

Shadows Change Places

OBJECTIVES

Students observe how a shadow changes due to the movement of the sun.

The students

- ▶ record the changes in the position of a shadow from morning to midday to afternoon
- ▶ note changes in the sun's position in the sky during the course of a day
- ▶ infer that shadow changes are caused by changes in the sun's position in the sky

SCHEDULE

Session I About 20 minutes, early in the day

Session II About 25 minutes, around midday

Session III About 25 minutes, in the afternoon

VOCABULARY

sun

MATERIALS

For each student

- 1 Activity Sheet 4

For each team of two

- 1 pc chalk, blue, large
- 1 pc chalk, red, large
- 1 pc chalk, yellow, large

For the class

- 1 pkg chalk, assorted
- 64 stickers, small*

*provided by the teacher

PREPARATION

Session I

- 1 This activity must be done on a day when the sun is expected to shine all day.
- 2 Select an outdoor area where students can make chalk drawings on the pavement that will not be disturbed during the course of the day.
- 3 Each team of two will need a piece of blue chalk.

Session II

- 1 This session should be conducted at or near the time when the sun is at its highest point in the sky.
- 2 Each team of two will need a piece of yellow chalk.

Session III

- 1 Make a copy of Activity Sheet 4 for each student.
- 2 Each team of two will need a piece of red chalk.

BACKGROUND INFORMATION

Any change in the position of a light source in relation to an object will cause a change in the shape, length, and position of the shadows it

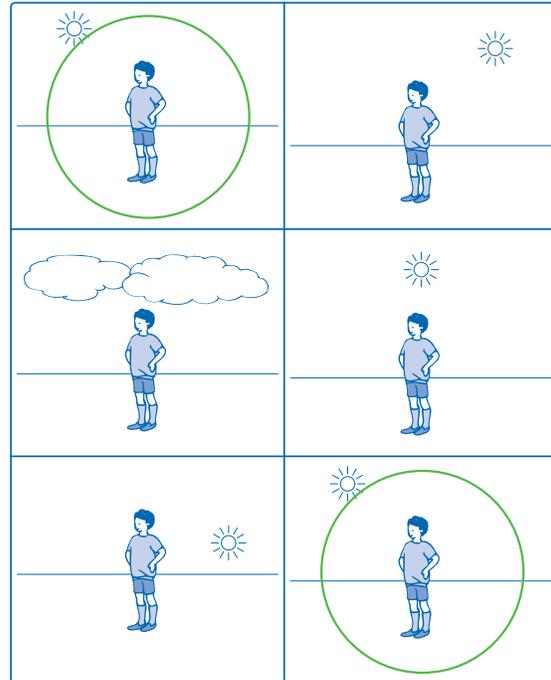
produces. The sun is the light source in this activity. The **sun** is the star around which Earth moves in orbit. Since the sun's position in the sky during the course of the day changes due to the rotation of Earth on its axis, the shapes of outdoor shadows also change during the course of the day.

As students do this activity, they may say that the sun is moving across the sky. The sun is not really moving, but rather Earth is. Depending on the level of your students, you may wish to tell them that Earth is what is really moving.

Shadows can change in length, shape, and position. In this activity, it is important only that students notice that shadows change in these ways. They will investigate more about how and why shadows change in later activities.

▼ Activity Sheet 4

Shadows Change Places



Guiding the Activity

Session I

- 1 Ask, **What is the light source for making shadows outside on a sunny day?** If necessary, explain that the **sun** is a star that Earth moves around. It shines or glows and makes heat and light for everything on Earth.

Ask, **If you are outside on a sunny day, do you think your shadow will look the same all day?**

Tell students they will answer this question by the end of the day.

- 2 Give each team of two a piece of blue chalk. Take the class outside to the predetermined paved area early in the day.

Arrange the students so that they are all standing with the morning sun to the left side of them.

Additional Information

the sun

Accept all ideas at this time.

Tell students to stand with their arms at their sides.

