ADVENTURE 9

A Day at the Beach

Time:
1 class period

Suggested grade levels: 7-8

Math Objectives:
Create, interpret and analyze graphs of data, Relate slope to rate of change

Science Objectives:
Determine the heating rates of wet sand and dry sand, Describe the effect of evaporation on heating rates

Materials:
TI-73 Explorer™, Calculator-Based Laboratory™ (CBL 2™), DataMate™, Temperature sensor
Two small aluminum trays, 1000 ml sand, Water, Heat lamp

OVERVIEW

Many vacationers end up on a beach. On hot summer days, dry sand can get so hot it hurts to walk on it. But the wet sand near the water feels cool and refreshing.

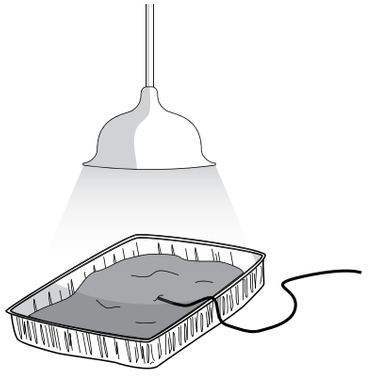
Evaporation occurs when water changes from a liquid to a gas. This requires an input of energy, usually heat energy. As heat energy necessary for evaporation is transferred to the water molecules, the matter from which the heat energy is derived is cooled.

In this adventure, students will compare the heating rates of wet sand and dry sand.

NOTE Demo the activity using the overhead calculator so the entire class can see the process. If you have only one CBL 2, have each group individually perform this activity. If you have enough CBL 2 units, have students work in small groups.

SET UP

1. Place 500 ml of dry sand into each of the two aluminum trays.
2. 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.



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3. 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 both trials.
4. Connect the CBL 2 to the calculator using the I/O unit-to-unit cable.
5. Plug the TI temperature sensor into Channel 1 (CH 1) on the CBL 2.
6. To launch the DATAMATE program, press the [APPS] key, select **DataMate** and then press [ENTER] to view the DataMate screen. **See Figure 1.**

Figure 1

NOTE: DataMate may be listed under Programs (Press [PRGM]).

NOTE: For help with transferring DataMate to the CBL 2, see Appendix D.

NOTE: DATAMATE moves slowly between screens. As you make selections, be patient as the program executes the command.

7. The DataMate screen changes to the Main Screen. Select **1:SETUP.** Then, select **CH1**. Select **1:TEMPERATURE** and **4:STAINLESS TEMP(C)**. If you are using a different temperature sensor, select the appropriate item from the menu. **See Figures 2a-b.**

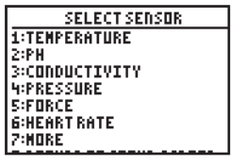

Figure 2a

Figure 2b

NOTE: The calculator may identify the temperature probe for you.

NOTE: The flexible TI temperature sensor is the same as the stainless steel.

8. Press [▼] to select MODE. Press [ENTER] and then select **2:TIME GRAPH.** Press **2:CHANGE TIME SETTINGS.** For **ENTER TIME BETWEEN SAMPLES IN SECONDS,** enter **30**. Press [ENTER]. For **ENTER NUMBER OF SAMPLES,** enter **11**. Press [ENTER]. The **TIME GRAPH SETTINGS** screen reappears, showing the new settings. The value for **EXPERIMENT LENGTH** automatically changes to **330** for these trials. Select **1:OK** twice to return to the Main Screen.

DATA COLLECTION

1. Bury the end of the temperature sensor 0.5 cm below the surface of the dry sand.
2. Place the heat lamp 20 cm above the tray of sand.
3. When you are ready to begin, select **2:START.** The CBL 2 beeps twice and displays a graph with the temperature in °C in the upper right corner. At the end of each 30 second interval, a data point is plotted.
4. Continue to hold the sensor in the dry sand. After 11 data samples are collected from the sensor and plotted, the CBL 2 beeps twice and the line graph is displayed. It will take $5\frac{1}{2}$ minutes.
5. Use the arrow keys ([▶] and [◀]) to move the cursor to each data point and record the values in the table and sketch the graph on your worksheet.
6. Repeat steps 1–5 for the tray of wet sand. Sketch both graphs on the same set of axes.
7. To exit from the DATAMATE program, press [ENTER] to return to the Main Screen. Select **6:QUIT** and press [ENTER].

