Janice VanCleave's

BIG BOOK of SCIENCE EXPERIMENTS

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64 Apparent Sizes of Celestial Objects

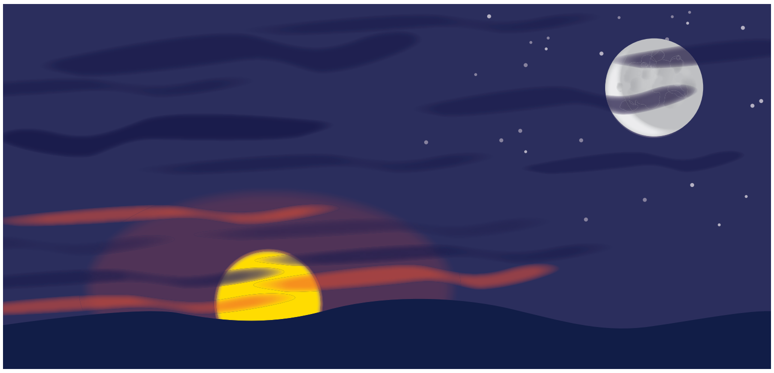

Figure 1

The **apparent size** of objects is how large they appear to a viewer. At a distance, objects appear to be smaller than they really are. This is especially true for celestial bodies. The Sun is about 400 times larger than the Moon; yet in the sky, the two appear to be circular disks with about the same diameter. When Earth, the Moon, and the Sun are in line with each other (in that order), viewing from Earth, the Moon blocks light from the Sun. This is called a **solar eclipse** and occurs because the Moon is closer to Earth than the Sun is, giving it a larger apparent size. All objects close to you look bigger than they would at a distance.

See for Yourself

Materials

pencil
white blank paper
scissors
masking tape
your thumb!

What to Do

1. Draw a large circle on the paper.
2. Cut the circle out and tape it to a wall at eye level.
3. Stand in front of the paper and as far away as possible.
4. Close your left eye, and hold your right thumb at arm's length from your open right eye.
5. Sight the white circle and determine how much of the object your thumb covers up.
6. Slowly move your thumb toward your open eye until it is close to but not touching your eye. As you move your thumb, make note of how much of the white circle is covered by your thumb.

Figure 2

What Happened

As the distance between your eye and your thumb decreased, your thumb blocked more of your view of the white circle. The closer your thumb was to your eye, the larger was its apparent size in comparison to the white circle. The same thing happens with the Moon and the Sun. Although the Sun is about 400 times as large as the Moon, the Sun is about 400 times farther from the Earth than is the Moon. So, to an observer on Earth, the apparent sizes of the Moon and the Sun are the same. Thus, from Earth, the Moon and the Sun appear to be equal-sized disks in the sky.

Challenge

Can you explain why the telephone poles in Figure 3 get smaller and smaller?

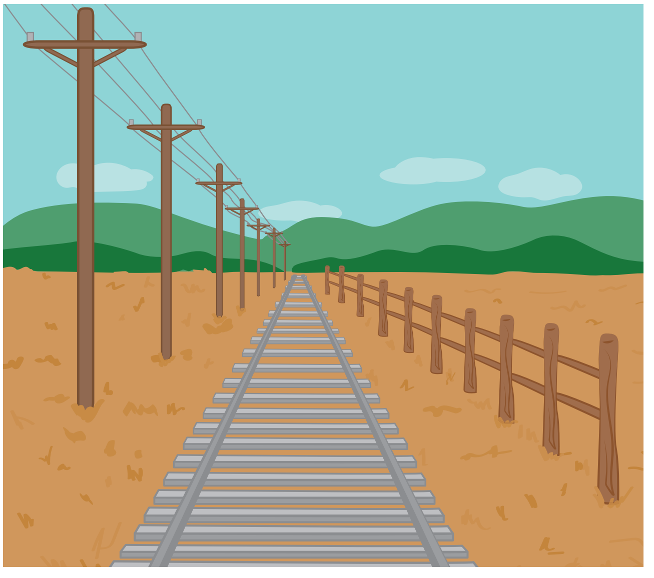

Figure 3

Think!

- The diagram represents the apparent size of telephone poles at different distances from a viewer.
- The telephone poles, like your thumb in the previous activity, are larger when closer to the viewing point.
- You can conclude that the apparent size of the telephone poles decreases with distance from the viewer.

