MiSP Insolation Worksheet #2 L2

Name _____ Date _____

ANGLE OF INSOLATION

Introduction:

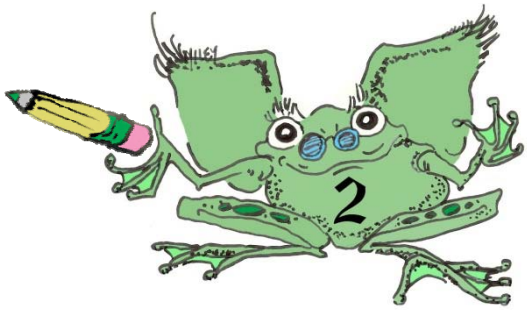
The angle at which the sun's rays strike the Earth varies depending on time of day, latitude, and season. In the morning the rising sun's rays hit the Earth at a slant. At noon they are the most direct (closest to straight up). At the equinoxes in April and September, the sun's rays are 90° (perpendicular) to the Earth at the equator. The angles decrease as you move to both the north and the south. Does the angle at which sunlight meets the Earth matter?

Problem or Question:

Does the angle at which light energy shines on a surface affect the amount of light that is converted to heat and therefore the amount that the temperature increases?

Procedure:

- Your teacher will give specific laboratory instructions. You will shine a heat lamp 20 cm from three thermometer strips attached to three blocks cut at three different angles for fifteen (15) minutes. During that time you will record the temperatures of each thermometer strip. <u>Be sure to get an initial temperature (time 0) before you turn on the light.</u>
- Lab notes:
  - ✓ Wear goggles.
  - ✓ Caution: The lamp will be hot.
  - ✓ The temperature strips must be at the same distance (20 cm) from the heat lamp.
  - ✓ Your teacher will give you a template to use in laying out the materials. Blocks should be placed at the ends of the arrows.
  - ✓ Your setup will look something like the picture on the next page:



