7. Night and Day

The Way the World Turns

Driving Question

How does the sun's light fall on our planet as it rotates?

Materials and Equipment

For each student or group:

- ☐ Data collection system
- ☐ Light sensor
- ☐ Utility lamp or flashlight
- ☐ Index card (2), 3 in. x 5 in.
- ☐ Marker (dark color)
- ☐ Tape

Safety

Add this important safety precaution to your normal laboratory procedures:

- Do not shine any light directly into others' eyes.

Thinking about the Question

People have observed the sky for many thousands of years. The most obvious objects in the sky, of course, are the sun in the day and the moon at night. Ancient people thought that the sun and the moon both revolved around the earth. We no longer believe this because we know that the earth rotates, or spins like a basketball on the tip of a player's finger. It is this rotation that is the cause for our night and day on Earth. Rotation is one of the types of motion found in our solar system and in the universe. Can you think of any other types of motion that occur in the solar system?

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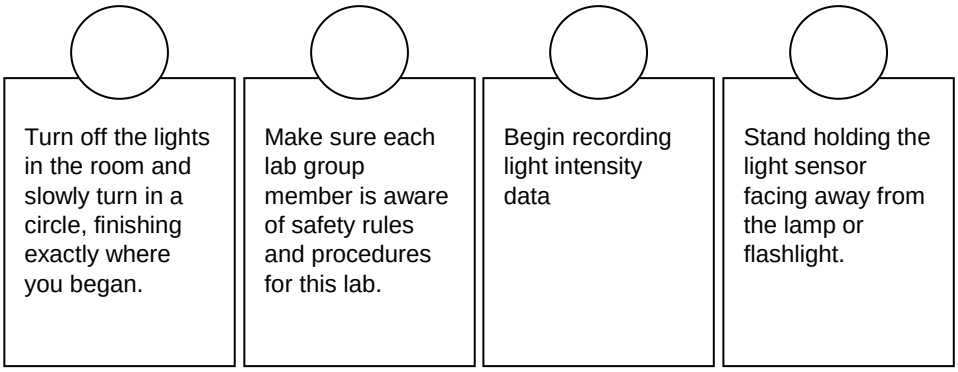
Ancient people were excellent observers of the night sky. They also had the benefit of very dark nights, in which the stars, the planets, and even the Milky Way—our own galaxy—were visible. This was because their only source of illumination was fire, so consequently there was very little light pollution. In addition, many of the world's great cultures were extremely interested in astronomical observations for religious or for practical reasons, such as knowing when to plant and harvest crops.

To these observers, it was evident that the celestial bodies traveled around the earth. How would their observations have been different if this type of motion really was occurring? Discuss in your group how the path traveled by the sun and moon would appear if the earth was *not* rotating, and the sun and the moon were orbiting the earth. Be prepared to share your thoughts with the rest of the class.

In this activity you will be working within your group to model Earth's rotational motion and how the sun's light falls upon the rotating planet. You will observe how this rotation causes night and day to happen in a regular, repeating cycle. You will need to have one volunteer to play the role of the earth, and a second volunteer to play the role of the sun.

Sequencing Challenge

☐ **The steps below are part of the Procedure for this lab activity. They are not in the right order. Determine the proper order and write numbers in the circles that put the steps in the correct sequence.**



Investigating the Question

☐ **Note:** When you see the symbol "[2]" with a superscripted number following a step, refer to the numbered Tech Tips listed in the Tech Tips appendix that corresponds to your PASCO data collection system. There you will find detailed technical instructions for performing that step. Your teacher will provide you with a copy of the instructions for these operations.

Part 1 – Making predictions

1. ☐ Write your predictions for the following:

   a. What will happen to the level of light that falls from a light source onto the light sensor as it is rotated in a complete circle by one of your classmates?

b. If the light sensor is rotated several times, what will a graph of light intensity versus time look like?

c. Would you be able to tell from the graph how many rotations the light sensor made? Explain your reasoning.

d. If the student playing the role of the earth has the direction "east" taped to his or her left shoulder and the direction "west" taped to his or her right shoulder, which direction will the student turn to make the "sun" appear to rise in the east and set in the west?

Part 2 – Measuring light through one rotation

In this activity one group member volunteers to play the role of the earth, and will be responsible for data recording. Another group member volunteers to play the role of the sun, and will be responsible for shining the lamp or flashlight on the "earth." Data recording is carried out with the room darkened.

2. ☐ Mark one index card with a large "E" and the other with a large "W."

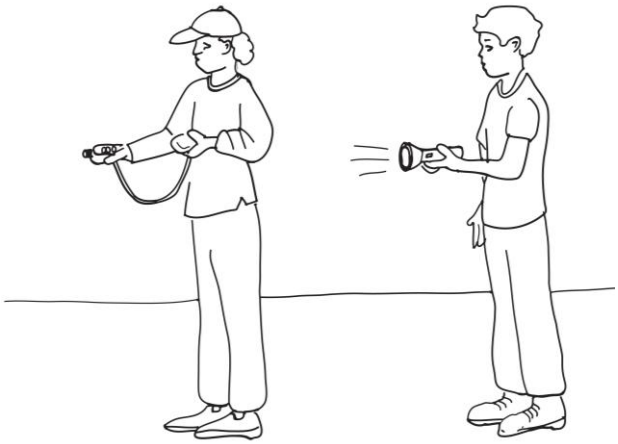
3. ☐ Tape the compass direction east to the "earth's" left shoulder, and tape west to the "earth's" right shoulder.

4. ☐ Start a new experiment on the data collection system. (1.2)

5. ☐ Connect a light sensor to the data collection system. (2.1) Select the medium sensitivity range (0–260 lux) for the light sensor.

