FACTORS AFFECTING REACTION RATES

Objective:

To determine the affect that concentration, nature of reactants, temperature, and the use of a catalyst can have on reaction rates.

Materials:

See each part of the procedure.

Procedure:

Part 1 - Concentration

reaction under study: $Mg_{(s)} + 2HCl_{(aq)} \Rightarrow MgCl_{2(aq)} + H_{2(g)}$

1. Using a pencil, ruler, and scissors, measure and cut three 2.0cm strips of Mg.
2. Fill the eudiometer tube full of water and the trough half full of water.
3. Put the eudiometer tube over the hole in the trough and clamp it down.
4. Put 20mL of 2.0M *HCl* in the flask.
5. Drop a 2 cm *Mg* strip into the flask and start timing simultaneously.
6. When the *Mg* disappears, stop and record the time to the nearest second.
7. Record the volume of H_2 produced from the eudiometer tube.
8. Repeat for 3.0M *HCl* and 6.0M *HCl.*

Part 2 - Nature of Reactants

reactions under study: $Mg_{(s)} + 2HCl_{(aq)} \Rightarrow MgCl_{2(aq)} + H_{2(g)}$

$Zn_{(s)} + 2HCl_{(aq)} \Rightarrow ZnCl_{2(aq)} + H_{2(g)}$

1. Weigh out 0.10g of *Mg* powder and 0.10g of *Zn* powder.
2. Fill a test tube ¼ full with 6.0*M HCl*.
3. Drop the *Mg* powder in the test tube and simultaneously start the timer.
4. Stop and record the time when the *Mg* disappears.
5. Do the same for *Zn* powder.

Part 3 - Temperature

reaction under study: Alka-Seltzer + $HCl_{(aq)} \Rightarrow CO_{2(g)}$ + other products

1. Fill two 100mL beakers with 40mL of 0.1*M HCl*. One flask should be put into a 250mL beaker cold water bath, and one should be put in a warm water bath.
2. Obtain two alka-seltzer tablets, and record the mass of each.

3. Use a thermometer and record the temperature of each HCl solution.
4. Drop an Alka-Seltzer tablet into the HCl in the cold water bath and time the reaction until it stops.
5. Repeat for warm HCl.

Part 4 - Catalyst

reaction under study:

Hydrogen peroxide (H_2O_2) decomposes *spontaneously* (but very slowly) to produce *water* and *oxygen*. $2H_2O_{2(aq)} \Rightarrow 2H_2O_{(l)} + O_{2(g)}$

*Throughout the procedure, make observations using the table in Data and Observations (look over the table before beginning).

1. Fill two test tubes 1/4 full with H_2O_2.
2. To one test tube add a spatula tip of MnO_2.
3. Record observations.

Data and Observations:

*Use significant figures for all measurements and calculations

*Make titles for each table

Part 1 - Concentration

Table 1 -

[HCl]	Volume H_2 produced (mL)	Time (s)	Rate (mL H_2/s)

Part 2 - Nature of Reactants

Table 2 -

Metal	Mass Loss (g)	Time (s)	Rate (g /s)

Part 3 – Temperature

Table 3 -

Temperature of HCl	Mass of Alka-Seltzer (g)	Time (s)	Rate (g/s)

Part 4 – Catalyst

*Observations include descriptions of the substances as well as descriptions of changes occurring

Table 4 -

Reaction	Before	During	After
H_2O_2 solution			
H_2O_2 solution with MnO_2			

Questions:

1. **Concentration**:

a) Using your rate results for support, describe, using collision theory, how a concentration increase affects reaction rate.

b) For the trial of your choice, utilize stoichiometry and find the mass of $Mg_{(s)}$ used starting with the rate in mL H_2 / second.

2. **Nature of Reactants**:

a) What was the independent variable in this reaction (what was different in each trial)?

b) Using your quantitative rate results as support, which metal reacts at a higher rate with HCl?
c) What does this tell you about Mg compared to Zn with respect to HCl?

3. **Temperature**:
a) Using your results as support, which temperature gave the highest reaction rate?
b) Describe how an increase in temperature affects reaction rate using collision theory. There are two different reasons that contribute (consult your notes).

4. **Catalyst**: A reaction was occurring in both test tubes, yet the reaction was observable in only one test tube.
a) What substance did the test tube with an observable reaction contain that the other didn't?
b) What was this substance acting as?
c) At the molecular level, how did it contribute to the reaction (using collision theory, how did it cause the reaction to speed up)?
d) Was it still present afterwards? Support with observations from Table 4.

Conclusion:

Using one sentence per factor (4 in total), describe how each factor studied in this experiment affected reaction rate.