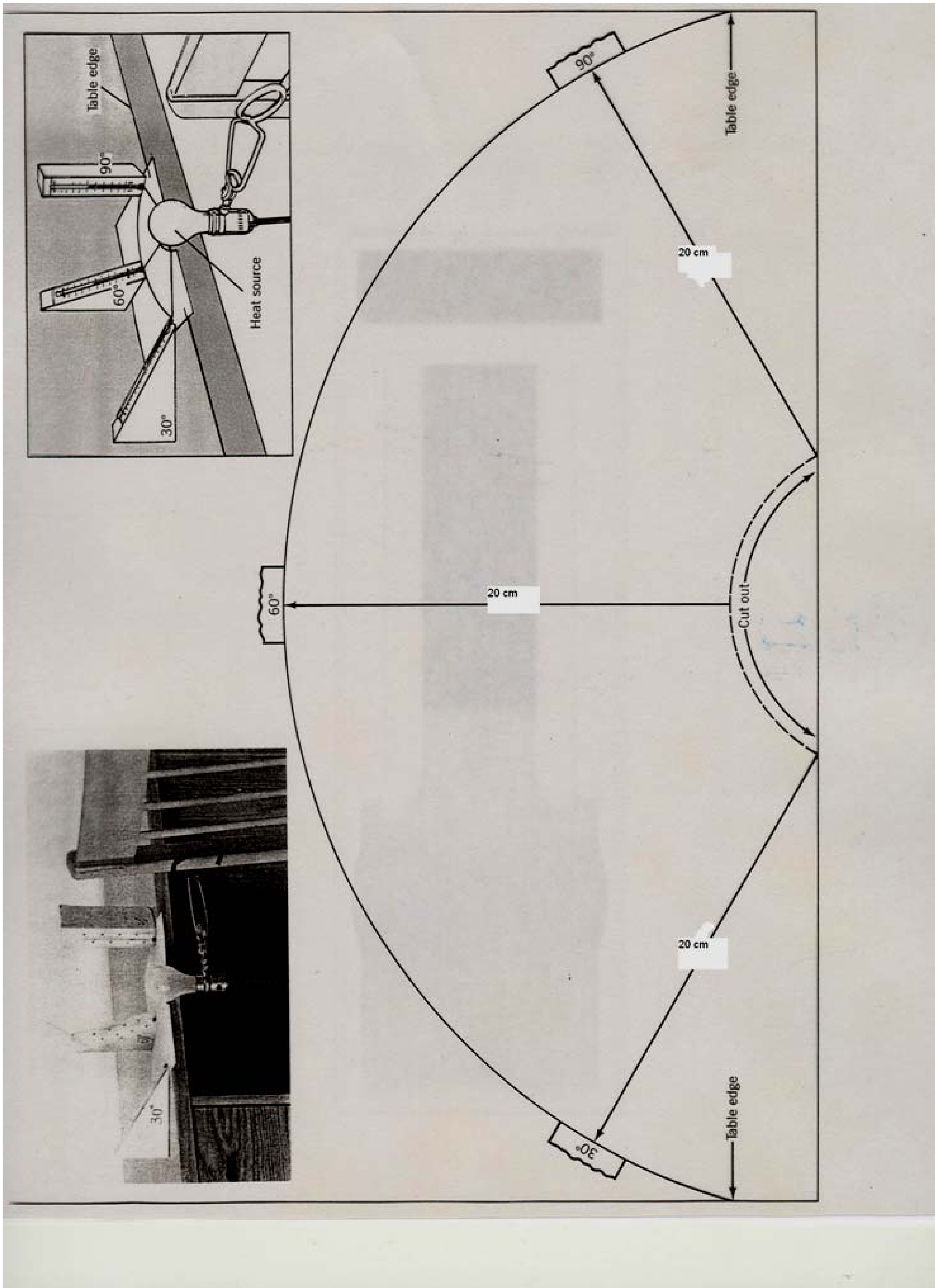
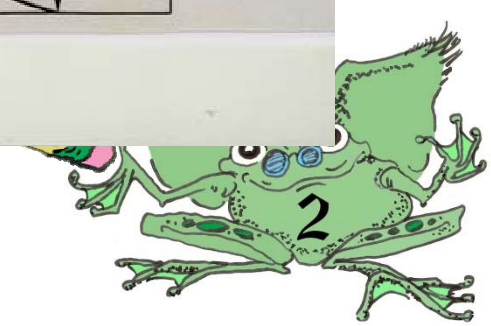
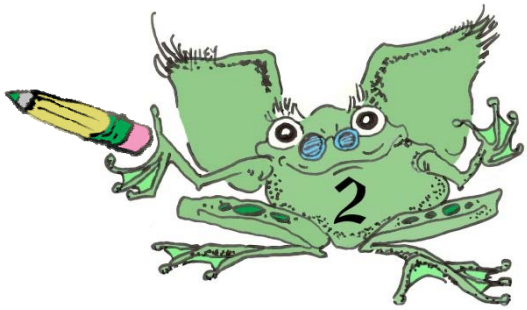


Table edge
90°
Heat source
60°
30°
20 cm
Cut out
Table edge
Table edge


2

Record your data here:

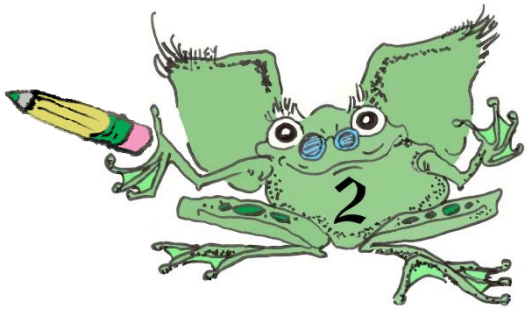
Light on or off	Time (minutes)	Thermometer strip at 30° angle Temperature °C	Thermometer strip at 60° angle Temperature °C	Thermometer strip at 90° angle Temperature °C
Take initial temperature; then turn On	0			
On	1.0			
On	2.0			
On	3.0			
On	4.0			
On	5.0			
On	6.0			
On	7.0			
On	8.0			
On	9.0			
On	10.0			
On	11.0			
On	12.0			
On	13.0			
On	14.0			
On	15.0			



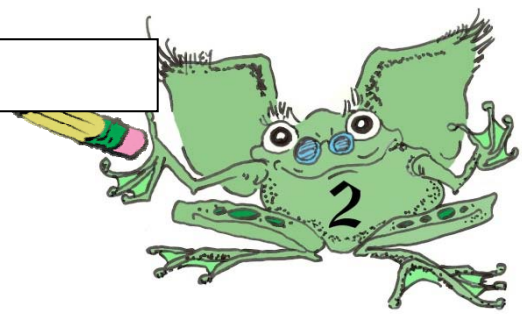
Graph your data:

Graph the data on the next page to show the relationships between time and the temperature changes in each thermometer. Graph each thermometer's data with a different color of pen or pencil. Label each line or write a key.