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Sun Shadows

Shadows are the results of light being blocked by an object. Outdoors, objects cast shadows because they block light from the Sun. The length of sun shadows is affected by the Sun's altitude. The direction of sun shadows is affected by the Sun's azimuth, which is its angular direction on the horizon. Azimuth readings give specific angular readings that basically tell **cardinal directions** of north, east, south, and west. Without access to azimuth measurements, sun shadows can be used to discover cardinal directions.

See for Yourself

Materials

dowel rod, 24 inches (60 cm) or longer
hammer or large rock
5 or more small stones
outdoor area

What to Do

1. On a sunny day, select an open outdoor area that will not be disturbed during the day.
2. Ask an adult to sharpen one end of the dowel rod.
3. Use a hammer or large rock to beat the pointed end of the rod into the ground. Ask an adult to help you with this. You want the rod to be sturdy and vertical.
4. On the ground, use a stone to mark the tip of the shadow cast by the rod. Record the time.
5. You want to observe and mark the sun shadow cast by the dowel rod at least five times: early morning, mid-morning, solar noon, mid-afternoon, and late afternoon. If you start the experiment after noon, complete the experiment by starting again in the early morning of the next day.

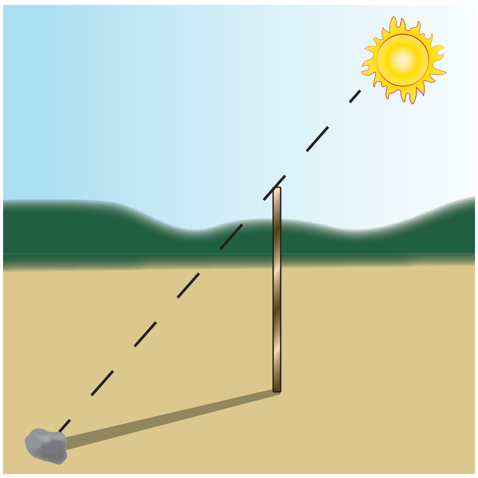

Figure 1

What Happened

The smaller the solar altitude angle, the longer is the sun shadow. At sunrise, the solar altitude angle is equal to zero; when the Sun is rising above the horizon, shadows are very long and pointing in a westerly direction. At sunset the shadows are again long but point in an easterly direction. Thus, the longest sun shadows are always at sunrise and sunset. The shortest shadows are at **solar noon**, when the Sun is at its highest point in the sky. In the Northern Hemisphere, the Sun appears to move across the southern sky; thus, at solar noon the Sun is at its highest altitude and shadows formed point due north.

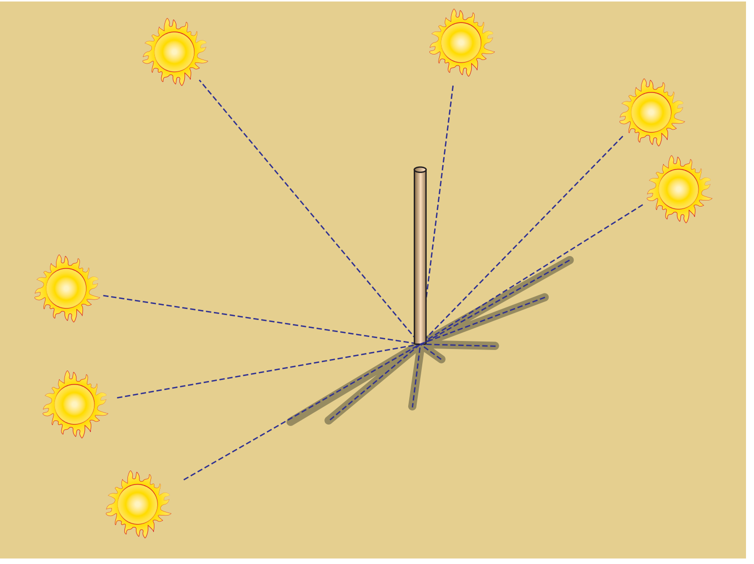

Figure 2

Challenge

Can you explain how your shadow can be used to determine the directions north, south, east, and west?

Think!

The girl's shadow points opposite the Sun; thus, knowing that the Sun sets in the west, she can identify the other three directions as shown.

FYI: The Sun doesn't rise and set at due east and due west, respectively, all year long, but shadows can give you general directions.

