



HANDS-ON ACTIVITY

## How Does A Shadow Grow?

### Objective

**Collaborate** to model how shadows change throughout the day.

What question will you investigate to meet this objective?

**Possible answer:** How does a change in the position of a light source cause a shadow to change?

### Materials

- new, unsharpened pencil
- modeling clay
- poster board
- metric ruler
- marker
- rocks (4)

### Procedure

**STEP 1** Use the clay to position the pencil upright in the center of the poster board.

Why is it important to position the pencil correctly?

**The pencil should be upright so that the shadow's length can be compared and measured throughout the day. The idea is for the sun's position to be the only variable that changes.**



**STEP 2** Place the poster board outside in a sunny, flat area away from trees and other tall objects. Put a rock on each corner of the poster board.

What might happen if you did not weigh down the poster board?

**The whole thing could be blown away by wind.**



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**HANDS-ON ACTIVITY** Small groups 1 day

## How Does A Shadow Grow?

### 3D Learning Objective

#### **SEP** Analyzing and Interpreting Data

Students create a type of sundial and use it to record data about how shadows change throughout the day.

### Materials

The materials listed are a starting point. You can also replace the pencil with different cylindrical objects, such as a cardboard paper towel roll.

### Preparation

Set aside time for students to participate in this activity by scheduling it out in advance. Keep in mind that this activity will require data collection over the course of a full, sunny day.

### Procedure

**STEP 1** Monitor students to make sure they are setting up their materials correctly. The pencil must be positioned upright and in the center of the poster board.

**STEP 2** Help students locate a spot outdoors for their poster boards.

**Ask:** Why is it important to place the poster boards away from tall trees or structures? **so that the tall trees or structures don't create shade**

#### **DCI** ESS1.B Earth and the Solar System

As students begin working on their experiments, circulate and probe for students' understanding of the position of the sun and Earth relative to each other.

**Ask:** What movement is causing the shadow to change? **Earth's rotation**



Student Lab Worksheet and complete Teacher Support available online.

EXPLORATION 2 HANDS-ON ACTIVITY, continued

**STEP 4** Emphasize to students the importance of not looking directly at the sun. This can damage their eyes. For students with light sensitivity, make sure they are properly clothed or covered or that a hat and/or sunglasses are made available.

**STEP 5** You may need to get the permission of other teachers to allow students time to take measurements of their models throughout the school day. Model for students how to complete the data table.

**CCC Patterns**

Remind students that the data they collect reflect a larger pattern. As students carry out their experiments, have them continue to think about how patterns help us make predictions.

**Ask:** Would you expect the pattern of shadows to be the same tomorrow? **Yes, because it is caused by the sun’s apparent movement across the sky, which repeats daily.**

**DCI ESS1.B Earth and the Solar System**

As students collect data, discuss what Earth and the sun are doing to produce the shadows and their changes.

**Ask:** Why do the shadows shift directions? **Earth rotates, meaning the sundial moves with Earth in relation to the sun’s position.**

**Ask:** Why do the shadow lengths change? **It is due to the sun’s height in the sky and its angle with respect to Earth’s surface.**

**Ask:** The word apparent means something that appears to be true but may not be. Why do we call it the apparent movement of the sun? **It looks as if the sun is moving in the sky but it is not. Earth is the object that is moving.**

**STEP 3** Measure the length of the pencil’s shadow. Mark the end of the shadow. Record the time of day and your measurement on the poster board.

Why should you write down the time of day and your measurement?

**Recording the time of day as well as the measurement will make it easier to analyze**

**the data later on to track the sun’s movements through the measurements.**



**STEP 4** Observe the position of the sun and the direction of the shadow in relation to the sun. Record your observations in the table below, along with your measurements of the shadow. **Caution:** Do not look directly at the sun.

Why is it important to observe the position of the sun?

**Observing the position of the sun will help make a connection with the position and length of the shadows the sun casts.**

**STEP 5** Repeat steps 3 and 4 each hour throughout the school day.

Why should you take measurements throughout the day?

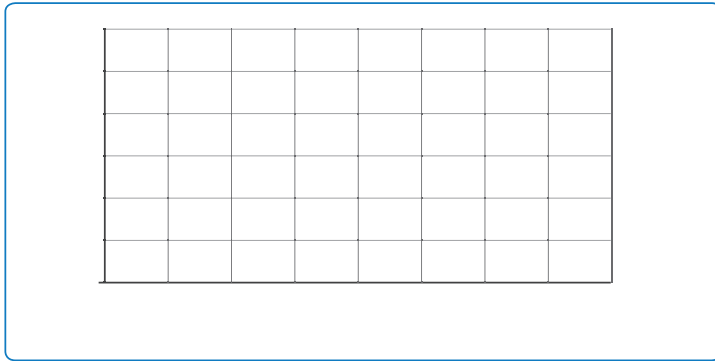
**The objective of the activity is to observe how shadows change over the course of a day. Taking measurements all day is the best way to get the most accurate data.**

**Complete the data table as you observe and measure.**

Shadow Data Table			
Time of day	Position of sun	Length of shadow	Direction of shadow in relation to sun
	Students’ data should show a pattern of lower sun positions		
	and longer shadows in early morning and later afternoon		
	and higher sun positions and shorter shadows at midday.		
	Shadow directions should always be opposite the sun.		

## Analyze Your Results

**STEP 6** Use your data to create a line graph. Label the horizontal axis (x-axis) *Time of day*. Label the vertical axis (y-axis) *Length of shadow*.



Students' line graphs should be u-shaped.

**STEP 7** Analyze your graph. What pattern do you observe?

The shadow of the pencil was long in the morning, shorter around noon, and then long again in the afternoon.

**STEP 8** Compare your results with your classmates. Why is it important for scientists to share the results of their investigations?

Sharing information helps scientists figure out if their data is accurate.

## Draw Conclusions

**STEP 9** Make a claim about the sun's movement based on the question you investigated. Cite evidence from your investigation to support this claim.

Possible answer: The shadow points in the direction opposite the sun throughout the day. Students should use data from their table to support this claim.

**STEP 10** If you could observe the shadow of a stick from morning to evening on a sunny day, what do you think you would observe?

Possible answer: The shadow would be long in the morning and get shorter in the middle of the day. Then it would start to get longer again as the sun starts to set.

## Analyze Your Results

**STEP 6** Assist students as needed to complete the graph.

## SEP Analyzing and Interpreting Data

**Ask:** What's the connection between the arc-like path of the sun across the sky and the u-shaped pattern in the graph? They are opposites, which makes sense because when the sun is low (early and late), it casts long shadows, and when it's high (noon), it casts short shadows.

## CCC Patterns

**Ask:** Use a map or compass to orient your sundial drawing and data with the local area. In which direction do most of the shadows run? Most students will answer north. Shadows running to the south should be rare in the Northern Hemisphere.

## Draw Conclusions

Circulate around the room to make sure students are able to draw conclusions about their findings.

## Claims, Evidence, and Reasoning

Have pairs of students swap papers with other pairs of students to critique each other's claims and evidence from Step 9. Ask each pair to be prepared to share one way that they could improve their claim by adding more evidence.

## Scoring Rubric for Hands-On Activity

3	Investigation is done correctly, results recorded accurately, analysis and conclusions reflect actual results, and evidence from data supports the claim.
2	Investigation and recording are mostly correct, analysis and conclusion are mostly correct, claim is supported by evidence.
1	Recording is unorganized, analysis has errors, and claim is attempted but not supported by evidence.
0	Little or no attempt was made to complete this assignment.