**The Reasons for the Seasons**

**STEM Activity**

**Principal-Led Professional Day October, 2011**

Introduction:

1. You will be given an article relating to the seasons. The article is folded such that only the title is exposed. Before you unstaple and unfold your paper, as a group read the title. Using consensus, pose a question, based on the title alone. Record your question below:

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1. Unstaple and read your article.
2. Answer your question. Again, as a group use consensus to decide the answer to your question based on the article you read.

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1. Using the marker, write your question and answer on the chart paper provided.

**Driving Questions:**

1. What are the reasons Earth experiences seasons?
2. Does the entire Earth experience the same season at the same time?
3. When is the Earth closest to the sun? Does this play a role in Earth’s seasons?

**Direct and Indirect Rays of the Sun**

***Materials:*** ring stand protractor flashlight calculator 3 pieces of graph paper tape pencil

***Prediction:***

1. Make a prediction about the relationship between angle of sunlight (angle of incidence), direct or indirect sunlight, and seasons.

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***Hypothesis:***

1. Make a hypothesis based on your prediction above regarding the relationship between angle of sunlight (angle of incidence) and direct or indirect sunlight.

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***Procedure:***

1. Construct an apparatus similar to the diagram

 at the right.

1. Shine a flashlight on the sheet of graph paper ![C:\Documents and Settings\AydelJen\Local Settings\Temporary Internet Files\Content.IE5\7G2QYR5Y\MC900340408[1].wmf]()

at an angle of 90º . With a pencil, draw the outline of the area lighted by the flashlight. Count the number of squares in this area. Record this information in the data table.

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Ringstand

Graph Paper

1. On another sheet of graph paper, shine the

flashlight at an angle of 60º. Again, make an

outline of the area the light covers. Record the

number of squares in the lighted area in the data

table.

1. Repeat this procedure a third time, shining the flashlight at an angle of 30º.

 ***Data Table:***

 Angle # of Squares in Light Energy per Season

 Lighted Area Square (units of light energy/km)

 90º

 60º

 30º

***Analysis:***

1. Which angle(s) simulates direct sunlight? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Which angle(s) simulates indirect sunlight? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. If the flashlight emitted 1 x 108 units of light energy and each square on the graph paper represents a km on the Earth’s surface, determine how much light energy each square received for each angle and record in the data table above.
4. Which angle(s) would produce the greatest shadow? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. Predict which season is simulated by each angle and record in the data table above.

***Conclusions:***

1. Explain how this activity relates to the direct and indirect rays of the sun that fall on the Earth’s surface?

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1. Develop a statement that explains the relationship between the angle of the flashlight and the lighted areas.

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1. Was your hypothesis proven? Explain.

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**Earth’s Motion in Space**

Label the following diagram:

SUN

Earth

1. If the rotational axis of the Earth were perpendicular to the ecliptic, would day and night be equally long? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. If the rotational axis of the Earth were perpendicular to the ecliptic, would the Earth experience seasons? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Label the following diagram:

SUN

Earth

i

1. What is the angle of the rotational axis (i), or tilt of the axis, with respect to an imaginary line (dashed line above) perpendicular to the ecliptic?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Rotation vs. Revolution**

***Materials:*** Globe Flashlight sticky note

***Procedure:***

1. Place a sticky note on North America.
2. With North America facing the flashlight, shine the flashlight on the globe.
3. Slowly spin the globe counterclockwise through one complete turn on the axis.
4. Observe the sticky note through one complete turn

***Analysis:***

1. What happened to the light shining on the sticky note during one full spin on the axis? \_\_\_\_\_\_\_\_\_\_\_

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1. What is the lit half of the globe called? \_\_\_\_\_\_\_\_\_\_\_\_\_ dark half? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What do we call the spinning of Earth on its axis? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Why did you spin the globe counterclockwise? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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***Conclusions:***

1. Does rotation play any role in the seasons? \_\_\_\_\_\_\_\_\_\_\_\_\_ Explain. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**“Sun” – Earth Model**

***Materials:*** globe flashlight 4 sets of different colored sticky notes

 marker chart paper computer (if necessary)

 reference page orbital position cards (A, B, C, D)

***Prediction:***

1. Make a prediction about the location of Earth on the ecliptic for spring, summer, autumn, and winter.

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SUN

***Hypothesis:***

1. Make a hypothesis about the location of Earth on the ecliptic for spring, summer, autumn, and winter.

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***Procedure:***

1. Orbit location A (use orbital position card) is toward the “North Star.”
2. Use the globe, flashlight, orbital position cards and colored sticky notes to create a model of the 4 positions of Earth on the ecliptic representing spring, summer, autumn, and winter. (Hints: Hold both the flashlight and globe at waist height and remember to keep the axis always pointed towards the “North Star.” Also, remember that the Earth revolves counterclockwise around the sun.)
3. Use the sticky notes to mark the top and bottom of the brightest band of light (using different colors for each season). Record this latitude range of most direct “sunlight” in the data table below.
4. Be sure to rotate the Earth on its axis during the revolution around the sun.
5. List &/or describe the steps of your design model procedure.

