

# Elaine Cloward, 6<sup>th</sup> Grade Eastlake

Credit: STEM ideas found on Pintrest

## STEM Science Season's Lesson

Objective: Using the science core for 6<sup>th</sup> grade-seasons, the students will use technology to create a graph showing results after engineering and communicating mathematically how the sun's angles cause the seasons.

### SCIENCE

#### Vocabulary

- Orbit
- Axis
- Stable

#### Questions for KWL

- How does Earth's tilt create seasons?
- What is a significant feature of the Moon?
- Why is the Moon important to life on Earth?
- What are the seasons like in the southern hemisphere, as compared to seasons in the northern hemisphere?
- Why do slanted rays from the Sun feel weaker than direct rays from the Sun?

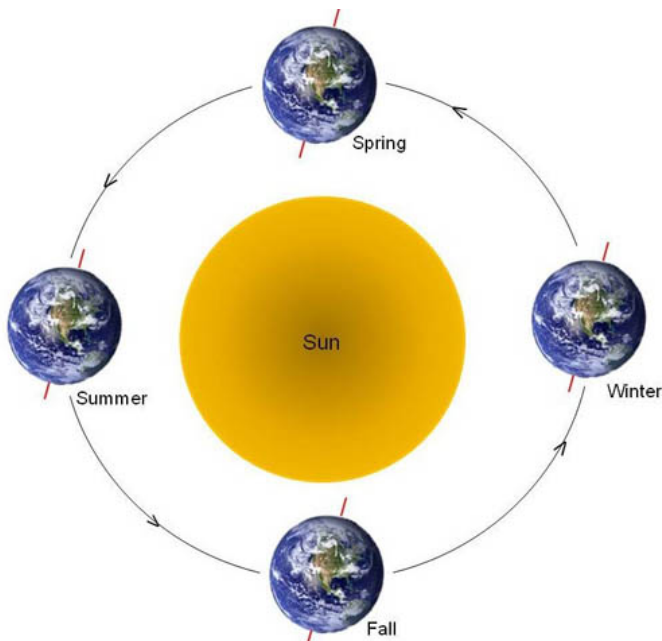
# SCIENCE

## SEASONS Guided Reading

Where most people live on Earth, summers are hot and filled with many hours of strong sunlight, while winters are cold due to shortened hours of daylight and weak sunlight. You might think that the extreme heat of summer and the icy cold of winter have something to do with how close Earth is to the Sun, but actually, Earth's **orbit** is almost *circular* around the Sun, so there is very little difference in the distance from Earth to the Sun throughout the year. So, what are the reasons for the seasons, if it is not the distance from the Sun? One big part of the answer is that Earth is *tilted* on an axis.

What is an **axis**? Picture an imaginary stick going through the north and south poles of Earth. Earth makes a complete *rotation* about this axis every 24 hours. However, this axis is not straight up and down as Earth goes through its orbit about the Sun. Instead, it is tilted approximately  $23 \frac{1}{3}$  degrees. The degree of tilt varies by about 1.5 degrees every 41,000 years. We can thank our relatively big Moon for keeping this degree of tilt so **stable**. Without the influence of our Moon's gravity, the tilt would vary dramatically, like that of a wobbling top, resulting in rapidly changing seasons that would make it difficult for life to exist on Earth. Planetary scientists think that our relatively big Moon, and the axis tilt itself, was created by enormous collisions Earth experienced early in its formation 4.5 billion years ago.