Guiding the Activity

Tell students you will give them an idea of where the sun is right now. Stand beside the students, so that the morning sun is also on your left side. Extend your arm, as if your arm were an arrow pointing to the sun's position. Remind students to look at you, not the sun. Ask them to imagine that your arm is very, very long, and at the tip of your fingers is the sun.

Ask the students to remember exactly how far up you are holding your arm, because you will ask them about it later.

Put your arm back down and face the students again. Ask, **Which side is the sun on?**

Instruct one student from each team to continue standing in this same position with his or her arms at their side. Have the other team members trace their partners' feet with blue chalk. Then have them trace their partners' shadows, as shown in Figure 4-1.

After students step out of their "feet," write their names, or have them write their names beside the "feet."

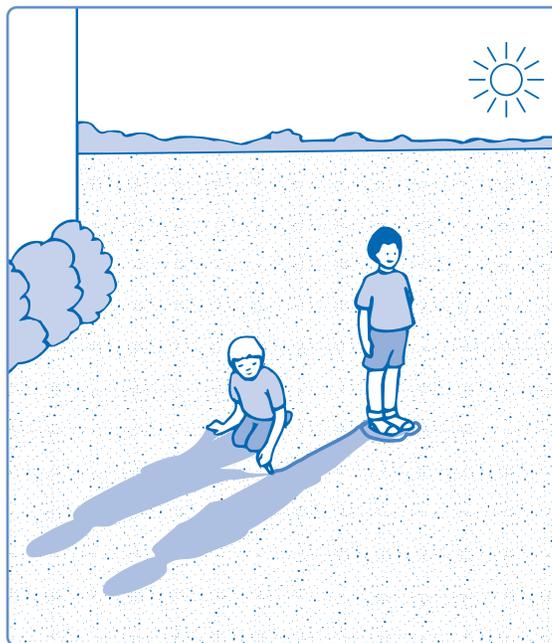
Then have team members switch roles, so that each student has a set of footprints and a shadow marked with blue chalk.

Additional Information

Safety Note: Warn students not to look directly at the sun. Doing so can cause severe eye damage.

Tell them they can also think of your arm as an arrow pointing to the sun.

As each student answers correctly "this side" or "that side," (or "left" or "right"), place a sticker on each student's corresponding hand. Tell them to leave the stickers on their hands. Alternatively, you may wish to use a rubber stamp.



▲ Figure 4-1. A student traces his partner's shadow.

Guiding the Activity

Additional Information

3 Back in the classroom, have students return the chalk to the kit.

Write *Morning* on the board with a piece of blue chalk from the assorted package.

Above the heading, draw an outline of two feet and tell students that this shows the place where everyone stood outside. Ask, **What was your light source for making shadows?**

Ask, **Which side was the sun on?**

Tell the students you want to draw the sun in the sky in its right place. Explain that they need to know more than just what side it was on, however. Ask, **Does anyone remember what position my arm was in when we were outdoors?**

Remind students that your arm was pointing to the sun.

Tell students you will draw your arm pointing to the sun. Then draw a dotted line from the “feet” to the place that represents the correct position of the sun in the sky. At this point, add the sun to your picture.

Have students remove the stickers from their hands. Leave the drawing on the board or paper for use in Session II.

Session II

4 Around midday (or whatever time the sun is at its highest point in the sky), give each team of two a piece of red chalk and take the class outside to the same location.

Arrange the students so that they are standing with their feet in the outlines drawn that morning.

If you do not have a chalkboard available, use a piece of chart paper and a blue marker.

the sun

If students need prompting, remind them that you put stickers on their hands—on the same side as the sun. Some students may correctly answer that the sun was on the left side.

Have students tell you to move your left arm up or down. As students answer, move your arm until it is positioned at the correct angle. Be sure you are facing the same direction as the students when you do this.

Guiding the Activity

Tell students you will again use your arm as a pointer to give them an idea of where the sun is right now. Stand beside the students, facing the same direction as they are, and extend your arm so that you are pointing directly to the sun's position.

Ask the students to remember the way you are holding your arm, because you will ask them about it later.

Have the teammates again trace each other's shadow, this time using the red chalk.

