A Sweet Drink
ID: 11619

Time Required
45 minutes

Activity Overview
Most hikers pack high energy foods, snacks, and drinks for long and difficult hikes. For multiple-day hikes, they may bring a powder to mix with water to make a thirst-quenching drink. If they use fresh, cold stream water, will their powder dissolve slower or quicker than if they used the warmer water that they have been carrying around in their backpack? What if they used water that was left out in the sun to heat while resting or camping? In this adventure, students will determine how the temperature of water affects the dissolving time of a sugar cube.

Topic: Chemical Reactions/Linear Functions
- *create, interpret, and analyze graphs of data*
- *find an equation of the line of best fit*
- *relate slope to rate of change*
- *effect of temperature increases on the rate of reaction*
- *collect, record, and analyze information using tools*

Teacher Preparation and Notes
- *The measurements shown are suggested measurements, and can be adjusted to meet size constraints of your classroom or hallway.*

- *You will need the following materials to complete this activity.*
    - *Calculator-Based Laboratory (CBL 2)*
    - *Data Mate Temperature sensor*
    - *Three 350 mL beakers*
    - *Timer or watch with a second hand*
    - *Graduated cylinder*
    - *Three sugar cubes*
    - *Water (5°C, 25°C, 35°C)*

- ***To download the student worksheet and TI-Navigator file, go to education.ti.com/exchange and enter "11619" in the quick search box.***

Associated Materials
- *SciAct07_SweetDrink_worksheet_TI73.doc*
- *SciAct07_Scatter.act*

Suggested Related Activities
To download any activity listed, go to education.ti.com/exchange and enter the number in the quick search box.
- *The Effect of Acid Rain (TI-73 Explorer) — 6403*
- *The Effect of Temperature on the Rate of Dissolving (TI-73 Explorer) — 3860*
- *Graphing Linear Functions (TI-73 Explorer) — 4416*

Setup

1. Collect the sugar cubes and the three containers of water (5°C, 25°C, 35°C). Use a combination of hot tap water and ice to achieve the desired temperatures. The starting temperatures do not have to be exact (± 3°C).

2. If students use different temperatures, make sure that they record the starting temperatures on their worksheets.

3. When students achieve a temperature, remind them to act quickly before the temperature changes.

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 A key, select **DataMate** and then press e to view the DataMate screen.

    Note: DataMate may be listed under Programs (press p).

```
APPLICATIONS
1:Link…
2:AreaForm
3:CBL/CBR
4█DataMate
5:GEOBOARD
6:NUMLINE
```

NOTES: For help with transferring DataMate to the CBL 2, see the Appendix at the end of the document.

   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. Last, select **1:OK** to return to the Main Screen.

```
   SELECT SENSOR
1:TEMPERATURE
2:PH
3:CONDUCTIVITY
4:PRESSURE
5:FORCE
6:HEART RATE
7:MORE
8:RETURN TO SETUP SCREEN
```

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

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

```
TEMPERATURE
1:DIR CONNECT TEMP(C)
2:DIR CONNECT TEMP(F)
3:EXTRA LONG TEMP(C)
4:STAINLESS TEMP(C)
5:STAINLESS TEMP(F)
6:THERMOCOUPLE(C)
```

8. Press ; to select **MODE**, and then select **3:EVENTS WITH ENTRY**. Select **1:OK** to return to the Main Screen.

Data Collection

1. Place the temperature sensor in the water and verify that the water is 25°C.

2. When you are ready to begin, select **2:START.** The screen displays **PRESS ENTER TO COLLECT OR STO TO STOP.**

3. Add one sugar cube to the 25°C water and start timing.

4. Stir constantly. When the sugar cube is dissolved, stop timing.

5. Press e.

6. The program asks you to enter a value. This value is the time it took for the sugar cube to dissolve, NOT the temperature. Type the time and press e for the next container of water.

7. Repeat steps 1–6 for the other two containers of water (5°C and 35°C), using the time it took for the sugar cube to dissolve when the program asks for the value after you press e. Try to stir in the same manner as for the first container. After you enter the first time, the last value you used is displayed at the bottom of the screen.