6. ☐ Display Light intensity on the y-axis of a graph with Time on the x-axis. (7.1.1)

7. ☐ The "earth" begins by holding the light sensor pointing outward, and facing away from the "sun," whose light should be shining on the "earth's" back.



8. ☐ Begin data recording. ⓪(6.2)

9. ☐ The "earth" turns slowly and steadily in a circle so that the left, or "eastern," shoulder is illuminated first, and so that the complete rotation takes between 30 and 40 seconds.

10. ☐ After completing the rotation, stop data recording. ⓪(6.2)

11. ☐ Observe your graph of light intensity data. You may need to adjust the scale of the graph to view all of your data. ⓪(7.1.2) Record your observations below.

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Part 3 – Measuring light through a series of rotations

As in Part 2, in this activity one group member volunteers to play the role of the earth, and will be responsible for data recording. Another group member volunteers to play the role of the sun, and will be responsible for shining the lamp or flashlight on the "earth." Data recording is carried out with the room darkened.

12. ☐ The "earth" begins by holding the light sensor pointing outward, and facing away from the "sun," whose light should be shining on the "earth's" back.

13. ☐ Begin data recording. ⓪(6.2)

14. ☐ The "earth" turns slowly and steadily in circles so that the left, or "eastern," shoulder is illuminated first, and so that each rotation takes between 20 and 30 seconds. The "earth" should rotate through at least 5 complete days and nights.

15. ☐ After completing the rotations, stop data recording. ⓪(6.2)

16. ☐ Observe your graph of light intensity data. You may need to adjust the scale of the graph to view all of your data. ◆(7.1.2) Record your observations below.

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17. ☐ Save your experiment according to your teacher's directions. ◆(11.1)

Answering the Question

Analysis

1. How did your predictions from Part 1 compare to your results in Part 2?

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2. How did your predictions from Part 1 compare to your results in Part 3? How many cycles of night and day did your group make?

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3. The term "solar noon" refers to the point when the sun has risen to its maximum height in the sky before appearing to begin its descent toward the west. Examine your light intensity versus time data. Can you tell from your data when it was "solar noon" at the light sensor on the "earth's" surface? Explain your thinking.

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4. Imagine you were living 2500 years ago in ancient Greece, and did not have access to a light sensor to assist in your observations of the night or day sky. How might you have used shadows cast by trees or other objects to determine when it was noon? Explain your reasoning.

5. Examine your data from Part 3 again. Can you tell how much time passes between the brightest point, or solar noon, of one day and the darkest point of the "night" by looking at the graph? You may need to adjust the scale of the axes or zoom in to a portion of the graph. Selecting specific data points in your graph (7.1.4) may help you in your analysis.

6. Through how many degrees did the "earth" rotate in the time between noon and night in the previous question?

7. Through how many degrees does the earth rotate for the following amounts of time: one complete night and day cycle, two complete night and day cycles, and three complete night and day cycles?

8. How long does earth take to rotate through 540 degrees? If you began counting the time at solar noon, would it be night or day when the rotation just passed 540 degrees?

Multiple Choice

☐ **Circle the best answer or completion to each of the questions or incomplete statements below.**

1. If it is midnight at your location on Earth's surface, what is true of your position on Earth?

   A. You are located on the side of our planet that is directly opposite the sun.
   B. The sun has traveled around behind your position on Earth's surface.
   C. You are located on Earth's surface at a right angle to the sun.

2. Which term is used to describe the motion that is responsible for Earth's nights and days?

   A. Spinning
   B. Axis-tilt
   C. Rotation

3. At any given moment in time, what fraction of the earth's surface is illuminated by the sun?

   A. This information cannot be determined.
   B. One half of the earth's surface is illuminated.
   C. Between one-fourth and one-third of the earth's surface is illuminated.

4 Which statement best describes solar noon?

   A. The time at which a location on the earth's surface is facing directly toward the sun.
   B. The exact moment in time when the earth has completed one rotation.
   C. The point in the earth's rotation when a location on the earth's surface is facing away from the sun.

5. Suppose there is a planet that takes 52 hours to rotate through 360 degrees. How long is one complete night and day cycle on that planet?

   A. 24 hours
   B. 360 hours
   C. 52 hours

6. The sun and moon appear to us to rise in the east and set in the west because the earth

   A. Rotates at a steady rate, turning through 360 degrees in the same amount of time for each rotation.
   B. Rotates on its axis, which is an imaginary line that goes through the earth's center from the North to the South Poles.
   C. Rotates in a counterclockwise direction when viewed from the North Pole.

7. Which of the following ancient cultures were observers of astronomical phenomena?

   A. The Babylonians and the Chinese
   B. The Chinese and the Greeks
   C. The Babylonians, the Chinese, and the Greeks

8. If our planet did not rotate on its axis every 24 hours, which of the following would be true?

   A. The sun would appear to move through the sky
   B. The moon would appear to rise in the west and set in the east
   C. There would be no cycle of night and day

True or False

☐ **Enter a "T" if the statement is true or an "F" if it is false.**

_____ 1. Because the sun and the moon appear to travel across the sky from east to west, ancient people thought the earth did not rotate, but that these celestial bodies travel in a circular path around our planet.

_____ 2. From our frame of reference on the earth's surface, it is not possible to determine which is moving – the earth or the sun.

_____ 3. Rotation and revolution refer to the same types of motion.

_____ 4. Someone standing on a particular point on the earth's surface will travel through 360 degrees of a rotation in 24 hours.

_____ 5. If you watch a sunset, you are seeing the moment in time where the earth's rotation carries you from the illuminated part of the planet to the part that is not illuminated.

_____ 6. The only place on Earth to see the sun appear to rise in the west and set in the east is on the equator.