Name: _____ Date: _____

Modeling Sunlight Angles

Materials per team of 2-3 students

1 tray (or thin, hardcover book)
2 pieces of graph paper
1 flashlight
1 ruler
1 pencil
tape
your science notebook

Directions

1. Tape one piece of graph paper to the flat surface (this may be a tray or a hardcover book). Decide who will hold the flashlight and who will hold the flat surface. A third team member, if in a group of three, will measure the distance between the flashlight and the surface and will record data.

2. Turn on the flashlight. Hold the flashlight about one foot from the tray your partner is holding. (Use your ruler to check the distance.) Point the flashlight directly toward the graph paper. Hold the tray straight up and down, directly in front of the flashlight.

3. The student holding the flashlight should observe the shape and size of the light image and describe it to your partner(s).

4. Trace around the pattern of light. The third group member can do this, or the person holding the tray can trace the pattern without moving the position of the tray. Take your time! Remove the paper from the flat surface and label it "Direct light." Draw a stick figure inside one square of the graph paper to represent someone standing in the sunlight.

5. Next, tape a new piece of graph paper to the tray. Then, tip the tray so the light shines on the graph paper at an angle or a slant. Remember to hold the flashlight about one foot from the tray at all times. (Use your ruler to check the distance.)

6. Observe the shape and size of the light image and describe it to your partner(s). Trace the new pattern of the light. (Remember to take your time to be as accurate as possible.) Then label it "Light at an angle." Draw a stick figure inside one square of the graph paper to represent someone standing in the sunlight.

7. Tip the tray at different angles and observe what happens to the light. (You do not need to record these images. Just notice what happens to the light when you have less of a slant—less of an angle—and more of a slant—a greater angle.) As you do this, discuss the questions on the following page with your group:
    a. Describe how the image of the light changes when the tray changes from one position to another.
    b. Do you observe any difference in the brightness of the light? Describe your observations.
    c. When you hold the tray in different positions, do you think there is any difference in the amount of energy from the flashlight that reaches any particular square on the graph paper?

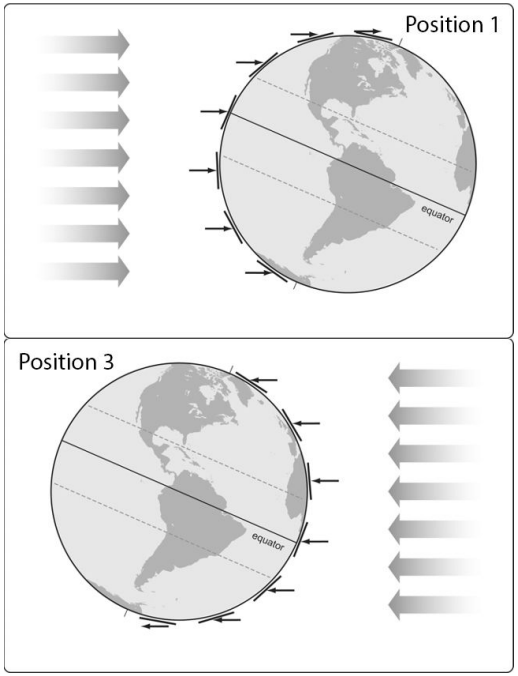
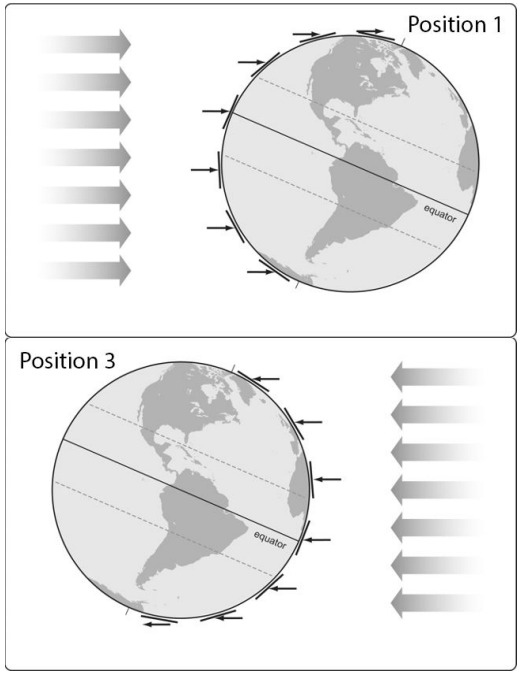
Making Sense

1. Fill in the data table below by following these steps:
    a. Count the number of squares on each image. In the table, write the number of squares that the light covered for each condition. (Decide how you want to count partial squares and be consistent. You could drop them all out, count them all, or estimate them to the nearest fraction.)
    b. Look for the wattage on the flashlight you are using. This number describes how much energy from light comes out of the flashlight every second, in joules. Write this number in the "Energy from the flashlight" column of the data table, in both rows. If you can't find the wattage of the flashlight, assume that the light is transferring about 5 joules of energy every second.
    c. Calculate how much energy from light is concentrated on each square of graph paper. Divide the energy put out by the flashlight every second ("Energy from the flashlight") by the number of squares ("Area") for each condition. Add this number to the last column of the data table.

Energy from light (column 1) ÷ Area (column 2) = Energy per square (column 3)

Condition	Energy from the flashlight (joules)	Area (total number of squares)	Energy from light per square of graph paper (joules/square)
Direct light (Sun higher in sky)			
Light at an angle (Sun lower in sky)			

2. Examine the images in the table below, representing the Earth at positions 1 and 3 in its orbit around the Sun. Lines drawn parallel to the Earth's surface help visualize the angle of the sunlight.
    - For each position, which places on Earth correspond to the tray model when the tray is straight up and down? Circle these locations in column 1 below.
    - For each position, which places on Earth correspond to the tray model when the tray is angled? Circle these locations in column 2 below.

Circle the places that correspond to when the tray is straight up and down (direct sunlight)	Circle the places that correspond to when the tray is angled (light at an angle)
	

3. When the flashlight is shining directly onto the paper (the tray is straight up and down), what can we say about how much energy each graph paper square is getting from light compared to when the flashlight is shining at an angle?

4. How does this model explain why it's warmer in the summer where we live?