MiSP Insolation Worksheet #1 L3

Name ______________________________ Date _____________

INSOLATION: ABSORPTION AND RADIATION BY LAND AND WATER

Introduction:

The word *insolation* comes from the three-word phrase *incoming solar radiation*. Insolation is the electromagnetic radiation or sunlight that comes to Earth. As we all know from entering a car on a bright, sunny day, the sun's light energy can be transformed into heat energy.

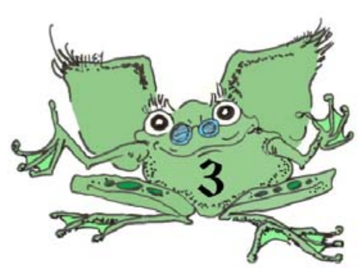
Absorption occurs when matter takes in heat and its temperature increases. Radiation (in this situation) occurs when an object releases its heat to its surroundings.

Problem or Question:

What happens to the temperatures of soil and water when exposed to the same light, and what happens to the temperatures of soil and water when they cool down in the same environment?

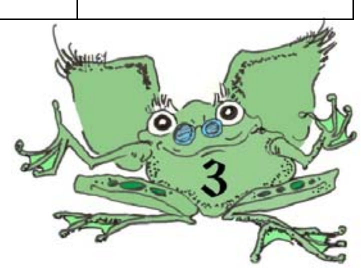
Procedure:

- Your teacher will give specific laboratory instructions. You will be using equal amounts (100 ml) of soil and water in approximately 250 ml containers, and you will shine a heat lamp 10 cm from the samples for ten (10) minutes. During that time you will record the temperatures of each sample at one-minute intervals. After ten minutes, the lamps will be turned off and removed, and you will record the temperatures as the soil and the water cool. Be sure to get an initial temperature (time 0) before you turn on the light.
- Lab notes:
  - ✓ Wear goggles.
  - ✓ Caution: The lamps will be hot.
  - ✓ Calibrate your thermometers by selecting two that have equal readings.
  - ✓ The bulbs of the thermometers should be placed 1 cm below the surface of the soil and the water.



Record your data here:

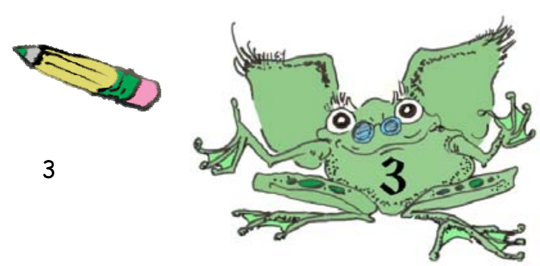
Light on or off	**Time (minutes)**	**Soil** Temperature ^{o}C	**Water** Temperature ^{o}C
Take initial temperature and then turn On	**0**		
On	**1.0**		
On	**2.0**		
On	**3.0**		
On	**4.0**		
On	**5.0**		
On	**6.0**		
On	**7.0**		
On	**8.0**		
On	**9.0**		
On –Take temperature -Then Off –REMOVE THE LAMP!	**10.0**		
Off	**11.0**		
Off	**12.0**		
Off	**13.0**		
Off	**14.0**		
Off	**15.0**		
Off	**16.0**		
Off	**17.0**		
Off	**18.0**		
Off	**19.0**		
Off	**20.0**		

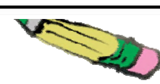


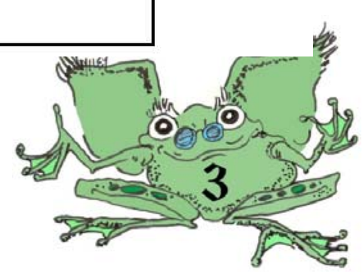
Graph your data:

Graph the data on the next page to show the relationships between time and the temperature changes in the soil and the water. Graph the soil data with one color of pen or pencil, and graph the water data with a different color. Label each line or write a key.

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



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Discussion Questions:

1. Light is a form of energy. Which material (soil or water) received the most energy from the lamp? Be careful; think about the question and the experimental setup. Explain.

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2. Which material (soil or water) heated up more rapidly?

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3. Which material (soil or water) cooled down more rapidly?

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4. How are your answers to #2 and #3 shown on the graph?

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5. On a clear, sunny summer afternoon at the beach, will the air be cooler over the sand or over the water? Explain your answer.

