cubic metres (m^3). The basic unit for measuring liquid volumes is the litre (Figure 2). A container measuring 10 cm × 10 cm × 10 cm holds 1000 cm^3 or one litre (L) of water. Since a litre is also equal to 1000 mL, 1 cm^3 equals 1 mL. We use millilitres to measure small volumes of fluids.

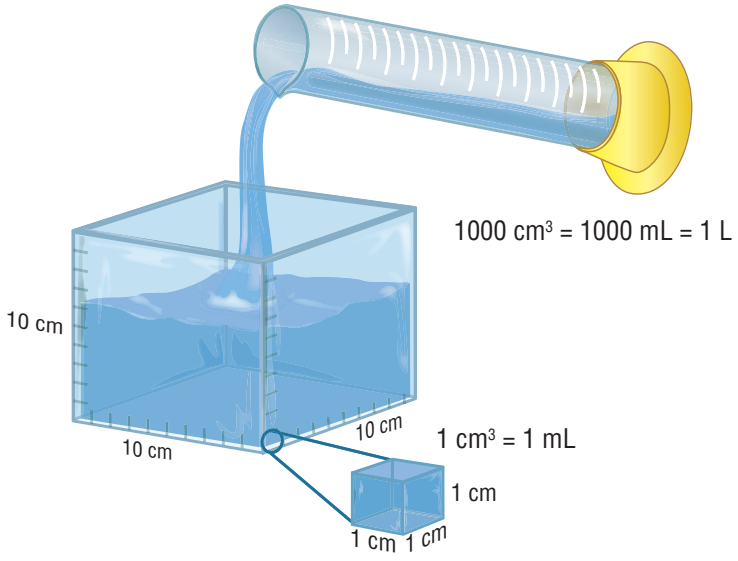

Figure 2 A litre of liquid would fill a container 10 cm long, 10 cm wide, and 10 cm high. So, 1 L = 1000 cm^3. Since 1 L also equals 1000 mL, then 1 mL = 1 cm^3.

LINKING TO LITERACY

Gaining Meaning from Context

Important words are highlighted in yellow and are bolded. You may be familiar with some of these terms, such as weight, mass, and volume. As you come across words you are not familiar with, make a note of these words in your notebook.

See if you can guess the meaning of unfamiliar words just by reading the sentence or paragraph where they are located. Write the definition in your notes. Often, a reader can learn the meaning of a new word from the text in which it is placed.

Finding Volume by Displacement

How can we measure volume when the object does not have a regular shape? You may have noticed that whenever you take a bath, the water rises as you settle into the tub. Since you and the water cannot occupy the same space, your body **displaces** water (pushes it out of the way), which causes the water level to rise. This property can be used to find the volume of irregularly shaped objects and is called the "finding volume by displacement" method.

displace: to take the place of

TRY THIS: Finding Volume by Displacement

SKILLS MENU: performing, observing, communicating

SKILLS HANDBOOK 6.A.2.

In this activity, you will measure the volume of small objects using the finding volume by displacement method. Remember that the apparent increase in water volume is equal to the volume occupied by the object.

Equipment and Materials: graduated cylinder; small objects that do not float, such as marbles or a standard weight

1. Fill the graduated cylinder approximately half full.
2. In your notebook, record the volume, making sure you have the water surface at eye level and you are reading from the bottom of the meniscus (Figure 3).
3. Place a small object in the graduated cylinder. Read and record the new water level. This is the volume of the water plus the volume of the object.

A. Use your values from steps 2 and 3 to calculate the volume of the object alone. In your notebook, record the volume of the object. Remember to use the proper units.

B. Why is it important to read the water volume with your eye at the same level as the surface of the water?

C. Why is it important to read the water level from the bottom of the meniscus?

D. Why is this method called "finding volume by displacement"?

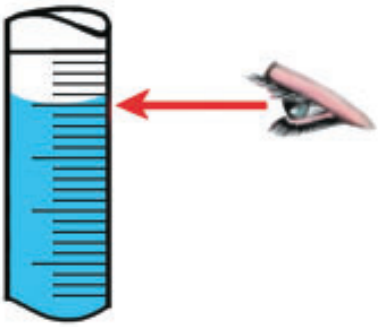

Figure 3 Read a meniscus at eye level.

When objects are too big to fit in a graduated cylinder, volume by displacement is measured using an overflow can (Figure 4). An overflow can has a spout near the top which allows displaced water to escape. If an object floats slightly, thin rods can be used to push it just under the water. Here is a suggested procedure for measuring volume by displacement:

- Place a container under the spout.
- Fill the can until it begins to overflow (be careful of spills).
- Wait until the flowing stops.
- Dispose of the water in the container and carefully place the container back under the spout.
- Slowly put the object into the can.
- Collect and measure the volume of the displaced water.

Figure 4 Collecting water from an overflow can

CHECK YOUR LEARNING

1. What in this section was already familiar to you? What was new information? How do you plan to remember this new information?
2. In your own words, describe the relationship between weight, mass, and volume. Use a diagram or chart if this is helpful.
3. Describe three ways of determining the volume of an object.