EXPLORATIONS

Activity 12

Wet Sand/Dry Sand

Objectives

- To determine the cooling rates of wet sand and dry sand
- To describe the effect of evaporation on cooling rates

Materials

- TI-73
- Unit-to-unit cable
- CBL 2™
- Two temperature sensors
- Two small aluminum trays
- 1000 ml sand
- Water
- Heat lamp
- Data Collection and Analysis pages (p. 108 - 110)

In this activity you will

- Compare the heating rates of wet sand and dry sand using the CBL 2™ with temperature sensors.
- Use the results of the experiment to help you understand more about the effects of evaporation.

Problem

Does wet sand or dry sand heat faster in the sun?

Introduction

It is a hot summer day, and you and your family are spending an afternoon at the beach. You step barefoot on the sand to walk to the water and feel the hot grains burning the soles of your feet. You run hurriedly toward the water. When you step onto the wet sand you are pleasantly surprised by the coolness.

Evaporation occurs when water changes from a liquid to a gas (water vapor). The change of matter from a liquid to a gas requires an input of energy. Frequently this energy is in the form of heat energy. As heat energy necessary for evaporation is transferred to the water molecules, the matter from which the heat energy is derived is cooled.

Many animals take advantage of the cooling through evaporation to lower their body temperatures. The evaporation of water from skin results in lowering the body temperature. Dogs pant to evaporate water from their tongues thereby lowering their body temperature.

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Hypothesis

Before testing, complete the **Hypothesis** and **Experimental Design** sections on the **Data Collection and Analysis** page.

Procedure: Collecting the Data

1. Collect one tray of dry sand and one tray of wet sand.
2. Plug the two temperature sensors into Channel 1 (**CH 1**) and Channel 2 (**CH 2**) on the CBL 2™.
3. Start the DATAMATE program.
4. The Main Screen is displayed. If **CH 1:TEMP(C)** and **CH 2:TEMP(C)** are displayed at the top of the screen, go to step 9. If **CH 1:TEMP(C)** and **CH 2:TEMP(C)** are not displayed, go to step 5.
5. Select **1:SETUP**.
6. Select **CH 1** or **CH 2**, as necessary. Select **1:TEMPERATURE**.
7. If you are using the TI stainless steel temperature sensor, select **4:STAINLESS TEMP(C)**. If you are using a different temperature sensor, select the appropriate item from the menu.
8. Repeat steps 6 and 7 until both channels are correct. Select **1:OK** to return to the Main Screen.
9. Select **1:SETUP**. Select **MODE**, and then select **2:TIME GRAPH**.
10. The **TIME GRAPH SETTINGS** are displayed. If the screen shows **TIME INTERVAL: 30**, **NUMBER OF SAMPLES: 11**, and **EXPERIMENT LENGTH: 330**, go to step 12. If the settings are not correct, got to step 11.
11. Select **2:CHANGE TIME SETTINGS**. For **ENTER TIME BETWEEN SAMPLES IN SECONDS**, enter **30**. For **ENTER NUMBER OF SAMPLES**, enter **11**. The **TIME GRAPH SETTINGS** screen reappears showing the new settings.
12. Select **1:OK** twice to return to the Main Screen.
13. Bury the end of a temperature sensor 0.5 cm below the surface of the sand in each tray. Note which sensor is in which tray on the **Data Collection and Analysis** page.
14. Place the heat lamp 20 cm above the two trays of sand.
15. When you are ready to begin, select **2:START**. The CBL 2 beeps twice, displays a graph, and begins collecting the data. At the end of each 30-second interval, the data point for each sensor is plotted on the graph.
16. After 11 data samples from each sensor have been collected and plotted, the line graphs are displayed. Use ▶ and ◀ to move to the points along the first line. Record the values in the table on the **Data Collection and Analysis** page. Use ▲ and ▼ to move to the second line, trace it, and record the values. Sketch the graph on the **Data Collection and Analysis** page.

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17. To exit from the DATAMATE program, press ENTER to return to the Main Screen. Select **6:QUIT** and press ENTER.

18. To display the lists showing the results, press LIST. The dissolving times are stored in **L1**. The temperatures are stored in **L2** and **L3**.

Data Analysis

Using the graph that is displayed after the 11 samples are collected, complete the questions on the **Data Collection and Analysis** page.

Extension

Try the same experimental procedure with a different type of soil. Are the results the same?

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Data Collection and Analysis

Name _____

Date _____

Activity 12: Wet Sand/Dry Sand

Problem

Does wet sand or dry sand heat faster in the sun?

Hypothesis

_____ sand heats faster in the sun than _____ sand.

Experimental Design

1. Independent Variable: _____
2. Treatments: _____
3. Dependent Variable: _____
4. Number of Trials: _____
5. Constants: _____

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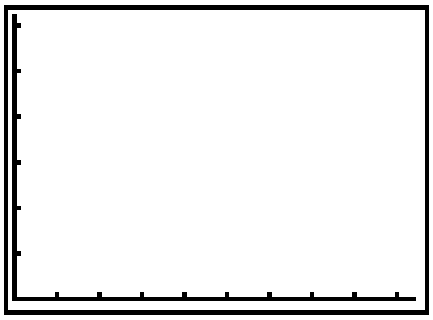
Data Collection

1. The temperature sensor plugged into **CH 1** is in the _____ sand, and the sensor plugged into **CH 2** is in the _____ sand.
2. Using the graph displayed after the 11 samples have been collected, record the temperatures in the table below.