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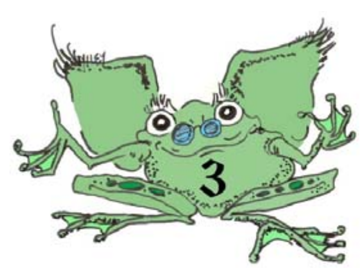
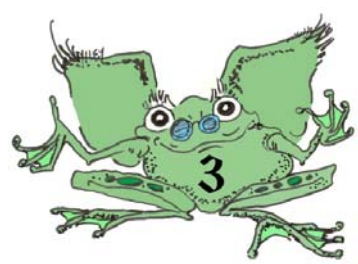


6. One summer day, two places received similar amounts of sunlight (insolation) but had very different air temperatures. One place, which was very far from any body of water, had a high temperature in the afternoon of 95^{o}F and a low temperature in the morning before dawn of 55^{o}F. The other place, which was near the ocean, had an afternoon high of 83^{o}F and an overnight low of 71^{o}F. On the basis of this lab, what is a likely reason for the very different high and low temperatures? Explain your answer.

7. Draw two separate best-fit lines on the graph for the soil and water data from 0 to 10 minutes. 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 rates of change [slopes] must be from the best-fit lines, not from your data chart.)*

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

Graphed data	Ordered Pair used for calculation (x_1, y_1) (x_2, y_2)	Δ Temperature ^{o}C Δy	Δ Time (minutes) Δx	**Unit Rate of Change (slope)** $\Delta y/\Delta x$
Soil				
Water				



8. How do the unit rates of change (slopes) for the best-fit lines of the two sets of data (soil and water) compare? Compare numerical value and sign (positive/+ or negative/-).

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9. Predict the sign (positive/+ or negative/-) of the unit rates of change (slopes) if you drew best-fit lines for 11 to 20 minutes. Which best-fit line from 11 to 20 minutes would have the biggest change in ^{o}C per minute?

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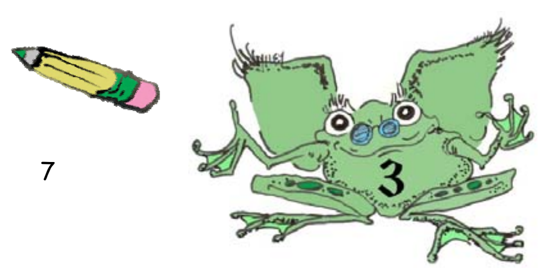
10. Determine the *y*-intercept for each of the two best-fit lines that were drawn on the graph from 0 to 10 minutes. Use the equation for a line to calculate the *y*-intercept. Use the best-fit lines you used in #7. The equation for a line is

$y = mx + b$
where *m* is the unit rate of change (slope) and
b is the *y*-intercept

Y-Intercept — soil 0-10 min. best-fit line	*Y*-Intercept — water 0-10 min. best-fit line
$m =$ Ordered pair $(x, y) =$ (___ , ___) $y = mx + b$ Solve for *b*:	

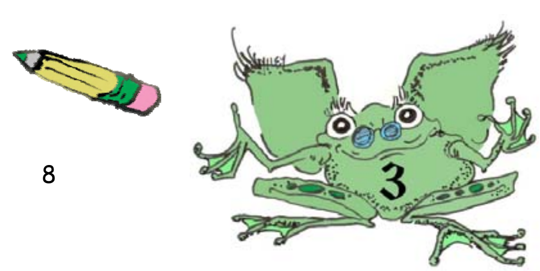


11. Based on the unit rates of change that you calculated above and the y-intercepts, write an equation for each of the 0 to 10 minute best-fit lines. Remember that the equation for a line is $\boldsymbol{y = mx + b}$ and m is the unit rate of change (slope) and b is the y-intercept.

Equation — soil 0-10 min. best-fit line	Equation — water 0-10 min. best-fit line

12. Use the formulas you determined above to calculate the temperature of the soil and the water after 25 minutes IF THE LIGHT WAS NOT TURNED OFF. Show your work.

MATERIALS	Calculated temperature °C
Soil x = 25 minutes	y = ____________________ °C
Water x = 25 minutes	y = ____________________ °C



13. The formula for a line has no limits. You could calculate the temperature of the soil and the water WITH THE LIGHT LEFT ON after 1,000 minutes. You don't have to do the calculation, but do you think that the soil and the water would continue to increase in temperature as long as the light was left shining on their surfaces? Explain your answer.