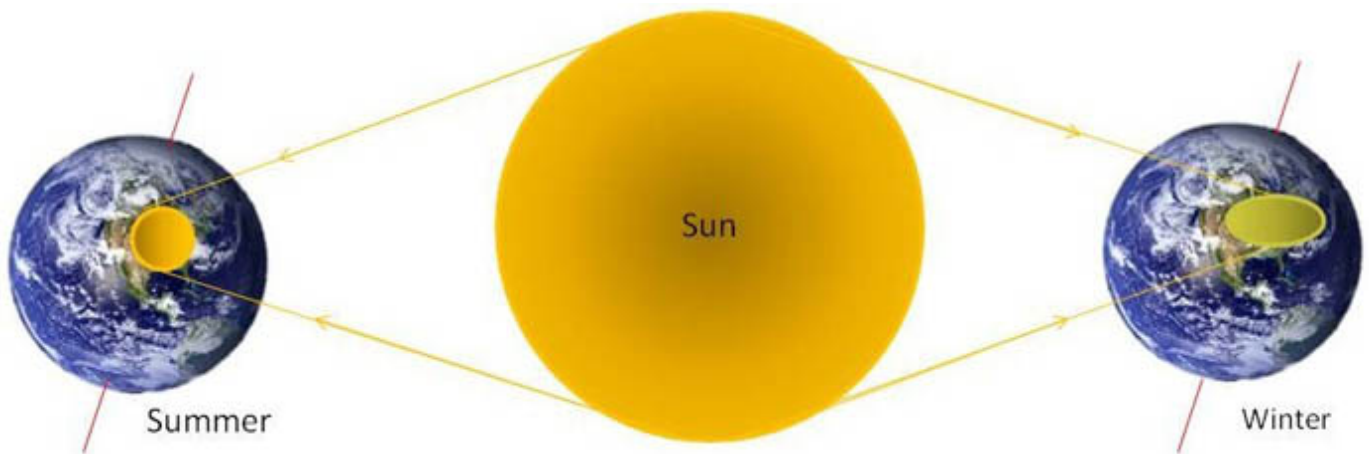
How does the tilt of the axis create seasons? The tilt changes how the sunlight hits Earth at a given location. As shown in Figure 1, Earth's axis (the red line) remains *fixed* in space. It always points in the same direction, as Earth goes through its orbit around the Sun.



**Figure 1.** This drawing shows how Earth's axis remains fixed in space (pointing in the same direction) as Earth goes through its orbit around the Sun.

When it is summer in North America, the top part of the axis (the north pole) points in the direction of the Sun, and the Sun's rays shine *directly* on North America; while in South America, the axis is tipped *away* from the Sun and the Sun's rays hit Earth on a *slant*. So, when it is summer in North America, it is winter in South America. When it is winter in North America, the North Pole is tipped away from the Sun, and the Sun's rays hit the Earth on a slant there; meaning it is summer in South America, because the Sun's rays hit Earth more directly in that hemisphere. As for the intermediate seasons, spring and fall, these are seasons when neither the top, nor the bottom, of Earth's axis are pointed in the direction of the Sun, days and nights are of equal length, and both the top half and the bottom half of Earth get equal amounts of light.

Slanted rays are weaker rays because they cover a larger area and heat the air and surface less than direct rays do, as shown in Figure 2, below. You can see this if you shine a flashlight on a large ball. If you point the flashlight directly at the ball, it makes a bright, circular spot on the ball; however, if you point the flashlight at the edge of the ball, the light makes a duller, more oval-looking spot on the ball. The same thing happens with Earth and the Sun—imagine the ball is Earth and the flashlight is the Sun. In this STEM activity project, you will investigate how tilting a surface affects how light rays hit that surface.



**Figure 2.** This drawing shows the different shapes and brightness produced by rays of sunlight that hit Earth more directly (in summer), and rays that hit Earth at a slant (in winter).

## MATH AND ENGINEERING

### • **Materials and Equipment**

- Sealed-shut cardboard box, stepping stool, brick, or large block of wood
- Flashlight
- Masking tape
- Scotch® tape
- Large, firm book or a cutting board
- Ruler, metric
- Protractor
- Optional: Camera or I-pad
- Helper
- Graph paper (3 sheets). Graph paper with lines spaced 5 mm apart should work well. You can use this website to [print free graph paper](#).
- Different-colored pens or pencils (5)
- Lab notebook

