**Clark Kent**

**Period 1**

**Heating the Earth**

***Focus Question:***

Do sand, soil, water, and air heat up at the same rate?

***Independent Variable:***

Type of earth material (sand, soil, water, and air)

***Dependent Variable:***

Temperature change of each material

***Hypothesis:***

If sand, soil, water, and air are heated equally, then water will heat up and cool off the slowest because water has a higher capacity for storing heat.

***Data:***

***Claim:***

Water heats up and cools down slower than sand, soil, or air.

***Evidence:***

The data shows that within the first 15 minutes, air heated up the quickest, followed by soil. Water was the most gradual and slow change at only 7 degrees after 15 minutes. Air, on the other hand, heated the most at 17 degrees hotter. After the heat lamp was turned off, water retained its energy the most, and only changed by 4 degrees.

***Reasoning:***

Since the data shows that water changed the least in a 30-minute period, it is clear that water would require more energy to heat up as fast as the other elements. According to the FOSS Science textbook, “Water has a higher capacity for storing heat than does land surfaces.” Therefore, if these earth materials are heated equally, then water will heat up the slowest because it takes more energy to move water molecules.

What this investigation shows on a larger scale is that differential heating explains why the sand at the beach is hotter than the water it touches. Additionally, this difference in heat affects the pressures over land and water, which explains why sea breezes occur during the day and why land breezes occur in the evening. Hot air over the sand rises and creates low-pressure. When the cooler air over the water is sinking, this creates a high-pressure area. High-pressure molecules are stronger than low pressure ones, so air over the sea pushes toward the land. If land and water heated up the same, global winds would not exist.

***Materials****:*

* 100 ml of each (sand, soil, water, and air)
* Thermometer
* Heat lamp
* 4 Plastic 250 ml containers with lid
* Timer

***Procedure:***

* 1. Fill each container with an earth material.
	2. Place thermometer through slit in lid.
	3. Clamp lamp on table leg or table.
	4. Put containers directly underneath lamp.
	5. Record starting temperature of each material.
	6. Turn on lamp.
	7. Record temperature every 3 minutes for 15 minutes.
	8. Turn off lamp.
	9. Repeat #7.

***Research:***

*1. What does differential heating cause?*

“Differential heating also creates mountain and valley breezes. On warm, sunny days, the floor and slopes of a valley are heated. The heated air rises up the sides of the valley, creating a valley breeze. At night, the air in close proximity to the sides of the valley cools. The cooler air drains down slope in the valley, creating a mountain breeze.”

Differential Heating

<http://www.energyeducation.tx.gov/renewables/section_4/topics/differential_heating/c/index.html>

*2. Why does water heat up differently than land?*

“Much of the solar radiation that reaches the ocean is reflected back to the atmosphere. Whatever is not reflected can penetrate into the water since it is somewhat transparent, thereby distributing any heating of the water to a certain depth, and therefore mass, of water.”

Land versus Water Heating and Cooling

<http://www.newton.dep.anl.gov/askasci/env99/env99395.htm>

“Water has a higher capacity for storing heat than do land surfaces.”

Differential Heating

FOSS Science Textbook

*3. What is heat?*

“Heat is a condition of matter. Heat is energy, specifically, kinetic energy.”

Heat and Radiation

FOSS Curriculum Guide

*4. How does heat transfer?*

“Heat transfer takes place in two fundamental ways: radiation and conduction.”

Heat and Radiation

FOSS Curriculum Guide

*5. What happens when molecules are heated?*

“When radiant energy strikes an atom or molecule, like a water molecule or a molecules in sand, soil, or air, the molecule gains energy and beings to move faster or vibrate more.”

Differential Heating

FOSS Curriculum Guide

“The tiny particles that make up all solids, liquids, and gases are constantly in motion, but when they are heated up (that is, when heat energy is added to them) they move faster and faster and bump into each other more and more often, and with greater force. As a result of these collisions, the molecules in a heated substance spread farther apart and the substance expands and becomes less and less dense. In this experiment, you will observe the effects of heating water. “

What Happens When Water is Heated?

<http://www.fofweb.com/onfiles/SEOF/Chemistry_Experiments/1-06.pdf>