HEATING AND COOLING OF LAND AND WATER

Westminster College

STANDARDS

- 3.1.7A
- 3.2.7B, 3.2.7C
- 3.5.7C, 3.5.7D
- 3.7.7A, 3.7.7B

INTRODUCTION

How fast land and water heat and cool influences our weather. In Part I of this experiment, you will heat sand and water. You will use two Temperature Probes to see which heats faster. In Part II, you will allow hot sand and hot water to cool. This time you will use two Temperature Probes to see which cools faster. You will then apply your results.

GUIDING QUESTIONS

- Does sand or water heat faster?
- Does sand or water cool faster?
- How does the heating and cooling of land and water influence weather?

SAFETY

The 100W light bulb will become quite hot during Part I of the experiment. Be careful to not to touch it.

MATERIALS

LabQuest
LabQuest App
2 Temperature Probes
2 rectangular pans
sand
water (room temperature)
metric ruler
lamp with a 100 W (or greater) bulb
test-tube rack
2 test tubes
Parafilm
beaker
hot water
ring stand and clamp

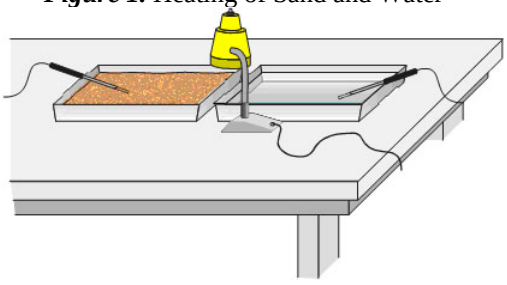
PROCEDURE

Part I Heating of Sand and Water

1. Fill one pan with sand ~1.0 cm deep. Fill another pan with water ~1.0 cm deep.

2. Lean Temperature Probe 1 in the pan with sand as shown in *Figure 1*. Lean Temperature Probe 2 in the pan with water. The probe tips should be at the centers of the pans. There is a square indentation in the middle of the pans to help center the sensors.

Figure 1. Heating of Sand and Water



3. Place a clamp low on the ring stand; this will keep the light source from slipping during the 10 minute experiment. Position the light source by attaching the light clamp to the ring stand. The light should be directly over the boundary between the two pans and about 10 cm above the pans as shown in *Figure 1*. The bulb should be the same distance from both probe tips.

4. Connect the Temperature sensors to the LabQuest and choose New from the File menu. Place Temperature Sensor #1 in the sand and Temperature Sensor #2 in the water. If you have older sensors that do not auto-ID, manually set up the sensors.

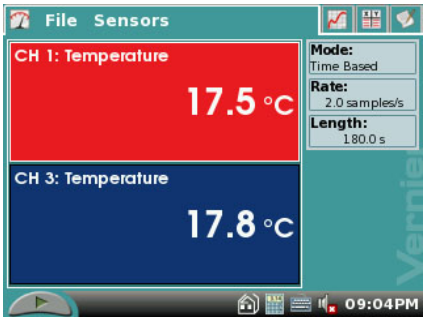
a. To manually identify the sensor, stay in the Meter mode and select Sensors → Sensor Setup…..

b. A sensor set-up screen will appear showing all the available probe ports (*Screen a, below*). Select the channel that the sensor is plugged into (ex. CH1 for channel 1), and tap the arrow to the side of the channel box.

c. A list of compatible probes will appear in alphabetical order. Scroll down the list and select "Temperature" and "Stainless Steel". Do the same for the second temperature sensor. Select OK to return to the Meter mode screen.

d. Two boxes (red and blue) will now be in this window displaying the channels the Temperature sensors are plugged into (*Fig. 2*). Both boxes will be displaying temperature in °C. Ideally, the thermometers will read within ± 0.3°C of each other.

Figure 2. LabQuest Meter Screen



5. While still in Meter mode, tap the gray Length box to the right of the screen. Change the data-collection length to 10 minutes and the data-collection rate to 20 samples/minute.

