

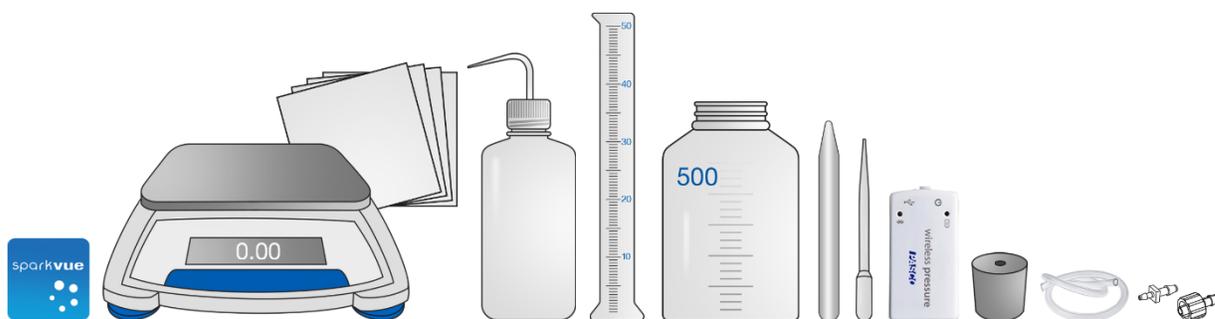
8D – DETERMINING LIMITING REACTANTS

INQUIRY

How can you produce the greatest amount of products without wasting any material?

MATERIALS

- Device with SPARKvue software
- Pressure sensor with tubing and connectors
- Digital balance (readability: 0.01 g)
- Weighing paper
- Sampling bottle, plastic, 500-mL,
OR 500-mL Erlenmeyer flask
- Rubber stopper, one-hole, to fit the sampling
bottle/flask
- Graduated cylinder, 50-mL
- Scoopula
- Pipet
- 0.12 M NaHCO_3 , sodium bicarbonate solution,
300 mL
- Citric acid ($\text{C}_6\text{H}_8\text{O}_7$) solid, 2.0 g
- Wash bottle with distilled water



BACKGROUND

In order to avoid wasting materials, chemists are often tasked with determining precisely how much of each reactant is necessary for a reaction. Using mole ratios from the balanced chemical equations and a known amount of one reactant, a chemist can calculate the exact amount of a different reactant is required for both reactants to be completely consumed. But what happens to a chemical reaction when the limiting reactant is consumed? This activity explores how you can determine experimentally which of the two reactants, sodium bicarbonate (baking soda) or citric acid, is limiting through several runs of the reaction.

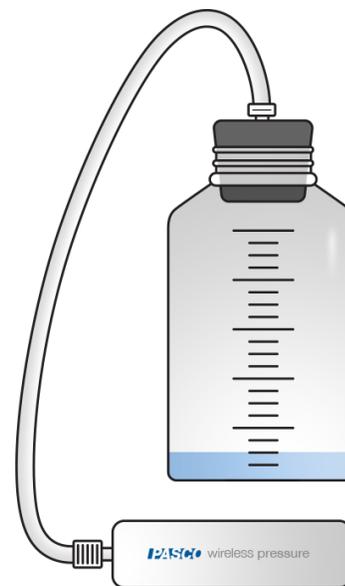
SAFETY

Follow these important safety precautions in addition to your regular classroom procedures.

- Wear safety goggles at all times.
- The gas being generated causes an increase in pressure which may expel the stopper from the bottle. Hold the stopper in place during the experiment but avoid squeezing the body of the sampling bottle/flask.
- Do not point the sampling bottle toward yourself or anyone else.

PROCEDURE

1. Open SPARKvue.
2. Open the 08D Determining Limiting Reactants lab file in SPARKvue.
3. Use the Bluetooth icon to connect the Pressure sensor.
4. Attach the pressure sensor to the threaded sensor tubing connector as shown. Use a double-barbed connector to attach the open end of the tubing to the rubber stopper.
5. Pour just under 40 mL of the sodium bicarbonate solution into the graduated cylinder. Use a pipet to measure exactly 40.0 mL. Have the same person read the graduated cylinder each time for precision.
6. Pour the sodium bicarbonate solution you just measured into the bottle.
7. Measure about 0.10 g of citric acid. Record the exact mass in Table 1 and in Table 2 on your answer sheet.
8. Start collecting data.
9. It is very important to complete this step as quickly as possible. As soon as one lab partner pours the solid citric acid into the bottle, the other lab partner immediately seals the bottle/flask with the stopper. Avoid squeezing the sides of the bottle/flask.
10. Hold the stopper firmly in place and gently swirl the bottle to help the reactants mix. Continue holding the stopper and swirling at the same speed for the duration of the reaction.
11. Stop collecting data when the reaction is complete. Upon reaction completion, no gas bubbles form and the pressure levels off on the graph.
12. Slowly remove the stopper to release the pressure from the bottle.
13. Pour the contents of the bottle/flask into the designated waste container. Thoroughly rinse the bottle/flask with distilled water.
14. Use the graph to find initial pressure, final pressure, and pressure change. Record the values in Table 1.
15. Repeat steps 4-14 for 0.20 g, 0.30 g, 0.40 g, and 0.50 g of citric acid. Make sure all runs are visible in SPARKvue as you collect data.



ANALYSIS

Complete the analysis on your answer sheet.

QUESTIONS

Answer the questions on your answer sheet.