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***Data Table:***

 **Orbit Location Dot Color Latitude Range Season in Northern Hemisphere**

 **(spring, summer, autumn, winter)**

 **A**

 **B**

 **C**

 **D**

***Analysis:***

Answer the following questions based on your model:

1. Which orbit location produced the most direct sunlight for the Northern Hemisphere? \_\_\_\_\_\_ What does this location represent? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Which orbit location produced the least direct sunlight for the Northern Hemisphere? \_\_\_\_\_\_ What does this location represent? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. What is another name for an orbit around the sun? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. How does this model prove that rotation has nothing to do with the seasons? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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***Conclusions:***

1. How does the range of latitudes for the brightest light shift throughout Earth’s orbit? \_\_\_\_\_\_\_\_\_\_\_\_

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1. What can be said about surface heating and the length of daylight for different locations on Earth at different points in its orbit? Discuss and compare how sunlight (or lack of sunlight) might affect equatorial regions, North America, and polar regions.

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1. Was your hypothesis correct? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Draw and label your model of the Earth on the ecliptic for spring, summer, autumn, and winter. Be sure to label it with seasons, equinoxes, and solstices. Also, indicate the tilt of Earth’s axis on your drawing. Note where the North Star is.
3. Transfer this model to chart paper using the marker. Leave enough room for your answer further questions!

**The Reasons for the Seasons Analysis:**

Answer 2 of the following questions based on your lab inquiries. You may use a computer if necessary to answer a few questions. **See slide and group number card for the questions your group is to answer**. After you have answered your assigned questions, write the questions on your chart paper along with your answer. Write your group number at the top of your chart. Post your chart on wall.

1. Because of the inclination angle (i) of Earth’s axis, sometimes the North Pole of the Earth points towards the Sun, and sometimes it points away. How are those times connected to the seasons of the year?

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1. Why does winter in the northern hemisphere correspond to summer in the southern hemisphere, and vice versa?

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1. When it is summer north of the equator, how does the Sun appear from the North Pole? What about locations near the North Pole?

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1. In summer, at or near the North Pole, how does the Sun appear to move?

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1. In winter, at or near the North Pole, how does the Sun appear?

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1. When is Earth closest, in its orbit, to the Sun?

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1. Is the sun always directly overhead at the equator? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Describe the effects on Earth’s seasons if Earth’s axis was not tilted.

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1. Approximately how many hours of daylight does the Equator receive on March 20? \_\_\_\_\_\_\_\_\_\_\_\_\_
2. Approximately how many hours of daylight does the Tropic of Capricorn receive on March 20?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. How does the angle of incidence change with the seasons for Hagerstown, MD? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. Describe what is happening to length of daylight and angle of incidence between June 21 and September 22 for the Northern Hemisphere. How about the Southern Hemisphere for those dates?

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1. What would be the angle of the sun above the horizon at noon on March 20, if you were standing on the Tropic of Cancer? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Several deciduous plants in your garden have just gone through the process of abscission. What season is it? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. What would happen to the seasons if the Earth’s axis was greater than 23.5 degrees? \_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Moderately warm but short summers and long cold winters are typical of which of the following? taiga savannas tropical climates humid subtropics climates
2. What would happen to the seasons if the tilt of Earth’s axis was less than 23.5 degrees? \_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Trees would begin to bud and grass would begin to green up at which of the following locations earliest in the year? **Why?** Chicago, IL Denver, CO Albany, NY

Jackson, MS St. Louis, MO

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1. The greatest seasonal changes occur in which of the following cities? **Why?** Phoenix, AZ

Buffalo, NY Montgomery, AL San Diego, CA Baton Rouge, LA

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1. How might the change in direction of Earth’s tilted axis affect the seasons? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Gallery Walk:***

1. Circulate around room and view your peer’s models and questions/answers.
2. If time permits, write the answers to the questions on your answer sheets, otherwise just read questions/answers.

***The Reason for Seasons Conclusions:***

Describe the three reasons Earth experiences seasons. Cite what you have learned through the activities today. Support your answer with evidence from various locations on Earth. Return to the driving questions to guide you.

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