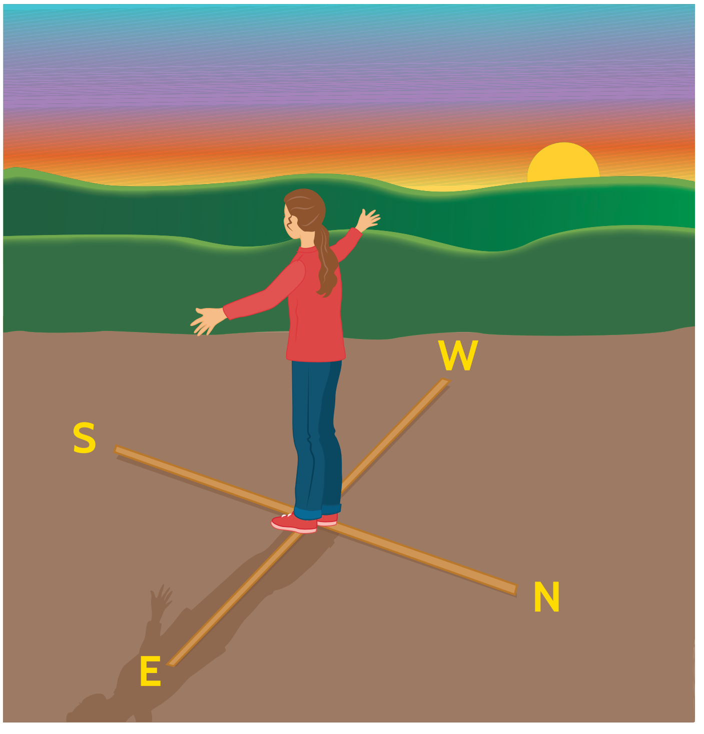

Figure 3

72 Circumpolar Constellations

Polaris is called the Pole Star or North Star because it apparently remains in the same place in the sky: almost exactly above the North Pole, night after night. Face Polaris and you will be facing north. Thus, to your right is east, to your left is west, and directly behind you is south.

Observe the sky for a period of time and you will find that from night to night some stars appear in the sky all year, while others are seasonal. These stars are part of constellations called **circumpolar constellations**, because they move in circular paths around Polaris, the Pole Star. Like horses on a carousel, the stars spin around a center point but still stay in line with one another. Thus, the shapes of constellations do not change even though they appear in different places during the night and on different nights of the year. From latitudes of 40° N or greater, the four most visible northern circumpolar constellations are Ursa Major, Ursa Minor, Cassiopeia, and Cepheus.

See for Yourself

Materials

sheet of black paper
pencil with eraser at end
pushpin
scissors

What to Do

1. Cut a circle as large as possible from the black paper.
2. Fold the circle in half twice, first from top to bottom, and then from side to side.
3. With the pencil and the star pattern in Figure 1 as a guide, mark the position of each star on the paper shown in Figure 1. Mark Ursa Major, Ursa Minor, Cephus, and the other constellations if there is room.
4. Using the pushpin, make a hole in the paper for each star.
5. Turn the circle upside down, and then push the pushpin through the star Polaris and into the end of the pencil's eraser. Turn the paper to hollow out the hole so the paper circle can be easily rotated.
6. During the day, darken the room, and then hold the end of the pushpin against a window.
7. Slowly turn the paper so that it rotates counterclockwise around the pushpin.

