Ms. Randall
Regents Chemistry
Lab Activity: "PLOP, PLOP, FIZZ, FIZZ"… RATE OF REACTION

Background: Chemical reactions occur at different rates. In this experiment, you will consider some of the key factors that influence the rate of a reaction. They include:

1) Nature of the reagents
2) Concentration of the reagents
3) Surface area of the reagents
4) Catalysts
5) Temperature

According to the collision theory, the rate of a reaction depends on the frequency of collisions between reacting particles. The more frequent the collisions, the faster the rate of the reaction. However, in order for the collisions to be effective, the particles must collide with enough energy (activation energy). Furthermore, the particles must collide with proper orientation (fitting together). In today's experiment you will be studying energy exchange (exo/endothermic), and the effect of temperature and surface area on the rate of reaction. You will be using Alka-Selzer (or a generic equivalent) dissolved in water. As the tablet dissolves and the principle components react carbon dioxide gas is released. This is due to the reaction between sodium bicarbonate ($NaHCO_3$) and citric acid ($H_3C_3H_5O_7$) in the tablet. You are also producing water and sodium citrate ($Na_3C_3H_5O_7$ aq.) which remain in solution.

The balanced equation is as follows:

$3\ NaHCO_3(aq) + H_3C_3H_5O_7(aq) \rightarrow Na_3C_3H_5O_7(aq) + 3\ CO_2(g) + 3\ H_20(l)$

Objective: To examine the factors that influence reaction rates

Materials:

Styrofoam cup
Antacid tablets (6)
Water
Ice
Thermometer
Reaction vessel (35mm film canister, or other container holding ~10mL with lid that can pop off)
Graduated cylinder
250mL beaker
Stopwatch
Mortar and pestle

Part I-Thermodynamics

In this experiment you will determine if the reaction that occurring between the sodium bicarbonate and the citric acid is exothermic or endothermic.

1) Place 100mL of water that is near room temperature in a styrofoam cup, place the cup inside a larger beaker to help insulate it from the bench. Measure and record the temperature of the water to the nearest tenth of a degree.

2) Place an alka-seltzer tablet in the water and allow the reaction to proceed until completion (no bubbles or fizzing). Record the final temperature of the solution to the nearest tenth of a degree.

3) Clean up this solution and proceed to part II.

Part II-Kinetics

Temperature vs reaction rate-

1) Obtain a film canister or other clean and dry reaction vessel, place an antacid tablet in the vessel.

2) Obtain about 100mL of warm water, place it in a styrofoam cup inside the beaker to isolate it from the bench, and measure the temperature of the water.

3) After the temperature of the water has been determined immediately measure 10mL of water in a graduated cylinder and pour the water into the film canister. As soon as the water has been mixed with the tablet close the lid on the canister and start your stopwatch. Record the time it takes for the lid to pop off.

4) Clean and dry your reaction vessel, and place another alka-seltzer tablet in the film canister.

5) Prepare an ice water bath in a beaker, and measure and record the temperature. Quickly measure out 10mL and place it in the film canister, and again record the time it takes for the lid to fly off.

6) Repeat step 4, now prepare a solution of water with a temperature in between your warm and cold water. Record the temperature of the water, place 10mL in your reaction vessel and record the time it takes for the lid to pop off once again.

Particle size vs reaction rate-

7) Clean and dry your reaction vessel. Using a mortar and pestle crush an alka seltzer tablet into a fine powder, try to avoid stirring up excessive dust.

8) Carefully transfer all of the powder into your reaction vessel, choose one of your water solutions (hot, cold, or medium), measure and record the temperature and quickly transfer 10mL of water into your reaction vessel. Close the lid and measure and record the time of reaction.

Analysis:

1) Did the temperature of the water increase or decrease in part I? Is this reaction exothermic or endothermic?

