ACTIVITY 5

HOW LONG IS MY SHADOW?

Grades :	Level of preparation:	Student groupings:	Length:	Location of activity:
4 and higher	**intermediate**	**small groups**	**30 minutes, plus 15 minutes per observation**	**at school**

BRIEF DESCRIPTION

In this activity, students use the length of their shadow to understand the apparent movement of the Sun in the sky. They must take measurements at different times of the day to notice the differences.

LEARNING GOALS

- Observe how the length and direction of a shadow change during the day.
- Explain how the changes observed in the shadow depend on the apparent movement of the Sun in the sky.
- Understand the Sun's motion from east to west in the sky during the day.
- Observe the change in the height of the Sun in the sky throughout the year.
- Observe the Moon in the sky.
- Model the phase of the Moon visible in the sky.

MATERIALS

- Several long rulers or measuring tapes
- Notebook
- Pens
- Sunny day!

INTRODUCTION

Since it is dangerous to observe the Sun directly, this activity uses the changes in a shadow to determine the movement of the Sun in the sky. The shadow projected on the ground will always be in the opposite direction to the Sun. In addition, the lower the Sun in the sky, the longer the shadows. Conversely, a very high Sun in the sky will create very short shadows.

In this activity, students observe the changes in their shadow over the course of a day. These observations will allow the students to realize that the Sun starts the day low in the east, then moves up in the sky until it reaches its highest point around noon in the south and it eventually goes down in the west in the afternoon and evening. This motion is due to the rotation of the Earth on its axis, which takes 24 hours.

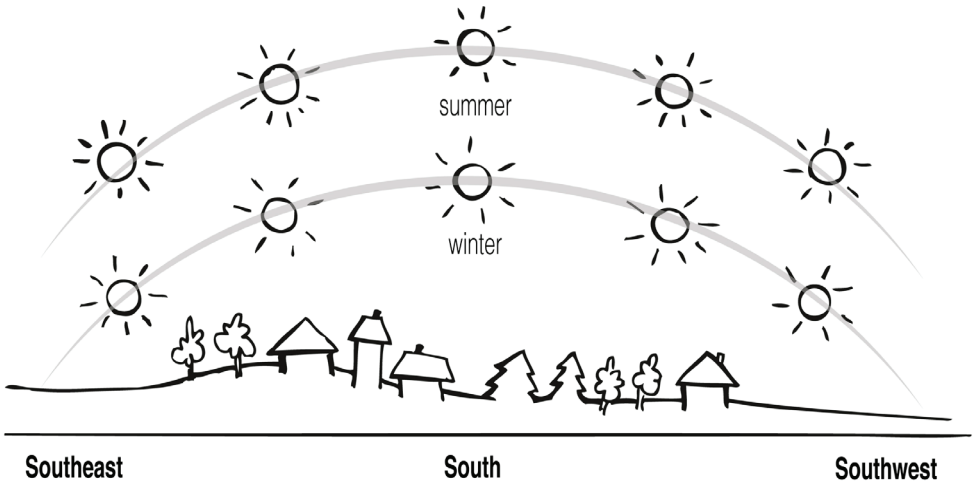

Figure 6. Apparent motion of the Sun in the sky over the course of a single day in summer and winter. In both cases, the Sun moves from east to west (left to right in this picture).

PREPARATION

- Make sure you find a place in the schoolyard where it will be possible to observe the Sun. Ideally, this spot would have a relatively clear horizon from southeast to southwest. You can do the activity yourself before doing it with students to ensure that your observing location works well.
- If you have trouble knowing the orientation (north, south, east, west), you can use a compass to find north. You can also pay attention to the position of the Sun in the sky when you arrive at school in the morning: this is east.

METHOD

- Form teams of three or four students and go outside with the rulers or measuring tapes. Each student should also have a notebook and a pencil.

- Invite students to measure their height in order to compare their shadows with their actual size. This can be done in the classroom before going outside.

- For the measurements, ask students to choose a location where their shadows will be obvious and easy to measure. Guide them in their choice to ensure they can see their shadow from the same place over several hours.

- If you want students to pay attention to the change in direction of their shadow during the day, ask them to notice their orientation by facing something obvious or using markers on the ground. They should place themselves in the exact same position and orientation every time.

