Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_ Period \_\_\_\_\_ **Heating of the Earth’s Surface Lab IS1**

**Background Information:**

As solar energy in the form of electromagnetic radiation (EMR) enters the atmosphere and strikes Earth’s surface, the light energy changes to [thermal energy](http://app.discoveryeducation.com/techbook2%3Aconcept/view/guidConceptId/920b4725-a379-4eda-85d6-fe493c90d624/guidUnitId/26f04ce1-d316-44d8-993d-b636877247e8). This warms the air, the ground, and ocean surfaces. The ground and the ocean also radiate most of this energy back to the atmosphere. Gases in the Earth’s atmosphere act like a greenhouse and trap much of this thermal energy. While the earth's temperature is dependent upon this greenhouse-like action of the atmosphere, the amount of heating and cooling is strongly influenced by several factors.

The type of surface that sunlight first encounters is a very important factor. Forests, grasslands, ocean surfaces, ice caps, deserts, and cities all absorb, reflect, and radiate radiation differently. Sunlight falling on a white glacier surface strongly reflects back into space, resulting in minimal heating of the surface and lower atmosphere. Sunlight falling on a dark desert soil is strongly absorbed, on the other hand, and contributes to significant heating of the surface and lower atmosphere. Liquid water, which is what covers most of the Earth’s surface, can absorb a significant amount of heat without a large temperature change. This is the reason we say that water has a high heat capacity. The ***heat capacity*** of a substance is the amount of heat needed to raise the temperature of 1 gram by 1C. Water has a much higher heat capacity than nearly any other substance and therefore can absorb a tremendous amount of heat. The ***albedo*** of a surface is a measure of the amount of light it reflects. It is used to determine how much of the Sun’s energy is reflected back into space. Ice has an incredibly high albedo and dark soil has a very low albedo.

In this investigation you will be observing the temperature changes in water and soil as they absorb and release the sun’s energy. A light will be used to represent the sun and will shine on a container of soil and a container of water. The changes in temperature of the water and soil, as well as the air above each of these, will be measured for a period of heating and cooling.

Works Cited:

Science Techbook. (2013). Discovery Education. Retrieved on Oct 2, 2013, from http://app.discoveryeducation.com/techbook2:course/view/techbook/science

**Problem Statement:** (Refer to EDR)

|  |
| --- |
| State the **Purpose** of this lab. (Include independent and dependent variables) |
| Identify the **Independent Variable**. | Identify the **Dependent Variable**. |
| Identify conditions that will remain **constant** throughout this lab. |
| Rewrite this Problem Statement to include all four boxes above, in complete sentences beginning with: The purpose of the lab is…. |

**Hypothesis:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|

|  |
| --- |
| **State** or predict how the Independent Variable will affect the Dependent Variable(s).  |
| **Explain why** you think the dependent variable will be affected this way. |
| **Write a supporting quote here to support your explanation. Include a reference at the end of the quote. (author, date)** |
| Cite your source, APA style |

 |

**DESIGN**

Materials:

2 containers 2 ring stands with rings 4 thermometers tap water

String ruler lamp soil

Safety:

1. Do not touch the hot surfaces of the lamp.
2. When removing the plug from the wall outlet, be sure to pull the plug itself and not the wire. This will prevent the wires from becoming exposed and causing a shock.

Procedure:

1. Fill a container about 2/3 full of soil.
2. Fill the other container about 2/3 full of water.
3. Tie about a 10 cm length of string to the top of each thermometer.
4. The following instructions are to be carried out for both ring stands. Tape two thermometers to the ring portion of the ring stand shown in the diagram below. The red bulb of the first thermometer is to be 1 cm above the surface of the water or soil. The red bulb of the second thermometer is to be 0.5 cm under the surface of the water or soil. Be certain, when you are taping the strings to the ring portions of the ring stand that the thermometers will be the correct height or depth.
5. Place the two containers side by side.
6. Place the lamp in a position so that both containers are directly beneath the lamp and the lamp can still be plugged in. Do not turn the lamp on, yet.
7. Place the two ring stands in such a position that the thermometers are in their proper positions either above or below the surface of the soil and water.
8. Record the starting temperatures of the thermometers in the proper locations on the data table.
9. Note the time and the position of the second hand on the clock or your watch. (The time is 0 minutes, because the light has not yet been turned on).
10. **Turn the lamp on** and record the temperatures of each of the thermometers every minute for 14 minutes. Begin recording the temperature after one minute has passed.
11. After heating for 14 minutes, turn the lamp off and continue, for 14 more minutes, to record the temperatures each minute as the soil and water cool.