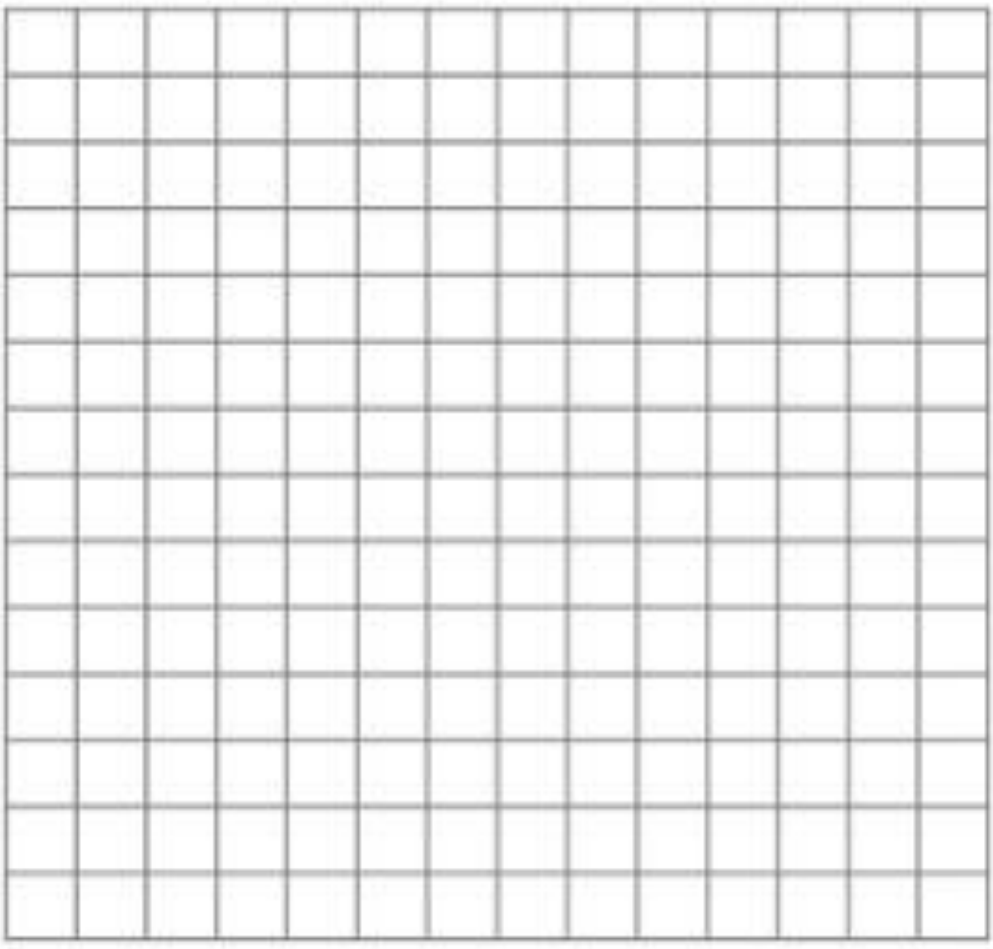
2) Given that the heat capacity of water is 4.18 Joules / gram °C how many joules did the reaction give off or take in? (Hint: recall the density of water is 1 grams/cm^3 at 25°C)

3) Prepare a graph of your three data points from part II. Temperature vs time of reaction. (a grid is attached on the next page for your convenience)

4) Describe how the temperature affects the rate of reaction?

5) Compare your points for the same temperature and different surface areas? Did the fine powder react faster or slower? Could you determine any rate of reaction difference by increasing the surface area?

If you could not measure a difference in the speed of the reaction do you think trying it a different [lower] temperature would make surface area more or less significant?



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Lab conclusion: "PLOP, PLOP, FIZZ, FIZZ"… RATE OF REACTION

1. **Write a paragraph summarizing what you have learned about the scientific concept of the lab from doing the lab. Back up your statement with details from your lab experience**.

2. Why can an increase in temperature lead to more effective collisions between reactant particles and an increase in the rate of a chemical reaction?

a) The activation energy of the reaction increases.
b) The activation energy of the reaction decreases.
c) The number of molecules with sufficient energy to react increases.
d) The number of molecules with sufficient energy to react decreases.

3. A 1.0-gram piece of zinc reacts with 5 milliliters of HCl (aq). Which of these conditions of concentration and temperature would produce the greatest rate of reaction?

a) 1.0 M HCl (aq) at 20.°C
b) 1.0 M HCl (aq) at 40.°C
c) 2.0 M HCl (aq) at 20.°C
d) 2.0 M HCl (aq) at 40.°C

4. Given the reaction:

$Fe(s) + 2\ HCl\ (aq) \rightarrow FeCl2(aq) + H2(g)$

In this reaction, 5 grams of powdered iron will react faster than a 1-gram piece of solid iron because the powdered iron

a) Has less surface area
b) Has more surface area
c) is less dense
d) is denser

5. Adding a catalyst to a chemical reaction results in

a) A decrease in activation energy and a decrease in the reaction rate
b) A decrease in activation energy and an increase in the reaction rate
c) An increase in activation energy and a decrease in the reaction rate
d) An increase in activation energy and an increase in the reaction rate