- Each member of the team should take their turn to stand at the precise location. The other members of the team should then measure this person's shadow. Each student should note the time and the length of their shadow in their notebook. Students may also make a drawing of the direction of the shadow while making sure they include their reference point in the drawing, as in Figure 7.

- Repeat the measurements every hour or so to observe the changes.

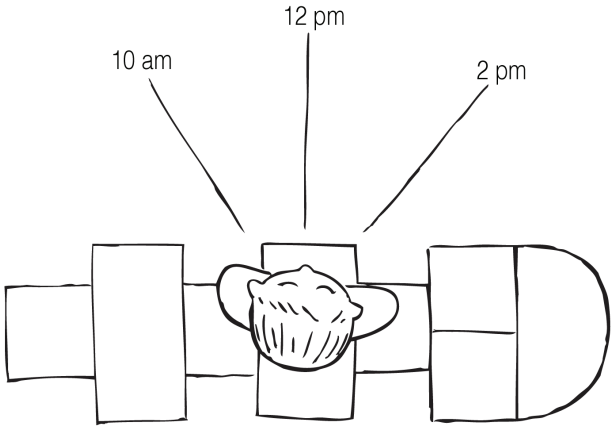

Figure 7. Direction of the shadow of the student at different times of the day.

Here are **some questions you may wish to ask your students** depending on the level of analysis and inquiry you want to reach (answers are given in italics).

- Even before finishing the steps, ask students to predict where their shadow will be at the next observation and estimate its length. They can then compare their predictions with the true measurements.

- Describe how the length of the shadow varies during the day. *The shadow shortens until noon and then lengthens in the afternoon*.

- Why does it vary this way? *The Sun is at its highest point in the sky around noon, causing the smallest shadow.*

- How has your shadow moved during the day? *From west to east (or left to right on their paper)*.
- Describe the apparent motion of the Sun during the day. *The Sun moves from the east to the south and then the west. Moreover, it is lower in the sky in the morning and afternoon and is at its highest around noon.*

- Make a graph of the length of the shadow based on the time of day.

- Is there a time when your shadow was your exact height? *This is possible when the Sun is in an elevation of 45° in the sky, but the Sun does not reach that height for several months of the year in Canada (October to April, in southern Canada)*.

TO OBSERVE VARIATIONS THROUGHOUT THE YEAR

To observe the changes at different times of the year, you can do this activity several times a year and compare the results. Changes in the length of the shadow during the year (and thus the height of the Sun in the sky) are due to the tilt of the Earth and the motion of the Earth around the sun. This tilt of the Earth and the resulting variations in the height of the Sun over the course of a year, is the cause of the seasons.

DIFFERENT OPTIONS FOR THE ACTIVITY

- Explore how sunlight enters the classroom or creates shadows in the classroom. Observe the changes during a day.
- Instead of measuring the shadows of the students, you could use an object that will always be placed at the same location. A plunger works well because it has a stable base, a long stick, and is easy to carry.

ADDITIONAL INFORMATION

Can the Sun be directly above our heads?

In Canada, the Sun never reaches the zenith, the point directly overhead. It reaches its highest point at the summer solstice around noon, but it is always several degrees off the zenith. To view the Sun directly overhead, one must be located between the two tropics, or at a latitude of less than 23.5 degrees north or south.

Does the Sun reach its highest point in the sky at noon exactly?

No, it is not always exactly at noon. When we are using daylight saving time, the Sun reaches its highest point around 1pm instead of noon. There is also a difference of a few minutes given your position in your time zone. The Sun reaches its highest point in the sky when it is directly to the south, and that time varies by a few minutes depending whether you are towards the eastern border of the time zone or western border. Other factors relating to characteristics of the orbit of the Earth also cause a slight lag between noon and the time when the Sun is directly south.

Why do we talk about the apparent motion of the Sun?

The motion of the Sun observed in this activity is the effect of the motions of the Earth. You can find more information about it on page 22. It is important to realize that children intuitively think the Sun is moving around us. This is normal because this is what we see in the sky. It was also believed by the first astronomers in history. The purpose of this activity is to become familiar with the apparent motion of the Sun in order to then explain astronomical phenomena describing this motion: rotation and revolution of the Earth as well as the tilt of the Earth's axis of rotation.