Name: _____   Date: _____

Student Exploration: Seasons: Why do we have them?

Vocabulary: direct sunlight, Earth's axis, equator, indirect sunlight, northern hemisphere, North Pole, season, solstice, southern hemisphere, South Pole, summer solstice, winter solstice

Prior Knowledge Questions (Do these BEFORE using the Gizmo.)

1. At what time of day is sunlight strongest – in the early morning (when the Sun has just risen)

   or at noon (when the Sun reaches its highest point)? _____

2. At what time of year does the noon Sun rise highest in the sky? _____

3. Based on your answers, why is it warmer in summer than in winter? _____

   _____
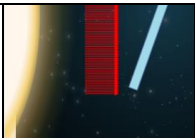
   _____

Gizmo Warm-up

The reasons for **seasons** have a lot to do with the angle at which the Sun's rays hit Earth. To see why, select the PLATE tab on the *Seasons: Why do we have them?* Gizmo™. The image shows a solar panel (**Plate M**) facing the Sun. Check that the ***Axis angle*** is set to 0˚.

1. Click **Fire** to release 100 "rays" of sunlight. Look next to "Number of hits" below the plate.

   How many of these rays hit **Plate M**? _____

2. Click **Reset**. Change the **Axis angle** to 40˚, and click

   Fire. How many rays hit **Plate M** now? _____
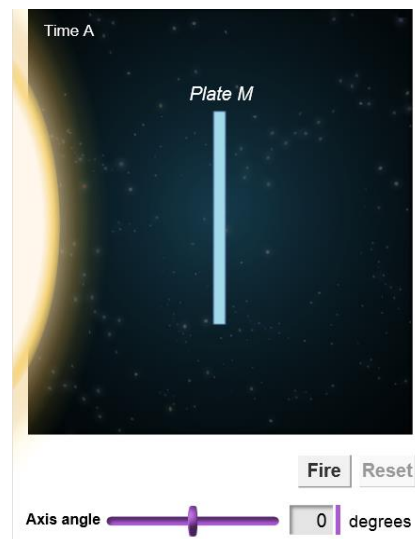
3. Which do you think will warm up the plate more quickly? (Circle one.)

   A. **Direct sunlight** (sunlight that hits the plate at a 90° angle)

   B. **Indirect sunlight** (sunlight that hits the plate at an angle of less than 90°)

Activity A: Sunlight on a plate	Get the Gizmo ready: • Click **Reset**.	

Question: How does the angle of sunlight affect the amount of energy that is absorbed?

1. <u>Form hypothesis</u>: How do you think the angle of the plate will affect how much sunlight hits

   the plate? _____

2. <u>Collect data</u>: Set the **Axis angle** to -80° and click **Fire**. Record the **Number of hits**. Repeat for each angle and fill in the tables below. You can use the slider or type the number into the text field directly and click **Enter** on your keyboard. (Note that "0°" appears in both tables.)

Axis angle	Hits
-80°	
-60°	
-40°	
-20°	
0°	

Axis angle	Hits
0°	
20°	
40°	
60°	
80°	

3. <u>Analyze</u>: What is the relationship between the axis angle and the number of solar rays that

   hit the plate? _____

4. <u>Interpret</u>: Select the GRAPH tab. What does the graph show? _____

   _____

5. <u>Apply</u>: At what angle will the plate get the hottest? _____

6. <u>Extend your thinking</u>: The plate is a model for how sunlight hits Earth's surface.

   A. Which parts of Earth are most similar to the plate with an axis angle of 0°? Explain.

      _____

   B. Which parts of Earth are most similar to the plate with an axis angle of 80°? _____

      _____

| **Activity B:**

Sunlight on Earth | Get the Gizmo ready:

• Select the EARTH tab on the left and the DESCRIPTION tab on the right.
• Check that the **Axis angle** is set to 0 degrees. | |

Question: What causes seasons on Earth?

1. <u>Predict</u>: Look at the image of Earth (not to scale). Plate **A** is located at the **North Pole**, and plate **G** is located at the **South Pole**. Plates **D** and **J** are located at the **equator**.

    A. Of the plates that are facing the Sun (plates A through G), which ones will receive

       the most solar energy? _____

    B. Which of plates A through G will receive the least? _____

2. <u>Check</u>: Click **Fire**. Select the TABLE tab to see how many rays hit each plate.

    A. Which plate got the most sunlight? _____   The least? _____

    B. Why is it colder at the poles than at the equator? _____

       _____

3. <u>Set up Gizmo</u>: Click **Reset**, and turn on **Show axis**. **Earth's axis** is an imaginary line that connects the North Pole to the South Pole. Earth spins around its axis, which is tilted relative to Earth's orbit. Click **Earth axis angle** to set the axis angle to a realistic 23°.

4. <u>Collect data</u>: On the DESCRIPTION pane, check that **Time A** is selected. Click **Fire**. Select the TABLE pane to see the results, and fill in the left table below. Click **Reset**, and on the DESCRIPTION pane select **Time A + 6 months**. Click **Fire** and fill in the right table.

Time A

Plate	Angle	Hits
A		
B		
C		
D		
E		
F		
G		

Time A + 6 months

Plate	Angle	Hits
A		
B		
C		
D		
E		
F		
G		

(Activity B continued on next page)

Activity B (continued from previous page)

5. <u>Analyze</u>: Plates **A**, **B**, and **C** all lie in the **northern hemisphere**, the half of Earth north of the equator. Plates **E**, **F**, and **G** all lie in the **southern hemisphere**, south of the equator.

   A. Which hemisphere gets more direct sunlight at **Time A**? _____

   B. Which hemisphere gets more sunlight at **Time A + 6 months**? _____

6. <u>Interpret</u>: Plate **B** is a typical northern hemisphere location, and plate **F** is a typical southern hemisphere location. Circle the answer to each question below.

   A. On plate **B**, which season is **Time A**?   Start of summer   Start of winter

   B. On **B**, which season is **Time A + 6 months**?   Start of summer   Start of winter

   C. On **F**, which season is **Time A**?   Start of summer   Start of winter

   D. On **F**, which season is **Time A + 6 months**?   Start of summer   Start of winter

   E. In general, how are seasons in the northern hemisphere related to seasons in the

   southern hemisphere? _____

7. <u>Apply</u>: December 21 and June 21 are important dates called **solstices**. The **winter solstice** is the shortest day of the year. The **summer solstice** is the longest day of the year.

   A. Which date does **Time A** represent?   June 21   December 21

   This date is the winter solstice in the northern hemisphere, and the summer solstice in the southern hemisphere.

   B. Which date does **Time A + 6 months** represent?   June 21   December 21

   This date is the summer solstice in the northern hemisphere, and the winter solstice in the southern hemisphere.

8. <u>Summarize</u>: Based on what you have seen, what causes the seasons? _____

   _____

   _____

   _____

   _____

   _____