How Does Angle of Sun's Rays Affect Heating of Earth's Surface?

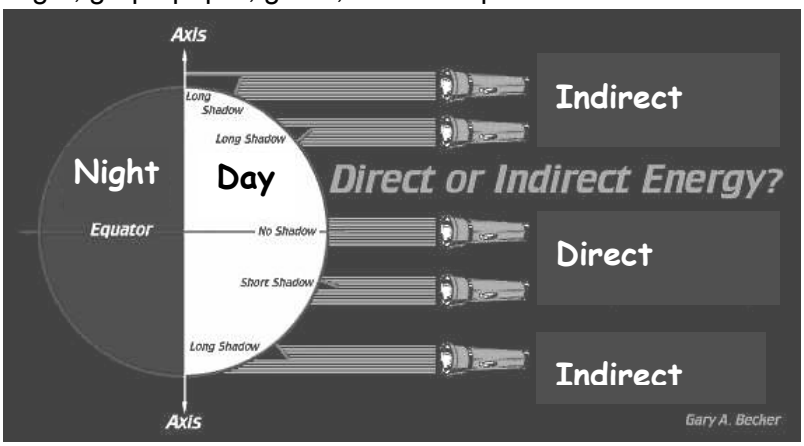
Name _____ Date _____

Problem: What causes Earth to have changing seasons throughout the year?

Hypothesis: _____

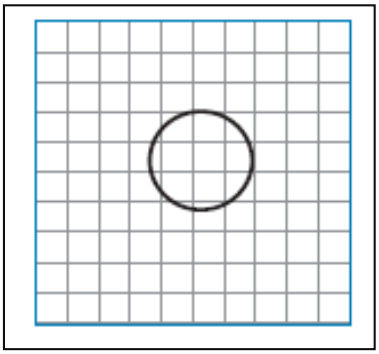
Objective: To understand the difference between direct and indirect rays of sunlight and their impact on surface temperatures across Earth.

Materials: flashlight, graph paper, globe, 2 colored pencils



"ASD planetarium" http://www.astronomy.org/programs/seasons/

1. Place a sheet of graph on the globe.
2. Turn on the flashlight and hold it perpendicular (at a 90° angle) to the equator about 6 inches from the globe.
3. Use a colored pencil to trace the outline of the lighted area on the graph paper. If your flashlight makes several concentric rings of light, choose the brightest one to trace.
4. Move the flashlight so that it is pointed towards the North Pole. (like in the image above)
5. Use a different color to trace the outline of the lighted area on the graph paper.
6. Determine the amount of surface area lighted by the direct compared to the indirect rays counting the squares inside each outlined area. First count the squares that are completed in the area with direct rays. (In the example on the right, there are 3 full squares.) Next count the partially shaded squares and divide that number by two. (In the example, there are 10 partial squares; 10/2 = 5.) Add the two numbers for the total light area. (Example: 3 + 5 = 8) This is the area lighted by direct rays of the Equator. Use the same process to count the entire area shaded by indirect rays of the Poles.



Area lighted by direct rays (Equator): _____

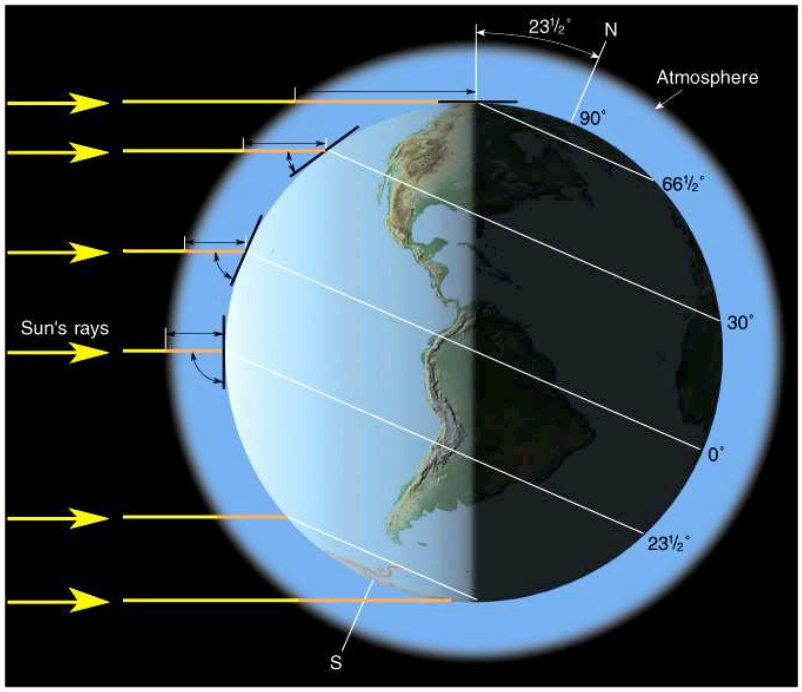
Area lighted by indirect rays (Pole): _____

Questions -- Fill in the blanks. Where a choice appears in parentheses after the blank, choose the answer or answers that best complete the statement.

1. How did the brightness and the area that was lit by the flashlight change as you moved towards the Pole? _____

2. Which rays, direct or indirect, were more concentrated (covered a smaller area) on the graph paper? _____

3. In your own words, explain what it means to say that light is “direct” or “indirect”. _____



Tarbuck and Lutgens, Earth Science fig 14-9, 1988

4. Look at the picture above. The shape of Earth is basically a _____. The sun's rays come across space towards Earth (**parallel** or **perpendicular)** _____to each other direction, but when they strike Earth, they _____ (**do** or **do not**) strike all parts of Earth's surface at the same angle.

5. All of the rays of light that come from the sun have the same amount of energy. However, the angle at which they strike a place determines the **intensity** of the rays at that location. Direct rays are _____ (**more** or **less**) intense than indirect rays. That means that a place that receives more **direct** rays of sunlight will likely be _____ (**warmer** or **cooler**) than a place that receive more indirect rays.

6. In general, what happens to temperatures on Earth as you travel from the Equator towards the Poles? _____
How is this related to the intensity of the sunlight that strikes those locations? _____

7. Boston's latitude is about 42°N. Generally speaking, Massachusetts receives _____ (**direct** or **indirect**) rays from the sun throughout the year.

8. Compare Boston with Miami, Florida (latitude about 25°N, near the southern tip of Florida). Compare the intensity of the light striking Florida with the intensity of the light striking Boston: _____

   _____

   Which location, Boston or Miami, has warmer temperatures during the year? _____
   Explain why this is true, based on your observations regarding direct and indirect rays. _____

   _____

   _____

   _____

9. Because Earth rotates on its axis, the relative position of the sun in our sky changes during the day. This means that the angle of the sun's rays also changes during the day. When are the sun's rays most direct? Circle one: **morning midday late afternoon/evening**
   The hottest time of day is typically: (circle one)
   morning midday late afternoon/evening