## Experimental Procedure

### Preparing the Light Source

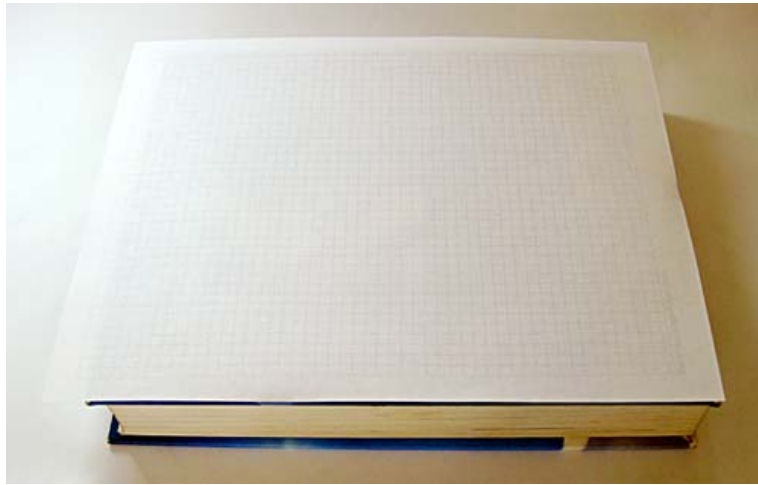
- Place the sealed-shut cardboard box, stepping stool, brick, or block of wood on a table, or on the flat, firm floor.
- Lay the flashlight on its side on top of the cardboard box (or other object) and line up the edge of the flashlight so it is close to the edge of the box. Use masking tape to tape the flashlight down so it cannot roll around. Your setup should now look like the one shown in Figure 3, below.



Figure 3

### Preparing the Surface

- Tape a sheet of graph paper to a firm surface, like a cutting board or a large book, as shown in Figure 4, below, so that the paper will be stiff enough to tilt, and so that you can draw on it. Use Scotch tape on the surface you have chosen.



**Figure 4**

Place the graph paper vertically in front of the flashlight. You may need to hold the surface upright that the paper is taped to (e.g., the book).



**Figure 5**

- Turn on the flashlight. Move the graph paper closer or farther away from the flashlight until the light on the paper forms a medium-sized, sharp circle 5 - 6 centimeters (cm) in diameter, as shown in Figure 6, below. Have a helper help you measure the distance from the edge of the graph paper to the cardboard box and write down this starting distance in your lab notebook. You will keep the graph paper at this starting distance for all testing.

*Note:* Make sure you have at least 5 cm of graph paper lines above the top of the circle of light on the graph paper. You will need this space to collect data. If needed, raise the graph paper (by taping it higher up on a large book or cutting board) and/or lower the flashlight (by taping it to a shorter box, stool, brick, or block of wood) so that there is at least 5 cm of graph paper lines above the top of the light's circle.



