CHAPTER 8

LAB ACTIVITY

Temperature and Chemical Weathering

Whether it's the granite of a New Hampshire mountain breaking down into sand and clay or the limestone of Kentucky decomposing to form rich soil, all chemical weathering processes involve water. What effect does the temperature of the water have on the rate at which chemical weathering occurs?

As you know, carbonic acid is a weak acid that forms when carbon dioxide dissolves naturally in rain, in streams, or in groundwater. A common chemical weathering process is the reaction between carbonate rocks, such as limestone and marble, with carbonic acid. In this lab activity, you will observe a model of this reaction. By changing the temperature of the water, you can model the effect of the temperature on the rate of the reaction between carbonate rocks and carbonic acid.

Lab Skills and Objectives

- To **model** a chemical weathering process
- To **graph** the data from the model and to interpret the graph
- To **predict** what will happen when the model is modified
- To **compare** the observed data with the theoretical data

Materials

- lab apron
- safety goggles
- 5 250 mL beakers
- 5 thermometers
- 5 effervescent antacid tablets
- hot water (40°–50°C)
- ice water
- stopwatch
- graph paper
- map of Earth's Climates, Appendix B, page 664

Procedure

1.  **CAUTION: Put on your lab apron and safety goggles.**
2. Arrange 5 beakers in a row. Assign each beaker a number from 1 to 5. Place a thermometer in each beaker. Each beaker should contain about 200 mL of water. The water temperature in each beaker will need to be adjusted to match the following: Beaker 1, 0°–10°C; Beaker 2, 10°–20°C; Beaker 3, 20°–30°C; Beaker 4, 30°–40°C; Beaker 5, 40°–50°C.
3. Begin with Beaker 1. Remove any pieces of ice from the water. Check to be sure that the water is within the correct temperature range and that the thermometer has stopped changing. Read the temperature of the water in Beaker 1 to the nearest half degree and record it on a copy of Data Table A. Remove the thermometer from the beaker and set it aside in a safe place.
4. Read all of this step before continuing. Drop the antacid tablet into Beaker 1. Start the stop watch at the instant the tablet enters the water. Stop the stopwatch when the last piece of the tablet dissolves. (You do not need to wait for all of the bubbling to stop; wait only for all pieces of the tablet to disappear.) Read the time on the stopwatch. Record the time to the nearest whole second on Data Table A.
5. Repeat steps 3 and 4 for each of the remaining beakers.
6. Plot a graph of the data for the 5 trials. One graph axis will be *Temperature* (in °C) and the other will be *Time* (in seconds). Connect the 5 points with a smooth curve. Label the curve *Observed Data*.
7. Answer *Analysis and Conclusions* questions 1–6.
8. Copy your Beaker 1 data from Data Table A to Data Table B. The remaining values in Data Table B will need to be calculated. For

the temperature values, add 10 to the reading for Beaker 1 and record that as the temperature for Beaker 2. In the same way, continue to add 10 to each temperature reading on the table.

9. For the time values on Data Table B, divide each reading in half to get the next reading. For example, the time for Beaker 2 will be one half the time for Beaker 1 and so on. When you divide the values, round off each result to the nearest whole second.
10. Using the same graph as before, plot the values from Data Table B. Connect the points with a smooth curve. Label the curve *Theoretical Data*.
11. Answer question 7 in *Analysis and Conclusions*.

Data Table A: Actual Data

Beaker Number	Temperature (°C)	Time (seconds)
1		
2		
3		
4		
5		

Data Table B: Theoretical Data

Beaker Number	Temperature (°C)	Time (seconds)
1		
2		
3		
4		
5		

Analysis and Conclusions

1. In which beaker did the reaction occur most slowly? In which beaker did the reaction occur most rapidly? What do you think is the relationship between the temperature and the rate of a reaction?
2. Based upon your observations, what do you think is the relationship between the temperature and the rate of natural chemical weathering?
3. Look at the temperatures you recorded. Are all of these temperatures likely to occur on Earth's surface? Explain.
4. Turn to the map of Earth's Climates on page 664. Locate Rio de Janeiro in South America and Seattle in North America. The map key indicates that both cities have climates with abundant moisture. (a) Recall what you know about carbonic acid in rain and in groundwater. Compare the weathering rate of a limestone in Rio de Janeiro with that of a limestone in Seattle. Is there a difference? Explain your answer. (b) Which of the two locations is likely to have thicker soil?
5. Now locate Barrow, Alaska, on the map. Why is a limestone in Barrow likely to weather very slowly?
6. How would the rate of the reaction have been different if the tablets had been ground into a powder before they were dropped into the water? Why? Would a graph for such a reaction result in a curve above or below the line of your actual data? Why?
7. Look at the calculated values in Data Table B. (a) On your graph, is the line for the theoretical data above, below, or the same as your line for the actual data? (b) What does this mean about the rate of the reaction you observed compared with the theoretical rate of reaction? (c) What change in the procedure might have made your actual results more like the theoretical results?