- Label the *x*-axis.
- Label the *y*-axis.
- Connect the data points by drawing a straight line between them.



Key:
30^{o} =
60^{o} =
90^{o} =



Discussion Questions:

1. Light energy falls on the thermometers and is converted into heat energy in this experiment. The heat causes an increase in temperature. Which thermometer strip (30^o, 60^o, or 90^o) had the greatest increase in temperature? Which had the smallest?

   Greatest increase in temperature: _____

   Smallest increase in temperature: _____

2. Which thermometer strip's (30^o, 60^o, or 90^o) data on the graph has the steepest slope (angle upward)? Which has the least steep slope?

   Greatest slope: _____

   Least steep slope: _____

3. All three thermometers were under the same source of light energy. The thermometers' only difference was the angle that they were positioned at. So, why did the different angles result in different increases in temperature?

   _____

   _____

4. Draw a line on the graph that shows your prediction for the temperature increase for a thermometer positioned at 45^o. Label the line.

5. Using the graph, predict (extrapolate) what the temperature of the 60^o thermometer will be if the light was left shining on it for 20 minutes.

6. During the equinox, all parts of the Earth receive 12 hours of daylight. Using information from this lab, why are the northern and southern latitudes always cooler than the equator on the equinox?

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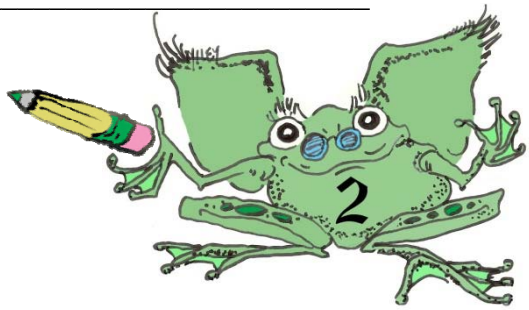
   _____



7. Solar panels convert light energy into heat energy or electrical energy. People who install solar panels are careful to position them correctly. On the basis of this lab, determine how solar panels should be positioned to ensure the maximum amount of heat or electricity.

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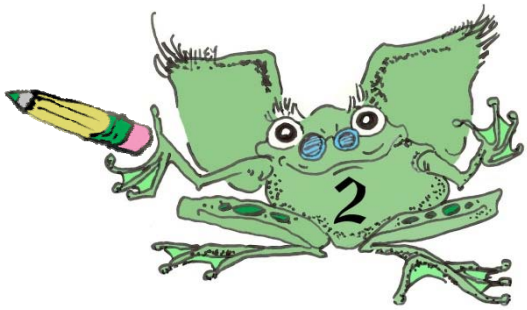
8. Draw best-fit lines on the graph for the 30° and 90° data. Compare the increases in temperature by calculating the unit rates of change (slopes) for each best-fit line. *(When using best-fit lines, the ordered pairs to determine unit rate of change [slope] must be from the best-fit lines, not from your data chart.)*

$$\text{Unit Rate of Change} = \frac{\Delta \text{ Temperature } ^\circ\text{C}}{\Delta \text{ Time (minutes)}} = \frac{\Delta y}{\Delta x} = \frac{(y_2 - y_1)}{(x_2 - x_1)}$$

Graphed data	Ordered Pair used for calculation (x_1, y_1) (x_2, y_2)	Δ Temperature °C Δy	Δ Time (minutes) Δx	**Unit Rate of Change (slope)** $\Delta y / \Delta x$
30°				
90°				



9. Which best-fit line has the greatest unit rate of change (slope): 30º or 90º?

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10. Estimate the unit rate of change (slope) for a best-fit line for the 60º data.

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