Name: _____ Period: _____ Date: _____

Reaction Rate Lab

Introduction

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

- Surface area of reactants
- Temperature
- Concentration
- Catalysts

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 sufficient energy (activation energy). The factors that will be examined in this lab influence reaction rate by either increasing how often collisions occur or by making collisions more effective.

Purpose

To examine factors that increase reaction rate.

Safety

Safety goggles must be worn when working with acids.

Collision Theory Simulation

Collision Theory: reactants can form products if they collide with enough energy
Faster reaction rate = more collisions and/or higher-energy collisions

Part 1: Concentration

1. Go to http://www.kscience.co.uk/animations/collision.htm.
2. Click on the yellow "setup" button.
3. Click "start" and run the simulation for 10 seconds. Then press "stop." Record your data in table 1.
4. Change the starting number of A to 40 and run the simulation again. Record your data in table 1.
5. Change the number of A and B to 40 and run the simulation again. Record your data in table 1.

Table 1: Effect of Reactant Concentration on Reaction Rate			
At Start			After 10 Seconds
Number of A	Number of B	Number of P	Number of P
20	20	0	
40	20	0	
40	40	0	

6. Based on the data that you collected in table 1, what is the effect of increased reactant concentration (more reactant particles) on reaction rate?

7. Why does increased concentration make reactions progress faster? Support your answer using collision theory.

Part 2: Temperature

8. Change the number of A and B back to 20.
9. Change the temperature to 30.
10. Run the simulation for 10 seconds. Then press "stop." Record your data in table 2.
11. Change the temperature 2 more times (you can use whatever values you like). Record all data in table 2.

Table 2: Effect of Temperature on Reaction Rate	
Temperature	Number of P After 10 Seconds
20	12
30	

12. Based on the data that you collected in table 2, what is the effect of increased temperature on reaction rate?

13. Why does increased temperature make reactions progress faster? Support your answer using collision theory.

Part 3: Pressure (Volume)

14. Change the temperature back to 20.
15. Change the volume to 300.
16. When you decrease the volume, what do you think happens to the pressure?

17. Run the simulation for 10 seconds. Then press "stop." Record your data in table 3.
18. Change the volume 2 more times (you can use whatever values you like). Record all data in table 2.

Table 3: Effect of Pressure on Reaction Rate	
Volume	Number of P After 10 Seconds
400	12
300	

19. Based on the data that you collected in table 3, what is the effect of increased pressure (decreased volume) on reaction rate?

20. Why does increased pressure make reactions progress faster? Support your answer using collision theory.

Hypotheses

1. Surface Area:
   The reaction between solid calcium carbonate and HCl will progress _____ than the reaction between powdered calcium carbonate.
   faster/slower

2. Temperature:
   The reaction between Alka-Seltzer and water will progress the fastest using _____ temperature water.
   cold/room temp/warm

3. Concentration:
   The reaction between zinc and HCl will progress the fastest using _____
   concentration of HCl. 1M, 3M, or 6M

4. Catalyst:
   The hydrogen peroxide reaction will progress the fastest _____ a catalyst.
   with/without

Pre-Lab Questions

1. What is the purpose of this lab?

2. What is concentration?

3. Why do you need both solid and powdered calcium carbonate for part 1?

4. Why do you need 3 different water temperatures for part 2?

5. How many drops of each catalyst should you add for part 4?

6. Which of the five factors that affect reaction rate are we not investigating today?

Materials

Part 1: Surface Area	Part 2: Temperature	Part 3: Concentration	Part 4: Catalyst
solid calcium carbonate calcium carbonate powder balance 2 test tubes test tube rack 1M HCl (approximately 10 mL)	3 Alka-Seltzer tablets 3 250-mL beakers water at three temperatures – with ice, room temperature, warm (around 70°C) thermometer	1M HCl, 5 mL 3M HCl, 5 mL 6M HCl, 5 mL 3 pieces of zinc metal, all the same size 3 test tubes test tube rack	0.3% hydrogen peroxide, H_2O_2 – 10 mL 0.1 M iron(III) nitrate, $Fe(NO_3)_3$ 0.1 M manganese dioxide, MnO_2 0.1 M calcium chloride, $CaCl_2$ 0.1 M potassium nitrate, KNO_3 100-mL graduated cylinder 4 test tubes test tube rack

Procedure

Part 1: Surface Area

1. Obtain a piece of solid calcium carbonate.
2. Find the mass of this sample and place it in a test tube.
3. Using the balance obtain a sample of powered calcium carbonate that is close to the mass of your piece of solid calcium carbonate. Place this sample in the second test tube.
4. Place both test tubes in a test tube rack.
5. Add 5 mL of 1M HCl to both test tubes. Be sure to wear your safety goggles.
6. Observe both test tubes and record your observations in the data table.

Part 2: Temperature

1. Half fill three 250-mL beakers with water.
2. In one beaker add several ice cubes. A second beaker will contain water at room temperature. In the third beaker add water that has been heated to about 70°C.
3. Record the water temperature in the three beakers, then add an Alka-Seltzer tablet to each.
4. Record the time it takes for the Alka-Seltzer tablet to completely dissolve.

Part 3: Concentration

1. Pour 5 mL of each of the three HCl solutions into separate test tubes.
2. Place the test tubes in a test tube rack.
3. Add one piece of zinc to each test tube.
4. Record the time you added the zinc to the tubes, and the time each reaction stops. Also record your observations for each tube.

Part 4: Catalyst

In this part of the lab you will determine which substance/substances act as a catalyst for the decomposition of hydrogen peroxide.

1. Place 5 mL of the 0.3% H_2O_2 solution into each of the 4 test tubes.
2. Add 5 drops of each of the following solutions to separate test tubes:
   - 0.1 M MnO_2
   - 0.1 M $Fe(NO_3)_3$
   - 0.1 M $CaCl_2$
   - 0.1 M KNO_3
3. Mix each tube by swirling the test tube or gently stirring with a clean stirring rod.
4. Observe each solution, noting the production of any gas bubbles that form.
5. Record each reaction rate as fast, slow, very slow, or none in your data table.

Data Table

Table 1. Effect of Particle Size on Reaction Rate.

Substance Tested	**Observations**
Powdered calcium carbonate	
Solid calcium carbonate	

Table 2. Effect of Temperature.

Water Condition	**Water Temperature (Celsius)**	**Time to Completion**
Cold		
Room temperature		
Warm		

Table 3. Effect of Concentration.

Acid Concentration	**Observations**
1 M HCl	
3 M HCl	
6 M HCl	

Table 4. Effect of a Catalyst.

Possible Catalysts	MnO_2	$Fe(NO_3)_3$	$CaCl_2$	KNO_3
Reaction Rate				