NOTE: If you have two temperature sensors, data can be collected in one trial using CH1 and CH2. Note which sensor is in which pan of sand.

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EXTENSION ACTIVITY

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

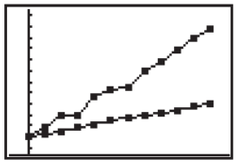
DISCUSSION NOTES

Discuss the effects of evaporation in other environments. 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.
The dampness of soil in a specific habitat affects the temperatures in that area. In a habitat with damp soil, the temperature of the area would probably be cooler than a similar habitat with dry soil.

WORKSHEET ANSWERS

NOTE: The data in these tables is simulated. Actual data will be slightly different.

Time (seconds)	Temperature of Dry Sand (°C)	Temperature of Wet Sand (°C)
0	23	23
30	23.89	23.27
60	25.04	23.44
90	24.97	23.91
120	26.44	24.05
150	27.23	24.57
180	27.56	24.66
210	28.93	25.02
240	29.78	25.22
270	30.91	25.31
300	31.93	25.72
330	32.8	26



1. The slopes of the lines on the graph represent the rate of heating of the sand.
2. The positive slope indicates that the temperatures 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.
3. The *y*-intercept represents the initial temperatures of the trays of sand.
4. Water keeps the temperature of the sand cooler for longer.
5. Answers will vary. Answers using sample data: Dry sand 9.8˚C, Wet sand 3˚C
6. Dry; wet

TI-NAVIGATOR™ EXTENSION ACTIVITY

1. Load the **RatesOfChange.act** activity settings file. Students will see a scatter plot in Activity Center. Each data point is labeled with a letter. Tell students that the *x*-axis represents time in seconds and the *y*-axis represents temperature. The activity settings files can be found on the CD located in the back of the book.
2. Use **Quick Poll** (with Open Response) to ask:
   - Between which set of points does the rate of change appear smallest? (A through D)
   - Between which sets of points does the rate of change appear greatest?(G through J)

   Have students list the first and last point, without any symbol in between. This will aggregate the data.
3. The rate of change between points E and F is 4 degrees per second. Have students use this information to guess the rate of change between other points. Collect guesses via **Quick Poll.**
4. Challenge students to tell a story that could be represented by this data. You can let the axes represent variables other than time and temperature.

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Name _____

ADVENTURE 9

A Day at the Beach Worksheet

Math Objectives:

Create, interpret and analyze graphs of data, Relate slope to rate of change

Science Objectives:

Determine the heating rates of wet sand and dry sand, Describe the effect of evaporation on heating rates

Materials:

TI-73 Explorer™, Calculator-Based Laboratory™ (CBL 2™), DataMate™, Temperature sensor
Two small aluminum trays, 1000 ml sand, Water, Heat lamp

In this adventure, you will compare the heating rates of wet sand and dry sand.

1. What do the slopes of the lines on the graph represent?

2. What do the differences in the two slopes indicate about the heating rates of the wet and dry sand?

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

4. Compare the temperatures of the wet and dry sand at the same time intervals. How does water affect the heating of the sand?

5. Compare the change in temperature for the dry sand and wet sand.
Dry sand: starting temp. (__°C) – ending temperature (__°C) = (__°C)
Wet sand: starting temp. (__°C) – ending temperature (__°C) = (__°C)

6. _____sand heats faster in the sun than_____ sand.

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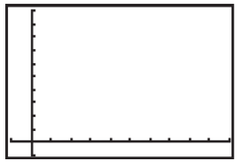
DATA COLLECTION SHEET

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



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