*Control: There is no control for this lab, as results from each experimental setup will be compared to each other.*

Diagram:use the materials list to label the diagram**RESULTS**

**Table 1. Time and Temperature During and After Heating of Soil and Water**

|  |  |  |
| --- | --- | --- |
| **Time (min.)** | **SOIL Temperature (OC)** | **WATER Temperature (OC)** |
| **Above Surface**  | **Below Surface** | **Above Surface**  | **Below Surface** |
| **0** |  |  |  |  |
| **Lamp Is Turned On** |
| **1** |  |  |  |  |
| **2** |  |  |  |  |
| **3** |  |  |  |  |
| **4** |  |  |  |  |
| **5** |  |  |  |  |
| **6** |  |  |  |  |
| **7** |  |  |  |  |
| **8** |  |  |  |  |
| **9** |  |  |  |  |
| **10** |  |  |  |  |
| **11** |  |  |  |  |
| **12** |  |  |  |  |
| **13** |  |  |  |  |
| **14** |  |  |  |  |
| **Lamp Is Turned Off And Temperature Is Still Recorded** |
| **15** |  |  |  |  |
| **16** |  |  |  |  |
| **17** |  |  |  |  |
| **18** |  |  |  |  |
| **19** |  |  |  |  |
| **20** |  |  |  |  |
| **21** |  |  |  |  |
| **22** |  |  |  |  |
| **23** |  |  |  |  |
| **24** |  |  |  |  |
| **25** |  |  |  |  |
| **26** |  |  |  |  |
| **27** |  |  |  |  |
| **28** |  |  |  |  |

**Data Processing and Presentation**

GRAPHING: Use graph paper to graph temperature changes for 28 minutes. Place all four sets of data on one graph (there will be four lines, one for each thermometer.) Use the table below to make sure you complete all of the requirements.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|

|  |  |
| --- | --- |
| **Graphing Requirements** | **Write YES for each** |
| Does your graph have a title? |  |
| Does the title indicate how the independent variable affects the dependent variable? (e.g., *The Effect of Magnesium Chloride on a Freshwater Ecosystem*) |  |
| Is time on the *X* axis? |  |
| Is the dependent variable on the *Y* axis? |  |
| Does each axis have a label? (e.g., *Temperature*) |  |
| Does each label have a unit? (e.g., 0C) |  |
| Does each axis have an appropriate scale?  |  |
| Does the graphed data utilize approximately 2/3 of the available space? |  |
| Are data points visible? |  |
| Is the trend line accurately plotted? |  |

 |

CALCULATIONS:(*Note: Your teacher will tell you whether or not you will be sharing class data for this lab.)* Use the following formula to calculate percent change for the temperature of each item below. Show ALL of your work and include units on all of your answers.

Percent change (%) = (final temperature–initial temperature) x 100%

 initial temperature

**SOIL**

air ABOVE the soil IN the soil

**before** the lamp was turned off **before** the lamp was turned off

**after** the lamp was turned off **after** the lamp was turned off

**WATER**

air ABOVE the water IN the water

**before** the lamp was turned off **before** the lamp was turned off

**after** the lamp was turned off **after** the lamp was turned off

CONCLUSION:

1. In the space below, restate the prediction in your hypothesis and then use your data from the analysis section to explain whether your hypothesis was supported or rejected.
2. Did the soil or the water absorb a greater amount of light energy from the lamp, or did they both absorb the same amount of light energy? Explain your answer. (Include heat capacity and numbers from your data in your explanation.)
3. Based on the results of this lab, how would the temperature throughout the year on land near a large body of water compare to land far away from water? Use data from the calculations section to support your reasoning.

EVALUATION:Identify one logical source of error for faulty data in this lab.

IMPROVEMENT: How could you modify/improve the experiment so that the data could be more valid?