**Activity:** Sun Angle and Radiant Energy

**Grade Level:** 8th Grade

**Subject:** Direct Versus Indirect Suns Rays, Earth Science

**Summary:**

Students will use an overhead projector and grid transparency to project the grid image onto a globe in order to measure and calculate the difference in area of a grid square between the equatorial regions and the polar regions. Students will then position the globe in relation to the projector to simulate tilt of the earth during summer and winter solstices in the northern hemisphere and record the difference in area of the grid square at these times of the year.

**Time Required:** 30-40 minutes

**Groups Size:** 2-3 students in each group

**What you will investigate:**

In this lab, students will investigate and measure how sunlight is distributed on the earth’s surface in different seasons, illustrating that the seasonal temperature variation has nothing to do with the distance from the earth to the sun, and everything to do with how much direct sunlight a region gets. Students are able to observe how direct sunrays delivers considerably more energy to the earth’s surface than indirect rays.

**Safety Precautions:**

* Do not look directly into bright overhead projector light.
* Take precautions not to get burned on hot overhead projector surfaces.

**Objectives:**

* Model Earth’s position with respect to the sun during summer and winter in the northern hemisphere.
* Calculate the area of the grid square projected onto the globe.
* Compare and associate the area of the grid square with the amount of energy received by the earth’s surface.

**Learning Goals:**

* Students understand that seasons are not caused by the earth’s orbit taking it closer to the sun
* Students understand that seasons are not caused because the earth tilting toward the sun means that one hemisphere is “closer” to the sun than the other
* Students understand that a region that gets more direct sunlight is hotter that a region which gets sunlight at an angle, and this is the reason for the seasons, as well as the reason the equator is hot and the poles are cold

**Materials:** Each station will need the following:

Globe of the Earth (preferably one on which marks can be made and erased)

Dry erase marker, wax pencil or crayon or other nonpermanent marker

Overhead projector

Transparency with grid squares (1 cm or ½ cm size works well)

A darkened room is helpful

**Procedure:**

1. Gather all materials needed and read through procedure steps before you begin to perform this activity.
2. Place the globe about 1-1.5 meters from the projector. NOTE: It will be helpful to place projector on a chair and globe up on a table, as the different height levels will allow for better focus of the grid squares onto the globe.
3. Place grid transparency onto projector and turn on the projector, focusing the grid squares onto the globe.
4. Position the globe so that the northern hemisphere is tilted away from the projector in the Winter Solstice position (Dec. 21st, 2019 at 4:12pm MST).
5. Focus the projector so the grid lines appear clearly on the front of the globe. In this position the smallest grid squares should appear directly over the Tropic of Capricorn (southern hemisphere). This location is the sun’s most direct rays striking the earth’s surface.
6. Using a non-permanent dry erase marker or crayon, trace around the smallest square at the Tropic of Capricorn and another square directly North of the first square over Nebraska. Over Nebraska the light, representing the sun’s rays, are not as direct and are striking the earth’s surface at an angle.
7. Calculate the areas of these two different “squares” and record on the data table under “Nebraska Winter Solstice”
8. Next, position the globe so that the northern hemisphere is tilted toward the projector in the Summer Solstice position (June. 21th, 2019 at 5:54 pm MST).
9. Focus the projector so the grid lines appear clearly on the front of the globe. In this position the smallest grid squares should appear directly over the Tropic of Cancer (northern hemisphere). This location is the sun’s most direct rays striking the earth’s surface.
10. Using a non-permanent dry erase marker or crayon, trace around the smallest square over Nebraska and another square directly South of the first square over the Tropic of Capricorn.
11. Calculate the areas of these two different “squares” and record on the data table under “Nebraska Summer Solstice”.

**Conclude and Apply:**

1. How do the areas of the squares over Nebraska compare between summer and winter solstices?
2. How do the areas of the squares over the tropic of Capricorn between summer and winter solstices?
3. Describe which size of square on the globe represent more direct light and which size of square on the globe represents more indirect light.
4. The source of light represents the sun shining on Earth. If the projector shines onto a flat surface, such as a wall, how would the size of the grid squares compare with one another?
5. After forming a hypothesis, test the hypothesis by shining the projector on a wall at a distance equal to that of the globe from the projector. NOTE. Do not adjust the focus of the projector, merely move it closer to or farther from the wall to get clear lines on the wall.
6. The grid squares of equal size on the transparency represent a certain amount of energy. When the grid transparency shines on a flat surface each square receives an equal amount of radiant energy spread over an equal area. When the grid transparency shines on a curved surface, such as a globe the same amount of energy for each grid square is spread over a different area depending on which part of the globe the square falls. How are the areas of the grid squares related to the seasons summer and winter seasons on Earth?

**Activity Closure**:

Even after this activity some students may find this a difficult concept to grasp. Teachers may need to carefully explain how a fixed amount of energy spread over smaller or larger areas result in different amounts of energy received per unit area.

For example: 10 units of energy spread over 10 m2 means that each 1 m2 receives 1 unit of energy. But if 10 units of energy are spread over 20 m2 as a result of less direct sunlight, then each 1 m2 of land area receives 0.5 units of energy.

**DATA TABLE: Area of grid square on globe**

|  |  |  |
| --- | --- | --- |
|  | Nebraska | Tropic of Capricorn |
| Winter Solstice |  |  |
| Summer Solstice |  |  |

**Conclude and Apply:**

1. How do the areas of the squares over Nebraska compare between summer and winter solstices? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
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3. Describe which size of square on the globe represent more direct light and which size of square on the globe represents indirect light. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. The projector light represents the sun shining on Earth. If the projector shines onto a flat surface, such as a wall, how would the size of the grid squares compare with one another? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
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6. The grid squares of equal size on the transparency represent a certain amount of energy. When the grid transparency shines on a flat surface each square receives an equal amount of radiant energy spread over an equal area. When the grid transparency shines on a curved surface, such as a globe the same amount of energy for each grid square is spread over a different area depending on the part of the globe the square falls. How are direct and indirect sunrays related to summer and winter seasons on Earth? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_