8. After you have collected the data for the last water sample, press =. A scatter plot is displayed showing the dissolving time and temperatures for all of the samples. Use the arrow keys ($<$ and $>$) to move the cursor to each data point and record the values in the table on your worksheet and sketch the graph.

9. Press e to return to the Main Screen.

10. The dissolving times are stored in **L1.** The temperatures are stored in **L2.**

11. To analyze the data, select **4:Analyze.**

12. Select **2:CurveFit.**

13. Select **1:linear(CH1 VS ENTRY)**. The linear function that best fits the data is displayed, including the slope (a) and the *y*-intercept (b). This is often called the linear regression line. Record the equation on your worksheet.

14. Press e to graph the best fit line with your plot and to answer questions 1–5 on the worksheet.

15. Use the arrow keys ($<$ and $>$) to answer questions 6–9 on the worksheet.

Discussion Notes

The rate the sugar dissolves depends on both temperature and rate of stirring. The only variable that should be different on each trial is the temperature of the water; the amount of water, sugar, and stirring should remain constant. Therefore, it may be best for the same student to stir in each trial.

After the experiment, explain that as water heats up, the water molecules move more, becoming further apart. This leaves space for the sugar molecules to move in and become part of the new solution (sugar water). The warmer the water, the faster the

water molecules move, and the quicker the sugar dissolves.

For the sake of time, only three trials were run, resulting in only three data points. In the real world, scientists would require more points in an actual experiment, and therefore run several more trials.

Extension Activity

Develop an experiment which will test the dissolving times of a sugar cube in different types of liquid (for example, milk, juice, and soda).

Worksheet Answers

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

Temperature (°C)	Dissolving Time (sec)
5°	30
25°	20
35°	15
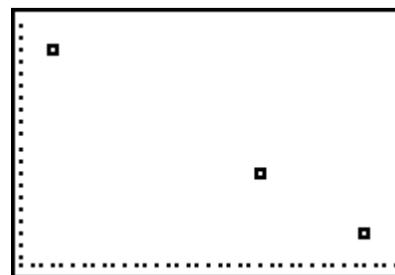
1. Answers will vary. Slope of sample data: –0.5

2. The slope represents the relationship between the temperature of the water and dissolving time. The negative slope indicates that as temperature increases, the dissolving time of the sugar cube decreases.

3. Answers will vary. *y*-intercept of sample data: 32.5

4. The *y*-intercept is the dissolving rate when the temperature of water is 0°C.

5. This is an unrealistic value because at 0°C, water would be ice. It would be difficult for ice to dissolve a sugar cube.

6. Answer using sample data: 45°C

7. Answer using sample data: 63°C

8. increases, decreases (or vice versa—as temperature decreases, dissolving time increases)

TI-Navigator™ Extension Activity

1. Load the **SciAct07_Scatter.act** activity settings file. Start the activity. Students will see a scatter plot in Activity Center. They can also view it on their calculator. The activity settings files can be found on the Activity Exchange.

2. Have students submit equations to make the line of best fit. If needed, remind students that in the form $y = mx + b$, *m* is the slope, or rate of change of the line, and *b* is the *y*-intercept.

3. After students have tried a few equations, enter the equation for the line of best fit

(*y* = -0.82*x* + 28) into Activity Center. See which student came closest!

Appendix – Transferring DataMate™

The DataMate software comes already loaded on the CBL 2™. Before you use the CBL 2 for the first time, you must transfer the DataMate software to the TI-73 Explorer.

To transfer DataMate to a TI-73 Explorer, follow these steps:

1. Connect the TI-73 Explorer to the CBL 2 with the I/O init-to-unit link cable.

2. Put the calculator in RECEIVE mode.

    a. Press A.

    b. Press > to select RECEIVE

    c. Press e.

3. On the CBL 2, press TRANSFER. The program or App is transferred and appears in the calculator's list or application list.

4. When the transfer is complete, press ` î on the calculator.

Need Help?

Contact Texas Instruments:

http://education.ti.com

ti-cares@ti.com

1-800-TI-CARES