Time (seconds)	Temperature of Dry Sand (°C)	Temperature of Wet Sand (°C)
0		
30		
60		
90		
120		
150		
180		
210		
240		
270		
300		
330		

3. Draw and label the graph of your data below, or print it on the computer and attach it to this page.



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Data Analysis

1. What do the slopes of the lines on the graph represent? What do the differences in the two slopes indicate about the heating rates of the wet and dry sand?

   _____

   _____

   _____

2. What does the *y*-intercept represent?

   _____

   _____

   _____

3. Use [TRACE] to compare the temperatures of the wet and dry sand at the same time intervals. How does water affect the heating of the sand?

   _____

   _____

   _____

4. Compare the change in temperature for the dry sand and wet sand.

   Dry sand: starting temperature (_____°C) – ending temperature (_____°C).

   Wet sand: starting temperature (_____°C) – ending temperature (_____°C).

5. How might the dampness of the soil in a specific habitat affect the temperatures of that area?

   _____

   _____

   _____

Conclusion

_____ sand heats faster in the sun than _____ sand.

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Teacher Notes

Activity 12

Wet Sand/Dry Sand

Objectives

- To determine the cooling rates of wet sand and dry sand
- To describe the effect of evaporation on cooling rates.

NSES Standards

- Science as Inquiry: Abilities necessary to do scientific inquiry
- Science as Inquiry: Understanding about scientific inquiry
- Science and Technology: Understanding about science and technology
- History and Nature of Science: Nature of science
- Physical Science: Properties and changes of properties in matter
- Physical Science: Transfer of energy
- Earth and Space Science: Structure of the earth system

Preparation

- Place 500 ml of dry sand into each of the two aluminum trays.
- Add enough water to one pan to thoroughly dampen the sand. Use room temperature water to keep the initial temperatures of the sand in the two containers the same.
- It is important that the starting temperatures of the wet and dry sand be as close as possible.
- Heat lamps with clamps designed for labs are optimal; however, student desk lamps with flexible necks and 60-/100-watt bulbs work fine. Keep the distance from the heat source constant for all trials.
- If students only have one temperature sensor, the trials can each be run separately. Data should be saved in a program after each trial so that the results can be recalled later.

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Management

- Assign these student jobs for this lab:
  - Materials/setup person (sets up samples, probe)
  - Tech person (operates CBL 2™ and TI-73)
  - Data recorder (reads off pH readings from the TI-73 at each collection interval)
  - Runner (brings CBL 2 and TI-73 to the computer to print graphs with TI-GRAPH LINK™ or TI™ Connect and brings **Data Collection and Analysis** pages to the teacher)
- Clear covered plastic shoeboxes will hold a CBL 2, pH probe, cups, rinsing bottle, and other equipment neatly at each station. If students are sharing one pH probe, representatives from each lab group should bring test beverages in the cups to the probe. Mounting the probe on a ring stand is an option.
- Students can record temperature readings in their lab journals as they are displayed on the TI-73. This keeps them engaged throughout the data collection period and if they lose the data/graph later, they can still write up their lab reports. Students can also access the data in the TI-73 lists after data collection. You can send the lists to all students' calculators using [APPS] **1:Link**:

  a. Press [APPS].

  b. Press [ENTER] to select **1:Link**.

  c. Select **4:List** and press [ENTER].

  d. Press [▼] to move the ▸ beside the list you wish to send. Press [ENTER].

  e. Repeat step **d** for each list you wish to send.

  f. Set the receiving unit by pressing [APPS] [ENTER] [▶] to select **RECEIVE**. Press [ENTER]. **Waiting…** displays on the TI-73 screen.

  g. On the sending unit, press [▶] to select **TRANSMIT** and press [ENTER].

  For more permanent storage of data, use TI-GRAPH LINK or TI Connect to save the lists in a computer folder. However, students may inadvertently lose their data or overwrite it in the next trial, so recording data in journals is a good option.
- Students can assess each other using a teamwork rubric after the lab. Provide a checklist of positive and negative behaviors. Copy these on quarter sheets of paper.

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Selected Answers

Experimental Design

1. Independent variable: *condition of sand (wet or dry)*
2. Treatments: *wet, dry*
3. Dependent variable: *temperature of sand*
4. Number of Trials: ——
5. Constants: *amount of sand, amount of heat*

Data Analysis

1. What do the slopes of the lines on the graph represent? What do the differences in the two slopes indicate about the heating rates of the wet and dry sand?

   The slopes of the lines on the graph represent the rate of heating of the sand. The positive slope indicates that the temperature of the sand increases with time. The steeper slope of the dry sand indicates that the rate of heating is faster than the wet sand with the less steep slope.

2. What does the *y*-intercept represent?

   The y-intercept represents the initial temperatures of the trays of sand.

3. Use the trace key to compare the temperatures of the wet and dry sand at the same time intervals. How does water affect the heating of the sand?

   Water keeps the temperature of the sand cooler for longer.

4. Compare the change in temperature for the dry sand and wet sand.

   Dry sand: starting temperature (____°C) – ending temperature (____°C).

   Wet sand: starting temperature (____°C) – ending temperature (____°C).

5. How might the dampness of the soil in a specific habitat affect the temperatures of that area?

   In a habitat with damp soil, the temperature of the area would probably be cooler than a habitat with dry soil.

Conclusion

Dry sand heats faster in the sun than *wet* sand.

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