Solar Insolation and Heat Transfer In The Earth

Geology **Mr. Traeger**

Name: _____ Period: ____ Date: _____

Background

The purpose of this lab is to investigate how heat transfer in the Earth affects temperature ranges in a particular area. The effects of sun angle will also be investigated.

Materials

- 1 beaker filled with sand
- 1 beaker filled with water
- 3 Celsius thermometers
- 1 beaker filled with soil
- heat lamp mounted on a stand
- stop watch

Part 1 Procedure: Heating of Water and Land Surfaces

Be safe! Exercise extreme caution when around electricity and water! The heat lamp is very hot! Do not get your hands near the bulb!

1. Move each beaker ***directly*** under the heat lamp, but *do not* turn on the lamp yet.
2. Place a thermometer in each beaker so the thermometer bulb is *just* below the surface. Tie the thermometer for the water to the ring on the stand. You may need to hold the thermometers in the sand and soil. *None* of the thermometers should be touching the side of the beaker.
3. Record the initial temperature of each substance in degrees Celsius. Put this reading under time = 0 in the table titled ***Heating*** below.
4. Turn on the lamp. Record the temperature of each substance in 1-minute intervals. Use the stopwatch to time these intervals. You will record temperature every minute until 10 minutes have passed.
5. Now turn off the lamp. Take the temperature of each substance in 1-minute intervals until another 10 minutes have passed.
6. Graph the data from the **Heating** and **Cooling** tables on the appropriate grid. Use a **triple-line** graph. You will have one line for each substance. On the horizontal axis, you should have time in minutes. On the vertical axis, you should have temperature in °C. Make sure to give a title to your graph, label both axes, *scale* your graph appropriately, and include a legend for what each line means.

Analysis Questions

1. **Heating**: Which substance heated up the fastest? Which one heated the slowest?
   Fastest? **Slowest?**

2. **Cooling**: Which substance cooled down the fastest? Which one cooled down the slowest?
   Fastest? **Slowest?**

3. **Calculate Energy Required to Heat a Substance:** The specific heat capacity of a material is the amount of heat (in Joules) required to raise the temperature of a one-gram mass by 1°C. The formula is:

   Heat energy (q) = Mass (m) X Specific Heat (c_s) X Change in Temperature (ΔT)

   Or

   $q = mc_s\Delta T$

Calculate the amount of energy (in Joules) that is needed to heat 1 gram of each of the following substances by 10° Celsius:

Sand (SiO_2)
c_s = 0.739 J / °C X g

Water (H_2O)
c_s = 4.18 J / °C X g

4. Which substance requires more energy to heat it to the same temperature? Why?

5. From what you have seen in this lab, why do you think that it is generally cooler near the ocean during the day? Why is it generally warmer the farther you go inland ***during the day***?

6. Would coastal areas be warmer or colder than deserts ***at night***? Why?

7. What would happen to the temperature of the sand if it were black?

8. Why are oceans such good transporters of heat throughout the planet?

9. What would happen to the temperature if the light were left on for a longer amount of time? How would this show the effects of increased day length?

10. What would happen to your temperatures overall if the light was placed at an angle instead of being straight overhead? How would this show the effects of the seasons and/or changes in latitude?

11. How would the presence of clouds affect temperature in the day? How about at night?

Record Temperature in Degrees Celsius and Make a Triple Line Graph

Beaker	Time (minutes) of heating (light on)											Time (minutes) of cooling (light off)									
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Sand																					
Water																					
Soil																					

Error Analysis
Discuss some possible errors with this lab. In what ways is it a good representation of heat transfer in the Earth? In what ways is it not a good representation of heat transfer in the Earth?