6. Tap the Start icon to begin data collection, then switch on the light bulb. Data collection will end automatically after 10 minutes. **Note:** Do Steps 9 and 10 of Part II while waiting for your Part I data to be collected.

7. Record your beginning and final temperatures.

a. When data collection is complete, a graph of temperature *vs*. time will be displayed. To examine the data pairs on the displayed graph, tap any data point. As you tap each data point, the temperature values of both Sensor 1 and Sensor 2 are displayed to the right of the graph.

b. Identify the beginning and final temperatures for both Sensor 1 and Sensor 2. Record these values to the nearest 0.1°C in your data table.

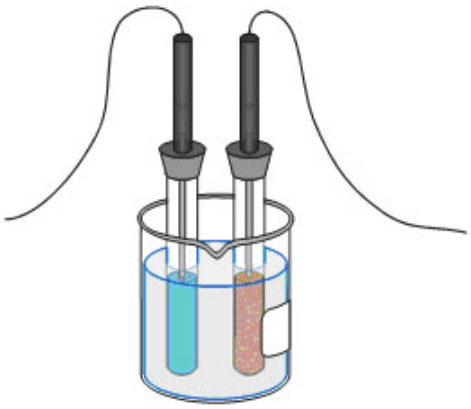
8. Store the data from the first run by tapping the File Cabinet icon to the right of the screen.

Part II Cooling of Sand and Water

9. Fill one test tube 2/3 full with sand. Fill another test tube 2/3 full with water.

10. Place both test tubes in a beaker of hot water for at least 10 minutes.

Figure 3. Cooling of Sand and Water



11. Carefully place a Temperature Sensor #1 into the test tube with sand, as shown in *Figure 3*. Tilt the test tube to loosen the sand and prevent damage to the probe. The bottom of the black sensor barrel should be about level with the top of the test tube for the best temperature readings. Secure the sensor in place with a couple of pieces of Parafilm. Suspend Sensor 2 at the same depth in the water, also using Parafilm to secure the sensor.

12. Tap the Meter tab to go to the Meter screen. Note the temperature readings displayed on the screen. When the temperatures stop rising and are nearly the same, tap the Start icon to begin data collection. Remove the test tubes from the hot water and stand them in a test-tube rack to cool.

13. When data collection is complete after 10 minutes, use the procedure in Step 7 to record the beginning and final temperatures for Sensor 1 and Sensor 2.

REFERENCES

Donald L Volz and Sandy Sapatka. Middle School Science with Vernier. (2007) Lab 2: Heating of Land and Water. Vernier Software & Technology; 13979 S.W. Millikan Way, Beaverton, OR pp. 2-1 to 2-4; 2-1T to 2-2T.

CREDITS

Special thanks go to Kim Schmidtke of Portersville Christian School, Portersville, PA, for testing, editing and reviewing this protocol. This lab was revised and adapted from the above reference by Dr. Stephanie Corrette-Bennett.

DATA SHEET

Name: _____
Group: _____
Date: _____

Table 1. Heating of Land and Water		
	Sensor # 1 – Sand	*Sensor # 2* - Water
Final Temperature	°C	°C
Beginning Temperature	°C	°C
Temperature Change	°C	°C

Table 2. Cooling of Land and Water		
	Sensor # 1 – Sand	*Sensor # 2* - Water
Final Temperature	°C	°C
Beginning Temperature	°C	°C
Temperature Change	°C	°C

DATA ANALYSIS AND QUESTIONS

1. In the space provided in the data table, subtract to find the temperature changes.

2. Discuss how the sand and water temperatures changed in Part I.

3. Discuss how the sand and water temperatures changed in Part II.

4. San Diego, California, is located on the Pacific Ocean while Barstow, California, is located in the Mojave Desert. Use the results of Part I to predict which city is warmer on summer afternoons. Explain.

5. Which city, San Diego or Barstow, cools more during summer nights? Explain.