Endothermic and Exothermic Reactions

Many chemical reactions give off energy. Chemical reactions that release energy are called *exothermic* reactions. Some chemical reactions absorb energy and are called *endothermic* reactions. You will study one exothermic and one endothermic reaction in this experiment.

In Part I, you will study the reaction between citric acid solution and baking soda. An equation for the reaction is:

$$H_3C_6H_5O_7(aq) + 3\ NaHCO_3(s) \longrightarrow 3\ CO_2(g) + 3\ H_2O(l) + Na_3C_6H_5O_7(aq)$$

In Part II, you will study the reaction between magnesium metal and hydrochloric acid. An equation for this reaction is:

$$Mg(s) + 2\ HCl(aq) \longrightarrow H_2(g) + MgCl_2(aq)$$

OBJECTIVES

In this experiment, you will

- Study one exothermic and one endothermic reaction.
- Become familiar with using Logger *Pro*.
- Collect and display data on a graph.

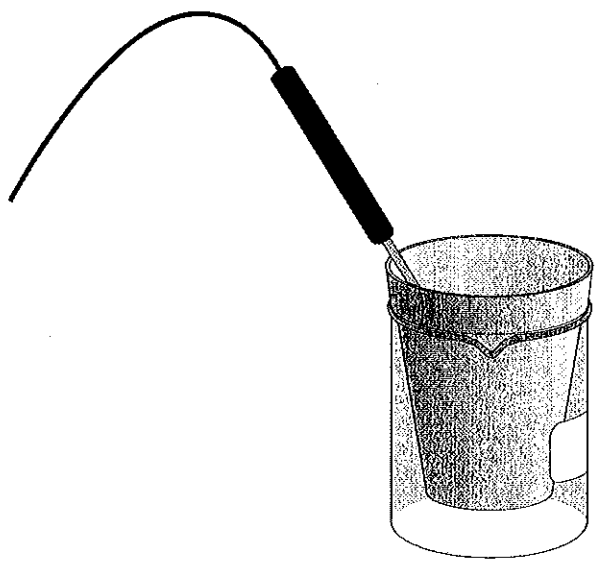

Figure 1

MATERIALS

computer
Vernier computer interface
Logger*Pro*
Temperature Probe
50 mL graduated cylinder
balance
Styrofoam cup
250 mL beaker
citric acid, $H_3C_6H_5O_7$, solution
baking soda, $NaHCO_3$
hydrochloric acid, HCl, solution
magnesium, Mg

PROCEDURE

1. Obtain and wear goggles.

Part I Citric Acid plus Baking Soda

2. Place a Styrofoam cup into a 250 mL beaker as shown in Figure 1. Measure out 30 mL of 1.5M citric acid solution into the Styrofoam cup. Place a Temperature Probe into the citric acid solution.
3. Connect the probe to the computer interface. Prepare the computer for data collection by opening the file "01 Endo Exothermic" from the *Chemistry with Computers* folder of Logger *Pro*.
4. Weigh out 10.0 g of solid baking soda on a piece of weighing paper.
5. The Temperature Probe must be in the citric acid solution for at least 30 seconds before this step. Begin data collection by clicking [Collect]. After about 20 seconds have elapsed, add the baking soda to the citric acid solution. Gently stir the solution with the Temperature Probe to ensure good mixing. Collect data until a minimum temperature has been reached and temperature readings begin to increase. You can click on [Stop] to end data collection or let the computer automatically end it after 300 seconds.
6. Dispose of the reaction products as directed by your teacher.
7. Sketch the graph on a piece of graph paper and record the initial and final temperature on the data table.

Part II Hydrochloric Acid Plus Magnesium

8. When you collect data in Part II of this experiment, the data will be collected as Latest run, the most recent set of data. The original Latest run will be lost if it is not saved or stored. Choose Store Latest Run from the Experiment menu to store Latest as Run 1, then save it later. The line should be different for the two runs.
9. Measure out 30 mL of 1M HCl solution into the Styrofoam cup. Place the Temperature Probe into the HCl solution. Note: The Temperature Probe must be in the HCl solution for at least 45 seconds before doing Step 11. **CAUTION:** *Hydrochloric acid is caustic. Avoid spilling it on your skin or clothing. Wear chemical splash goggles at all times. Notify your teacher in the event of an accident.*
10. Obtain a piece of magnesium metal from the teacher.
11. Begin data collection by clicking [Collect]. After about 20 seconds have elapsed, add the Mg to the HCl solution. Gently stir the solution with the Temperature Probe to ensure good mixing. **CAUTION:** *Do not breathe the vapors!* Collect data until a maximum temperature has been reached and the temperature readings begin to decrease.

12. Dispose of the reaction products as directed by your teacher.
13. Sketch the second line on to your graph and record the initial and final temperatures in the data table.

DATA TABLE

	Part I	Part II
Final temperature, t_2	°C	°C
Initial temperature, t_1	°C	°C
Temperature change, Δt	°C	°C

OBSERVATIONS

PROCESSING THE DATA

1. Calculate the temperature change, Δt, for each reaction by subtracting the initial temperature, t_1, from the final temperature, t_2 ($\Delta t = t_2 - t_1$).

2. Tell which reaction is exothermic. Explain.

3. Which reaction had a negative Δt value? Is the reaction endothermic or exothermic? Explain.

4. For each reaction, describe three ways you could tell a chemical reaction was taking place.

5. Which reaction took place at a greater rate? Explain your answer.

6. Does it make sense that the reaction that was taking in heat feels cold? Explain.