5 Have students step out of their "feet." Tell them to study their two shadow outlines. Ask, **What happened to your shadow from the morning to the middle of the day?**

Ask, **Do your two shadows look the same?**

Ask, **How are they different?**

6 Back in the classroom, write *Middle of the Day* on the board with a piece of red chalk, just under the *Morning* heading.

Point to the drawing you created that morning and tell students you are going to show the sun's place in the sky when it is the middle of the day.

Ask, **Does anyone remember what position my arm was in this time?**

Remind students that your arm was pointing to the sun.

Tell students you will draw your arm pointing to the sun. Then draw a dotted line from the "feet" to the place that represents the correct position of the sun in the sky. At this point, add another sun to your picture.

Leave the drawing on the board or paper for use in Session III.

Additional Information

At this time of day, the position of your arm should be fairly close to your head.

Students should take turns with their partners, just as they did in the morning.

Students should suggest that it changed.

no

Students should note that (1) they are in different places; (2) they are different shapes; and (3) one is longer than the other.

Use the red chalk from the assorted package. If you do not have a chalkboard available, use a red marker on the chart paper.

Remind students that the "feet" show where they were standing.

Have students tell you to move your arm up or down. As students answer, move your arm until it is positioned at the correct angle. Be sure you are facing the same direction as the students when you do this.

Guiding the Activity

Additional Information

Session III

7 Later in the afternoon, give each team of two a piece of yellow chalk and take the class outside to the same location.

Arrange the students so that they are standing with their feet in the outlines drawn that morning.

Tell students you will again use your arm as a pointer to give them an idea of where the sun is right now. Stand beside the students, facing the same direction as they are, and extend your arm so that you are pointing directly to the sun's position.

Ask the students to remember exactly how far up you are holding your arm, because you will ask them about it later.

Put your arm back down, and face the students again. Ask, **Which side is the sun on?**

Have the teammates again trace their shadows, this time with yellow chalk.

You should be extending your right arm this time.

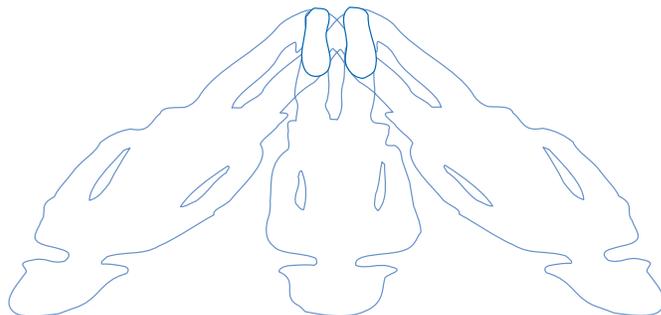
As each student answers correctly "this side" or "that side," (or "left" or "right"), place a sticker on each student's corresponding hand. Tell them to leave the stickers on their hands.

8 Have students step out of their "feet." Ask, **What happened to your shadow from the middle of the day to the afternoon?**

Ask, **How are your shadows different?**

Students should suggest that it changed again.

Students should say that 1) they are in different places; 2) they are different shapes; and 3) there are differences in how long they are. (See Figure 4-2.)



▲ *Figure 4-2. A student's morning, midday, and afternoon shadows.*

Guiding the Activity

9 Back in the classroom, write *Afternoon* on the board with a piece of yellow chalk, under the *Middle of the Day* heading.

Point to the drawing and tell students you are going to show the sun's place in the sky when it is afternoon.

Ask, **Which side was the sun on?**

Ask, **Does anyone remember what position my arm was in this last time?**

Remind students that your arm was pointing to the sun.

Tell students you will draw your arm pointing to the sun. Then draw a dotted line from the "feet" to the place that represents the correct position of the sun in the sky. At this point, add the third sun to your picture.

10 Remind students that they already noticed that their shadows changed during the day. Ask, **What changed during the day besides the shadows?**

Ask, **Why do you think your shadows changed from the morning to the middle of the day to the afternoon?**

11 Give each team of students a copy of **Activity Sheet 4**. Tell students to look at all of the pictures, and explain that the boy is standing in the same place in each picture. Explain that in two of the pictures, the boy's shadow would look the same. Ask them to circle those two pictures.

