EXPLORATIONS

Activity 6

The Effect of Temperature on the Rate of Dissolving

Objectives

- To identify temperature as a factor in the rate of reaction
- To determine the effect of temperature increases on the rate of reaction

Materials

- TI-73
- Unit-to-unit cable
- CBL 2™
- Temperature sensor
- Three 350 ml beakers
- Graduated cylinder
- Timer or watch with second hand
- Three sugar cubes
- Water (5°C, 25°C, 35°C)
- Data Collection and Analysis pages (p. 52 – 53)

In this activity you will

- Identify temperature as a factor in dissolving rate.
- Use CBL 2™ with the temperature sensor to collect data and then analyze that data to determine the effect of temperature increases on the rate of dissolving.

Problem

How does the temperature of water affect the dissolving time of a sugar cube?

Hypothesis

Before testing, complete the table on the **Data Collection and Analysis** page to predict the effect of water temperature on the dissolving time of a sugar cube. Also complete the questions in the **Experimental Design** section.

Procedure: Collecting the Data

1. Collect the sugar cubes and the three containers of water (5°C, 25°C, and 35°C).
2. Plug the temperature sensor into channel (**CH 1**) on the CBL 2™.
3. Start the DATAMATE program.
4. The Main Screen is displayed. **CH 1:TEMP(C)** is displayed at the top of the screen.
5. 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.

   Note: *For flexible TI temperature sensor, select **4:STAINLESS TEMP(C)**.*
6. Press ▼ to select **MODE** and press ENTER. Then select **3:EVENTS WITH ENTRY**.
7. Select **1:OK** to return to the Main Screen.
8. Place the temperature sensor in the water and verify that the water is 25°C.
9. When you are ready to begin, select **2:START**. The screen displays **PRESS ENTER TO COLLECT OR STO TO STOP**.
10. Add one sugar cube to the 25°C water and start timing.
11. Stir constantly. When the sugar cube is dissolved, stop timing.
12. Press ENTER.
13. 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 ENTER. The program returns to the data collection screen, ready for the next container of water.
14. Repeat steps 8 through 13 for the other two containers of water (35°C and 5°C), using the time it took for the sugar cube to dissolve when the program asks for a value after you press ENTER. After you enter the first time, the last value you used is displayed at the bottom of the screen.
15. After you have collected the data for the last water sample, press STO▶. A scatter plot is displayed showing the times and temperatures for all of the samples. Use ▶ and ◀ to move to each data point and record the values in the table on the **Data Collection and Analysis** page.
16. Press ENTER to return to the Main Screen.
17. To display the lists showing the results, press LIST. The dissolving times are stored in **L1**. The temperatures are stored in **L2**.

Procedure: Graphing the Data

1. Select **4:Analyze**.
2. Select **2:CurveFit**.
3. Select **1:Linear(CH1 VS TIME)**.

   The function that best fits the data is displayed, including the slope (a) and the *y*-intercept (b). Record them on the **Data Collection and Analysis** page.
4. Press ENTER. Answer questions 1 through 3 on the **Data Collection and Analysis** page.
5. Use the arrow keys to answer questions 4 through 5 on the **Data Collection and Analysis** page.

Data Analysis

Using the data you collected and the scatter plot with the linear regression line, answer the questions on the **Data Collection and Analysis** page.

Extension

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

Data Collection and Analysis

Name _____

Date _____

Activity 6: The Effect of Temperature on the Rate of Dissolving

Problem

How does the temperature of water affect the dissolving time of a sugar cube?

Hypothesis

Before testing, complete the following table to rank the effect water temperature will have on dissolving a sugar cube (1 = fastest).

Water Temperature (°C)	**Predicted Rank for Dissolving Sugar Cube** (Fastest to Slowest)
5°	
25°	
35°	

As the temperature of the water _____, the dissolving time of the sugar cube _____.

Experimental Design

1. Independent Variable: _____
2. Treatments: _____

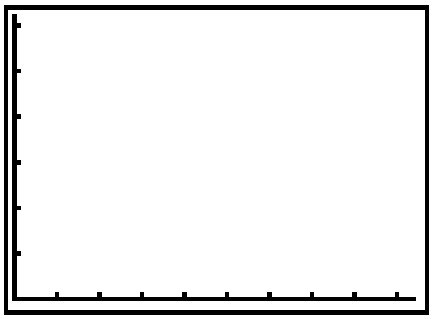
   _____
3. Dependent Variable: _____
4. Constants: _____
5. Control: _____

Data Collection

1. After you dissolve all three sugar cubes, use the scatter plot to fill in the times on the table below.

Temperature (°C)	**Dissolving Time (sec)**
5°	
25°	
35°	

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



Data Analysis

1. Compare the actual results from the table and graph to your prediction. Discuss any surprises or differences you find.

_____

_____

_____

2. What is the slope of the linear regression line? _____ .
What does this value represent? _____

_____

_____

_____

3. What is the *y*-intercept of the linear regression line? _____ .
What does this value represent? Is this a realistic value? Why or why not?

_____

_____

_____

4. Use the arrow keys to move along the regression line. At what temperature does the sugar cube dissolve in 10 seconds? _____
70 seconds? _____

5. Use the arrow keys to move along the regression line. If the water is 45°C, how long will it take for the sugar cube to dissolve? _____
At what temperature will the sugar cube dissolve in one second?_____

Conclusion

As the temperature of the water _____, the dissolving time of the sugar cube _____.

Teacher Notes

Activity 6

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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

Preparation

- 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).
- If students use different temperatures, make sure that they record the starting temperatures on the worksheet.
- When students achieve a temperature, remind them to act quickly before the temperature changes.

Management

- Ask students to sketch the lab setup before starting the lab and label the sketch with key terms. Students learn vocabulary in context and seem less confused by the procedure.
- Assign these student jobs for this lab:
  - Materials/setup person (sets up samples, sensor)
  - Tech person (operates CBL 2™ and TI-73)
  - Data recorder (reads temperature readings from the TI-73 at each collection interval)
  - Runner (brings CBL 2 and TI-73 to the computer to print out graphs with TI-GRAPH LINK™ or TI™ Connect and brings **Data Collection and Analysis** pages to the teacher)

- 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 their data/graph later, they can still write up their lab report. 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.

Selected Answers

Experimental Design

1. Independent Variable: *temperature*
2. Treatments: *ice water, cold water, hot water*
3. Dependent Variable: *dissolving time*
4. Constants: *amount of water, size of sugar cube, brand of sugar cube*
5. Control: *cold water*

Data Analysis

2. *The slope represents the relationship between the temperature of the water and the dissolving time. The negative slope indicates that as temperature increases the dissolving time of the sugar cube decreases.*
3. *The y-intercept is the dissolving rate when the temperature of water is 0°C. This is not a realistic value because at 0°C water would be ice. It would be difficult for ice to dissolve a sugar cube.*

4,5. Answers will vary with graph.

Conclusion

As the temperature of the water *increases*, the dissolving time of the sugar cube *decreases*.