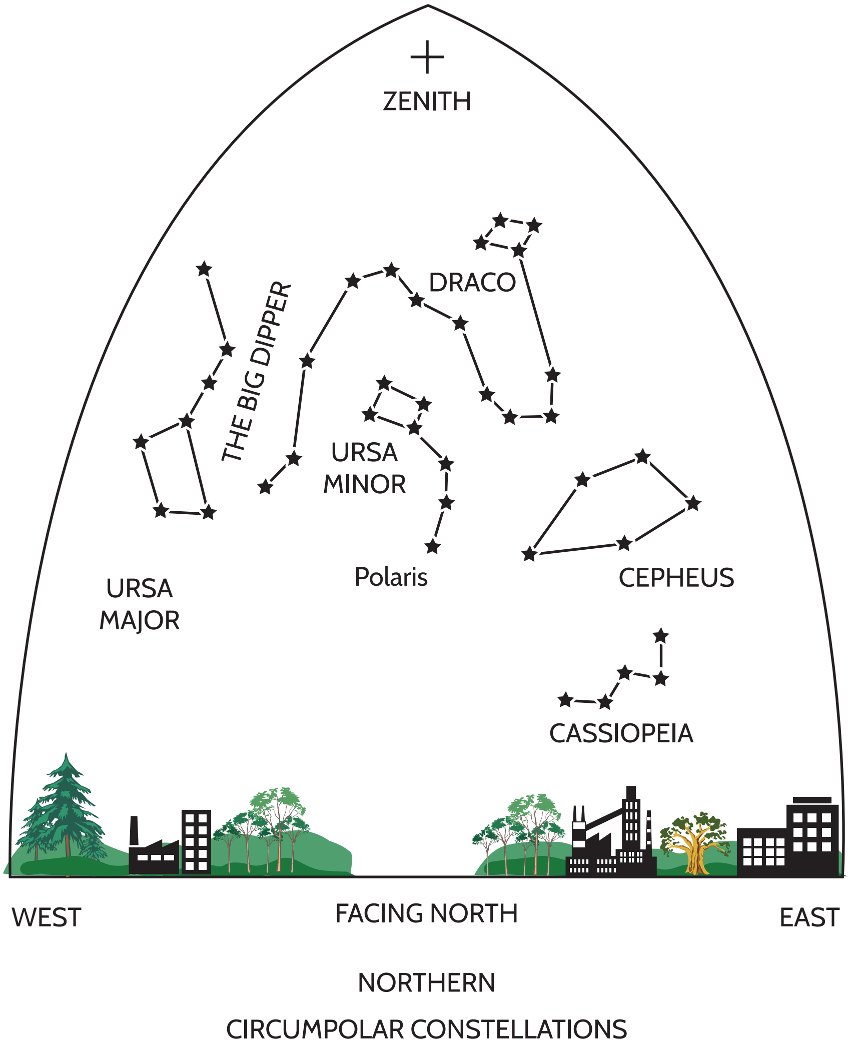

Figure 1

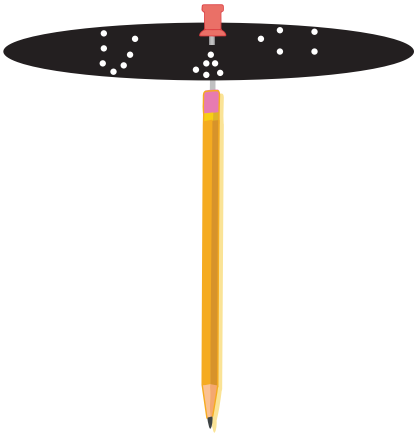

Figure 2

What Happened

You have made a model of the movement of northern circumpolar constellations. The apparent counterclockwise movement of these stars around Polaris is actually due to the clockwise rotation of Earth about its axis.

Earth not only rotates on its axis, but also changes position in the sky in relation to the stars as it revolves around the Sun. Earth's movement around the Sun causes a slight change in the southern part of the sky seen each day. This results in different stars being visible during each season. But Earth's North Pole continues to point toward Polaris, so the northern circumpolar stars remain the same during the year.

Challenge

Study Figure 3. Can you choose the star group – A, B, or C – that correctly represents the location of Polaris from the position of the Big Dipper?

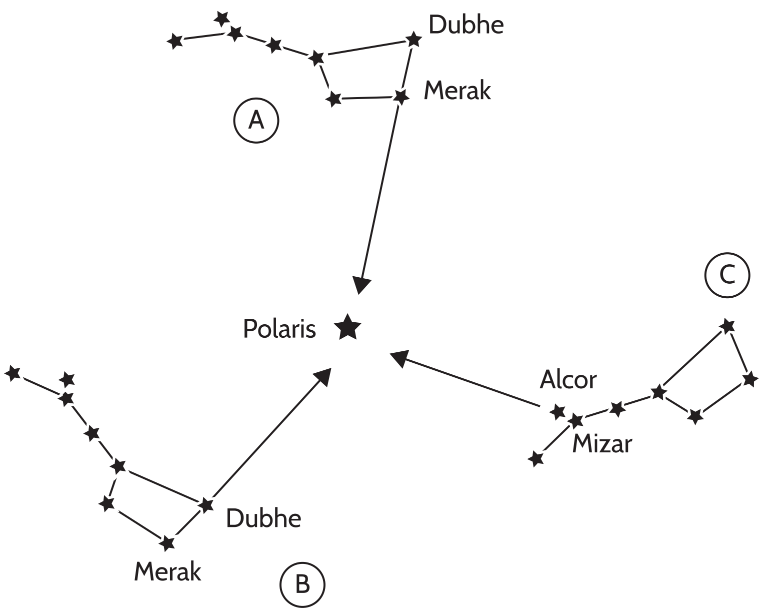

Figure 3

Think!