**Figure 6**

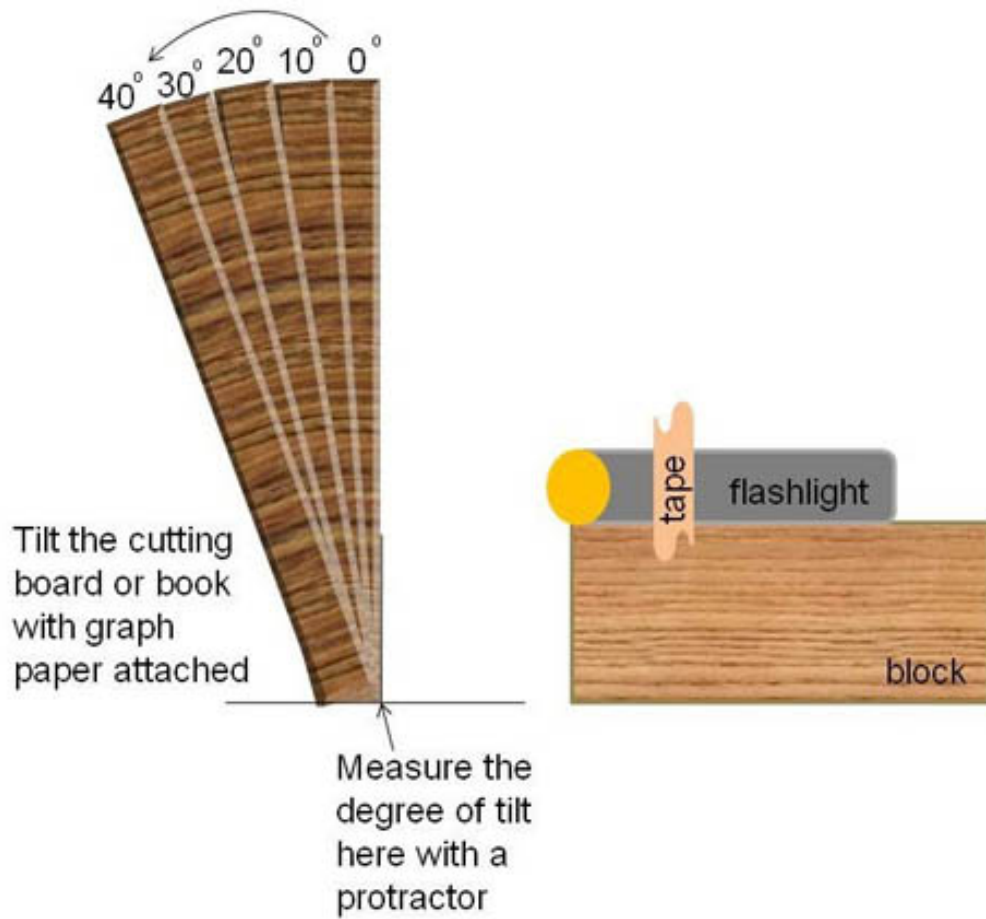
## Testing the Surface

- Have a helper hold the graph paper vertically (straight up and down) at the starting distance in front of the flashlight.
- Use a colored pen or pencil to draw around the outline of the light on the graph paper. Draw a line from the circle and note that the graph paper is at 0 degrees for this outline (no tilt).
- Observe the brightness of the light inside this outline and record your observation in your lab notebook, or (optionally) measure the brightness with a light meter held at a fixed distance from the graph paper.
- Place a protractor at the bottom of the graph paper (i.e., at the bottom of the book or cutting board, where it meets the table or floor). This is shown in



Figure 7, below. Then tilt the graph paper back, away from the flashlight, by 10 degrees (tip the book or cutting board from the 90-degree mark to the 100-degree mark).

TECHNOLOGY-use an Ipad to record or take pictures during the project.



**Figure 7.** This drawing shows how to measure the angle that the graph paper is tilted using a protractor.

(In your setup, you may be using a book instead of a cutting board, or a cardboard box or other object instead of a wood block.)

- Repeat steps 2-3 using a different colored pen or pencil to draw around the outline of the light on the same piece of graph paper. Compare the brightness of the light inside this outline to the light inside of the previous outline. Be sure to record your observations in your lab notebook.
- Repeat steps 4-5 for tilt angles of 20, 30, and 40 degrees. Use a different colored pen or pencil each time so each outline is in a different color.



- Remove the sheet of graph paper and attach a new one.
- Repeat steps 1-7 two more times.

## Analyzing the Graph Paper

- If you used a camera or Ipad instead of drawing around the light outlines, print out your photographs so you can analyze them.
- For each sheet of graph paper, count the approximate number of squares inside each different-colored light outline. For partial squares, estimate how much of the square is lit up; for example, if it looks like one-fourth of the square is lit up, add 0.25; if it looks like half of the square is lit up, add 0.5; if it looks like three-fourths of the square is lit up, add 0.75. Enter your counts in a data table, like Table 1, below.

**Number of Lighted Squares**

Degree of Tilt	Graph Paper 1	Graph Paper 2	Graph Paper 3	Average Number of Squares
0				
10				
20				
30				
40				

**Table 1.** In your lab notebook, make a data table like this one to record your results.

3. Calculate the average number of squares inside each outline for each degree of tilt and enter your calculations in the data table.
  - a. For example, if for the 10 degree tilt you counted 145.5 squares on graph paper 1, 153.25 squares on graph paper 2, and 138.5 on graph paper 3, the average for the 10 degree tilt would be 145.75 squares (since  $145.5 + 153.25 + 138.5 = 437.25$ , and  $437.25 \div 3$  is 145.75).
4. **TECHNOLOGY:** Make a line graph of your results. Plot the degree of tilt on the x-axis (the horizontal axis) and the average number of squares illuminated on the y-axis (the vertical axis). You can make the line graph by hand or use a website like [Create a Graph](#) to make the graph on the computer and print it.
5. Analyze your results. How did the numbers of squares inside the outline change as the degree of tilt increased? How did the brightness change? What degree of tilt produces light similar to what North America

experiences in summer? What degree of tilt produces light similar to what North America experiences in winter?