Additional Information

Use the yellow chalk from the assorted package. If you do not have a chalkboard available, use a green marker on the chart paper.

Remind students that the "feet" show where they were standing.

If students need prompting, remind them that you put stickers on their hands—on the same side as the sun. Some students may correctly answer that the sun was on their right side.

Have students tell you to move your right arm up or down. As students answer, move your arm until it is positioned at the correct angle. Be sure you are facing the same direction as the students when you do this.

The sun's place in the sky also changed.

Students should be able to infer that the shadows moved and changed because the sun's position (place) in the sky changed.

Have students draw in the shadows first, if necessary, then compare their positions.

Guiding the Activity

Review the students' answers with them. Make sure they understand the shadows in the other four pictures would look different from one another because the sun is in different places in the sky.

Tell students they will learn more about how and why shadows change in the coming activities.

Additional Information

REINFORCEMENT

To reinforce the changes in shadows from morning to afternoon, add additional sessions throughout the day. Use a different color chalk for each observation session. Students will see many changes in the shadows.

SCIENCE JOURNALS

Have students place their completed activity sheets in their science journals.

CLEANUP

Return all chalk to the kit. Clean the chalk off the pavement.

SCIENCE AT HOME

Have students observe shadows in their yards and note how they change positions during the course of the day. Also, ask them to track the position of the sun in the sky during the observation period.

Connections

Science Challenge

The following activity demonstrates that light travels only in straight lines—an important factor in understanding why the position of a shadow changes when the position of the light source changes.

Setup. Use a paper punch or nail to make a hole in the exact center of two file cards. (Determine the exact center by drawing diagonal lines connecting opposite corners of each card; the point where the two lines intersect is the exact center.) Use lumps of clay to hold the cards upright in a row, about 15 cm (6 in.) apart, and align the holes in a straight line by passing a string through them and pulling it taut. Behind the second card, set up a third card with no hole.

Investigation. Hold a lighted flashlight so its beam passes through both holes and makes a small spot of light on the third card. Then, without moving the flashlight, move the second card sideways slightly. The light will no longer strike the third card. Next, leaving the first and second cards in place, move the flashlight so it shines through both holes again and strikes the third card. (Move the third card sideways, if necessary.) Pass the string through the holes and pull it taut again to see the new angle of the light beam.

Follow-up discussion. Ask students to suggest why the light did not hit the third card when the second card was moved. (The light could not bend to reach and pass through the hole in the second card.) Explain that light always travels in straight lines. It cannot bend around objects. If it could bend, objects would not cast shadows. Also, because light travels in a straight line from its source to an object, the position of the object's shadow changes when the position of the light source changes.

Science Extension

The two activities suggested below will show students that shadows enable us to see the shapes and textures of objects.

- ▶ Locate several trees on or near the school grounds that have rough bark. Take students to observe the trees when the bark is directly lighted by the sun and again when it is lighted from one side, and ask them to describe the bark's appearance each time. If necessary, point out that sunlight striking the bark from the side creates shadows that make the bark look rough, while sunlight striking the bark directly creates few or no shadows, so the bark looks smoother.
- ▶ Provide each team with several objects that have a textured surface, such as an orange, a football, a brick, and a bath towel. You also may want to include a smooth rubber ball and a fuzzy tennis ball for comparison with the orange. Have students shine a flashlight at each object from different angles and observe the effects as the light casts shadows on the object's surface. Encourage students to use the flashlight to investigate the textures of various surfaces in the classroom.

Science and the Arts

As a follow-up to the two Science Extension activities above, show students how to make bark rubbings or rubbings of other textured surfaces: Lay a sheet of paper on the surface, then rub lightly with the side of a crayon or pencil point. Encourage students to make rubbings of a variety of textured objects. Create a classroom display of the rubbings and let students try to identify the object or material that was used to make each rubbing.