- The bowl of the Big Dipper always points toward Polaris.
- A line from the star Merak and continuing past Dubhe points to Polaris.
- Position B represents the location of the Big Dipper in relation to Polaris, the North Star.

73 Location of Polaris

Polaris is a star in the constellation Ursa Minor, which translates as "Little Bear." Polaris can only be seen by observers in the Northern Hemisphere. Even there, the position of Polaris above the horizon depends on the latitude of the observer. At the equator (latitude 0°), Polaris is on the horizon; at the North Pole (latitude 90°), Polaris is directly overhead. Thus, as one moves from the equator to the North Pole, Polaris is seen at increasing greater altitudes above the horizon.

See for Yourself

Materials

masking tape
3 ft (0.9 m) of string
coin
ruler
yardstick (meterstick)
marker
index card
adult helper

What to Do

1. Tape one end of the string to the coin. Ask your helper to tape the free end of the string to the center of the top of a doorframe. Adjust the length of the string so that it is about 6 inches (15 cm) above your head. Note: Choose a doorway that leads into a second room with a far wall.
2. Place a piece of masking tape on the floor beneath the coin. Label the tape "North Pole." Measure 6 ft (1.8 m) from this piece of tape and place a second piece of tape on the floor labeled "equator."
3. Draw a line across the index card and label it "horizon."

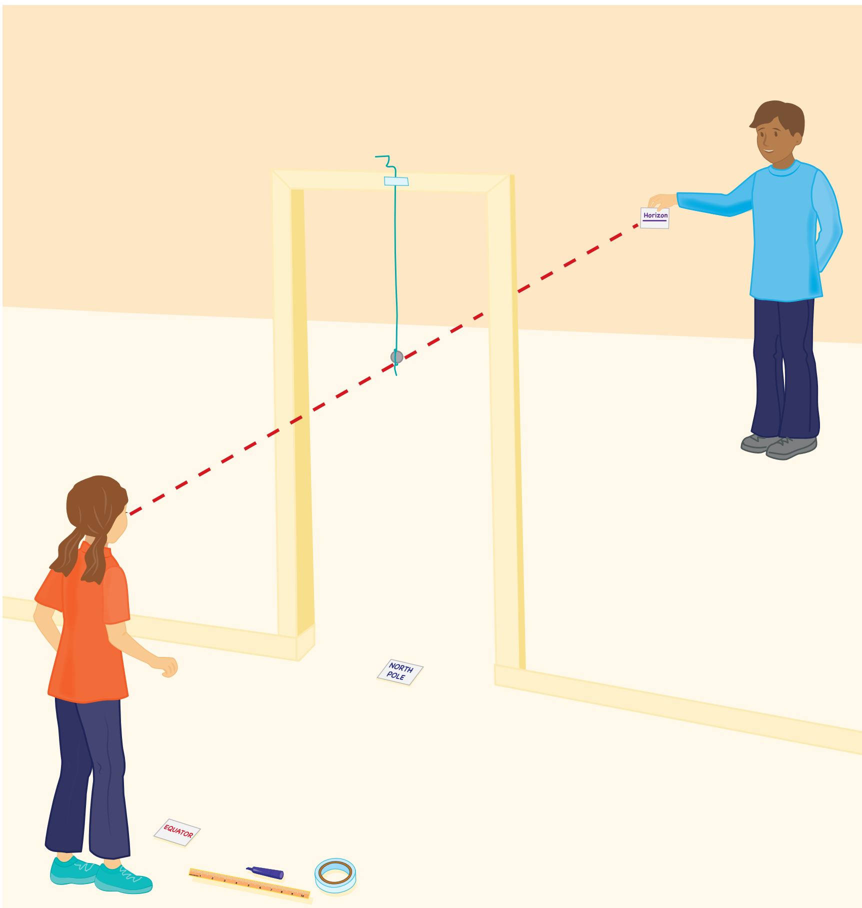

Figure 1

4. Stand behind the "equator" tape. Close one eye and look at the coin.
5. While you are looking at the coin, ask your helper to position the card against the far wall so that the horizon line on the card lines up with the bottom of the coin. The card needs to be taped in this position.
6. As you look at the coin, slowly walk toward it. Make note of how the bottom of the coin lines up with the horizon line on the card.

What Happened

At the equator line, the coin appears on the horizon. As you move away from the equator toward the North Pole, Polaris (the coin) rises above the horizon. The same results would happen if you could quickly walk from Earth's equator toward Earth's North Pole. The altitude of Polaris is the same as the latitude of the observer.

Challenge

Using the globe in Figure 2, can you determine the altitude that Polaris would be at for each observer, A and B?

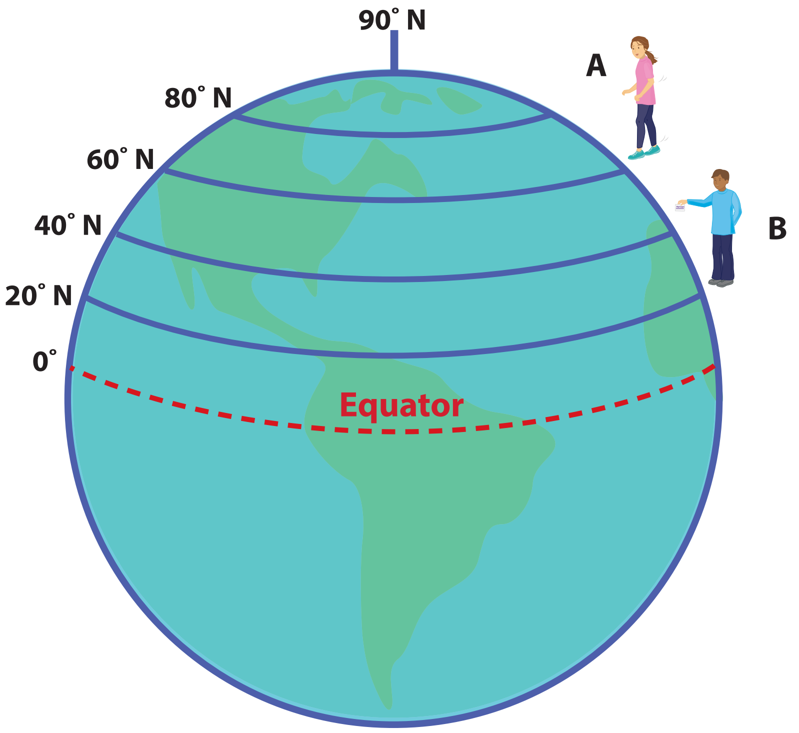

Figure 2

Think!

- The altitude of Polaris above the horizon is equal to the latitude of the observer.
- Observer A is standing at latitude 60° N; thus, Polaris would be visible at an altitude of 60° above the horizon.
- Observer B is standing at latitude 20° N; thus, Polaris would be visible at an altitude of 20° above the horizon.

76 Volcanoes

Models can be an important part of a science presentation. A lightweight volcano model that can be easily transported as well as repeatedly used is relatively easy to make with paper and plaster.

See for Yourself

Materials

2 poster boards at least 17 inches (42.5 cm) square
scissors
pencil
empty plastic bottle, 8 oz (240 mL)
masking tape
round tray with a diameter of at least 14 inches (36 cm)
2 cups (500 mL) of plaster of Paris
plastic throwaway container, 3 cups (750 mL)
measuring cup, 1 cup (250 mL)
tap water, 1 cup (250 mL)
plastic spoon
3 liquid tempera paint colors: brown, black, and red
art brush
goggles, face mask and gloves

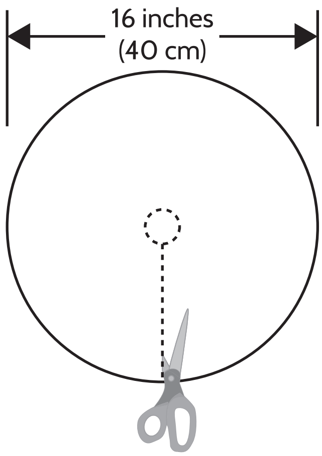

Figure 1

CAUTION Plaster of Paris is a fine powder. Wear goggles and take care not to get the powder in your nose. Never mix the plaster with your hands because it gets hot and could burn your skin. Never pour plaster down the drain; it could clog the drain. Discard the container and stirring stick used to make the plaster.

What to Do

1. Draw a circle on each poster board, one with an 8-inch (20-cm) radius and the other with a radius of 7 inches (17.5 cm). Let the larger circle be called "A" and the smaller one "B."
2. Cut out the circles.
3. Use circle A to prepare a cone for the volcano using the following:
   - Use the pencil to draw a circle in the center of circle A about the size of a quarter.
   - Cut out this small circle by cutting from one edge of the paper, then around the drawn circle (Figure 1).
4. Stand the plastic bottle in the center of paper circle B. Overlap the cut edges

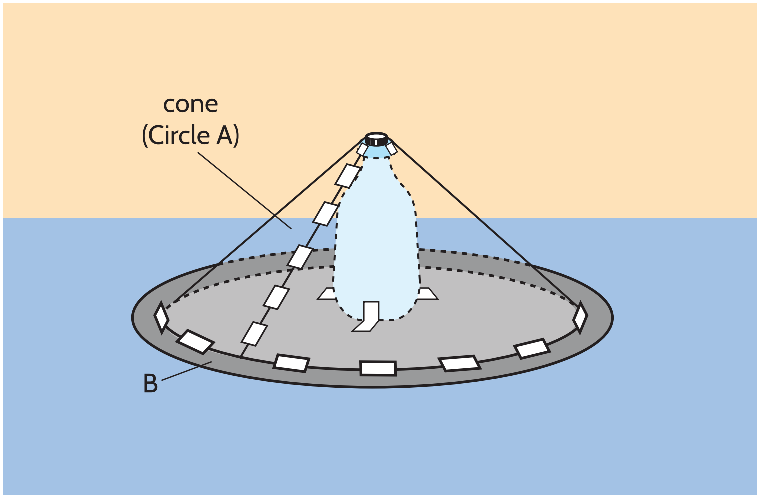

Figure 2

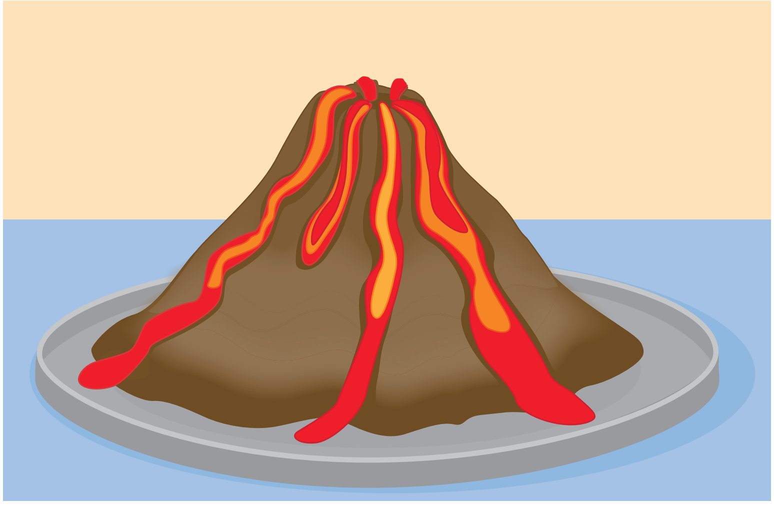

Figure 3

of circle A to form a cone with a small open end around the bottle and adjust the amount the edges overlap so that the cone's height is equal to that of the bottle. The mouth of the bottle should be at or near the small open end of the cone. Secure the overlapped edges of the cone with tape.

5. Use tape to secure the mouth of the bottle to the small hole in the cone.
6. With the cone centered on paper circle B, secure the edges of the cone to paper circle B with tape (Figure 2). You have made the foundation for a volcano.
7. Place the volcano foundation in the tray.
8. Prepare the plaster of Paris by pouring the water into the container and then adding the plaster. Stir with the plastic spoon.
9. Spread the wet plaster of Paris over the surface of the paper cone and base. Make the surface as rough as possible. Allow the plaster to dry, which will take 20 to 30 minutes. FYI: As the plaster dries, it gives off heat because an exothermic reaction is taking place.
10. Use the paint to color the volcano. Paint red stripes down the sides to represent lava flow.

What Happened

You have made a model of a volcano that has a durable outer structure with a bottle inside that can work as the magma chamber and vent. A magma chamber is a large pool of liquid rock (magma) beneath the surface of the Earth. A vent is an opening to the Earth's surface through which magma can flow. At the surface magma is called lava.

Challenge

Can you design a method for modeling a volcanic eruption?

Think!

- You need something that will react and cause fluid and gas to rise out of the volcano model. Effervescent tablets, such as Alka-Seltzer, produce gas bubbles when added to water.
- Liquid dishwashing soap produces large volumes of bubbles when gas is blown into it.
- Lava is so hot that it glows red, so red food dye could be added.
- Pour water, liquid dishwashing soap, and red food dye into the bottle, and then add the effervescent tablet. The amounts needed of each is something that can be discovered experimentally.

See for Yourself

An erupting volcano is always a fun demonstration, especially when it can be repeated. Follow the directions above and see for yourself!

78 Fossils

Paleontologists are scientists who study prehistoric life on Earth. They do this by searching for **fossils**, which are traces of the remains of prehistoric organisms buried in the Earth's crust. Preserved remains of prehistoric organisms, such as bones or shells, are known as **body fossils**. Tracks, trails, burrows, and other indirect evidence of prehistoric life are called **trace fossils**.

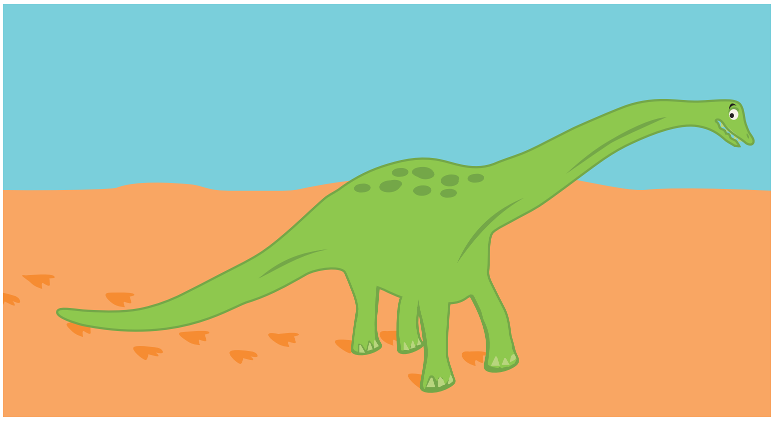

Figure 1

Fossils are not always the actual remains of organisms; instead, many are just copies. There are three ways that copies of fossils are formed: **imprint fossils** are impressions made in soft materials; **mold fossils** are cavities underground left when the organism decays; and **cast fossils** are formed when minerals fill mold fossils forming the shape of the organism. You can model the process for the formation of a cast fossil.

See for Yourself

Materials

- seashell (found where crafts are sold)
- piece of modeling clay twice the size of the seashell used
- paper plate
- jar of petroleum jelly
- paper cup, 7 oz (210 mL)
- plastic spoon
- 1 tbsp (15 mL)
- plaster of Paris
- tap water
- goggles, face mask and gloves

CAUTION Plaster of Paris is a fine powder. Wear goggles and take care not to get the powder in your nose. Never mix the plaster with your hands because it gets hot and could burn your skin. Never pour plaster down the drain; it could clog the drain. Discard the paper cup and plastic spoon used to make the plaster.

Figure 2

What to Do

1. Squeeze the clay until it soft and pliable, and then place the clay on the plate.
2. Coat the outside of the seashell with a thin layer of petroleum jelly.
3. Press the lubricated side of the seashell into the clay. You want as much of the shell pressed into the clay as possible.
4. Carefully remove the shell from the clay. If a good imprint of the shell is not made in the clay, repeat the process.
5. Wearing goggles, thoroughly mix together 4 tablespoons of plaster of Paris with 2 tablespoons of water in the paper cup.
6. Pour the plaster mixture into the shell imprint in the clay.
7. Allow the plaster to harden (about 20 minutes).
8. Gently separate the clay from the plaster.
9. Compare the shape and texture of the outside of the shell with that of the plaster cast.

What Happened

The imprint of the shell in the clay and the outside of the shell are mirror images. The outside of the plaster cast and the shell are identical.

Challenge

Can you explain how the previous activity modeled the formation of fossil imprints, molds, and casts?

Figure 3

Think!

- Pressing the shell into the clay and removing it represents a fossil imprint made in soft mud that was preserved when the mud hardened.
- You removed the shell leaving a **mold** of the seashell. In nature, the shell would have been totally buried in mud that hardened into rock around the shell. Over time, ground water dissolved the seashell, leaving a cavity shaped like the shell.
- You filled the seashell mold with plaster, which hardened into what is called a **cast** (a reproduction that has the same outer shape as the seashell). In nature, the mold of the seashell would be filled with mud or mineral materials that would harden into a cast.