

Chemistry 101

FACTORS AFFECTING REACTION RATES

Pre-Lab Exercises

Student: _____
 Date: _____
 Instructor: _____
 Section: _____

1. What are two ways of increasing a reaction rate?
2. Calculate the number of moles in 0.656 g of Aluminum.

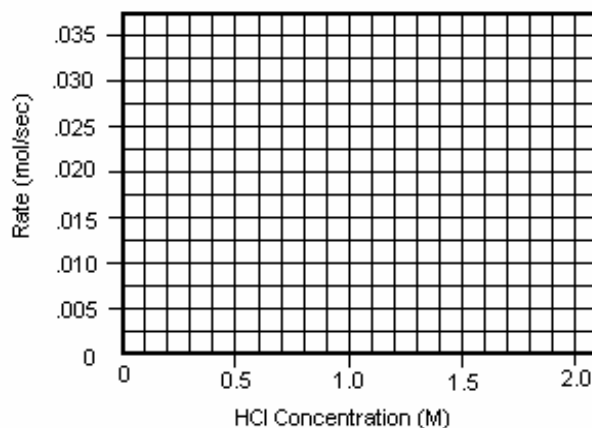
mol Al

3. If 0.656 g of Al reacts with a HCl solution in 425 seconds, what is the rate of the chemical reaction in units of mol/sec?

mol/sec

4. A student obtained the following rate of reaction data for the reaction of Mg in HCl solutions of the indicated concentrations. Plot the data in the graph below by placing the reaction rate on the y-axis and the HCl concentration on the x-axis. Draw a best-fit line and use the graph to estimate the concentration of the unknown HCl solution.

HCl Concentration	Rate of Reaction (mol/sec)
0.5 M	0.008
1.0 M	0.015
1.5 M	0.025
2.0 M	0.031
???????	0.019



Unknown HCl Concentration

M HCl

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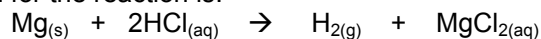
Student: _____
Partner: _____
Instructor: _____
Section: _____ Date: _____

DISCUSSION

The rate of a chemical reaction is defined as the change in the amount of reactant or product divided by the change in time. The amount of reactant or product is typically described in terms of moles. If the number of moles of a reactant that react and the time it takes for the reaction are both known, the rate of a reaction can be determined by the equation:

$$\text{Rate of Reaction} = \frac{\text{moles reactant}}{\text{time of reaction}}$$

In this lab you will investigate the effects of reactant concentration, amount of reactant, surface area of reactant and temperature of reaction upon the rate of the reaction of Mg metal with hydrochloric acid (HCl). The chemical equation for the reaction is:



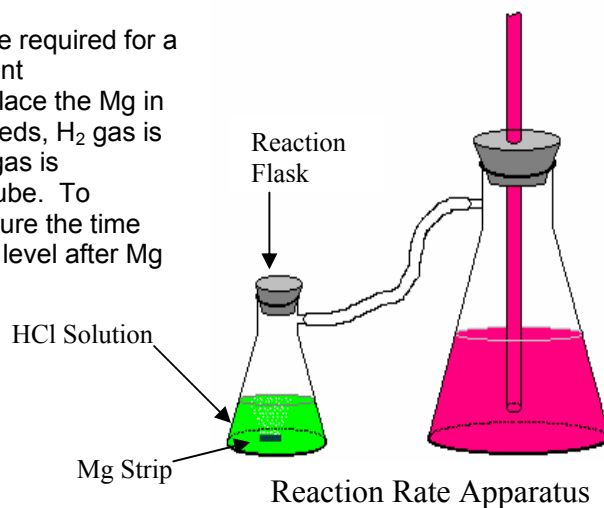
PROCEDURE AND REPORT

Affect of HCl Concentration upon Reaction Rate

1. Obtain 16 small strips of Mg ribbon and measure the mass of all 16 pieces.
2. Calculate the average mass by dividing #1 by 16.
3. Calculate the number of moles of Mg in one piece of Mg.

1. Mass of 16 small pieces of Mg	
2. Average mass of Mg piece	
3. Moles Mg in one piece Mg	

In this experiment you will measure the amount of time required for a small piece of Mg to react with HCl solutions of different concentrations. To make the measurement you will place the Mg in a flask containing HCl solution. As the reaction proceeds, H₂ gas is produced. The apparatus is designed so that as the gas is produced, the pressure of the gas forces water up a tube. To measure the time of the reaction you will simply measure the time that it takes for the water in the tube to reach a stable level after Mg has been added to the HCl.



- Place 20 mL of 0.5 M HCl in a reaction flask. Place 1 small piece of Mg into the flask and quickly stopper the flask. Gently swirl the flask as the reaction proceeds. Measure and record the time required for the HCl to react with all of the Mg. Repeat the process for trial #2. Calculate the average time of the reaction for the two trials. Calculate the rate of the reaction using the moles of Mg from #3 and the average time of reaction. Discard the solution.
- Repeat step #4 using 1.0 M HCl.
- Repeat step #4 using 1.5 M HCl.
- Repeat step #4 using 2.0 M HCl.
- Repeat step #4 using an HCl solution of unknown concentration. **Record the unknown number.**

HCl Concentration	Trial #1 Reaction Time (sec)	Trial #2 Reaction Time (sec)	Average Reaction Time (sec)	Rate of Reaction (mol/sec)
0.5 M				
1.0 M				
1.5 M				
2.0 M				
???????				

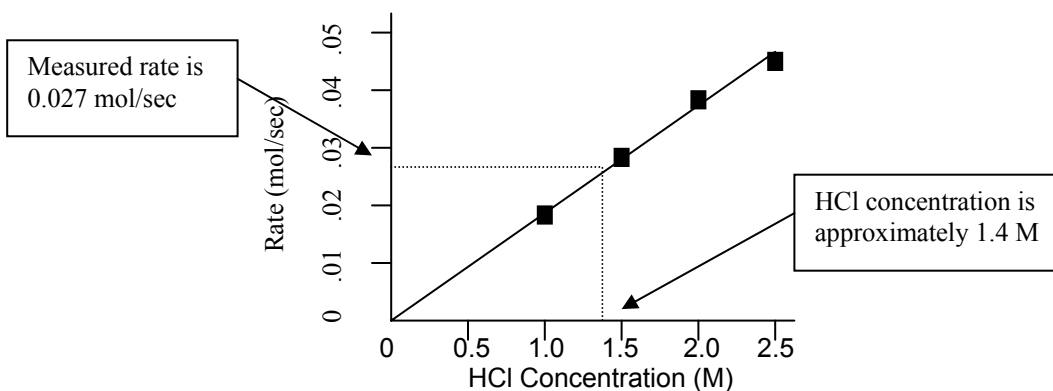
Calculations:

What effect does an increase in concentration of acid have on the rate of the chemical reaction?

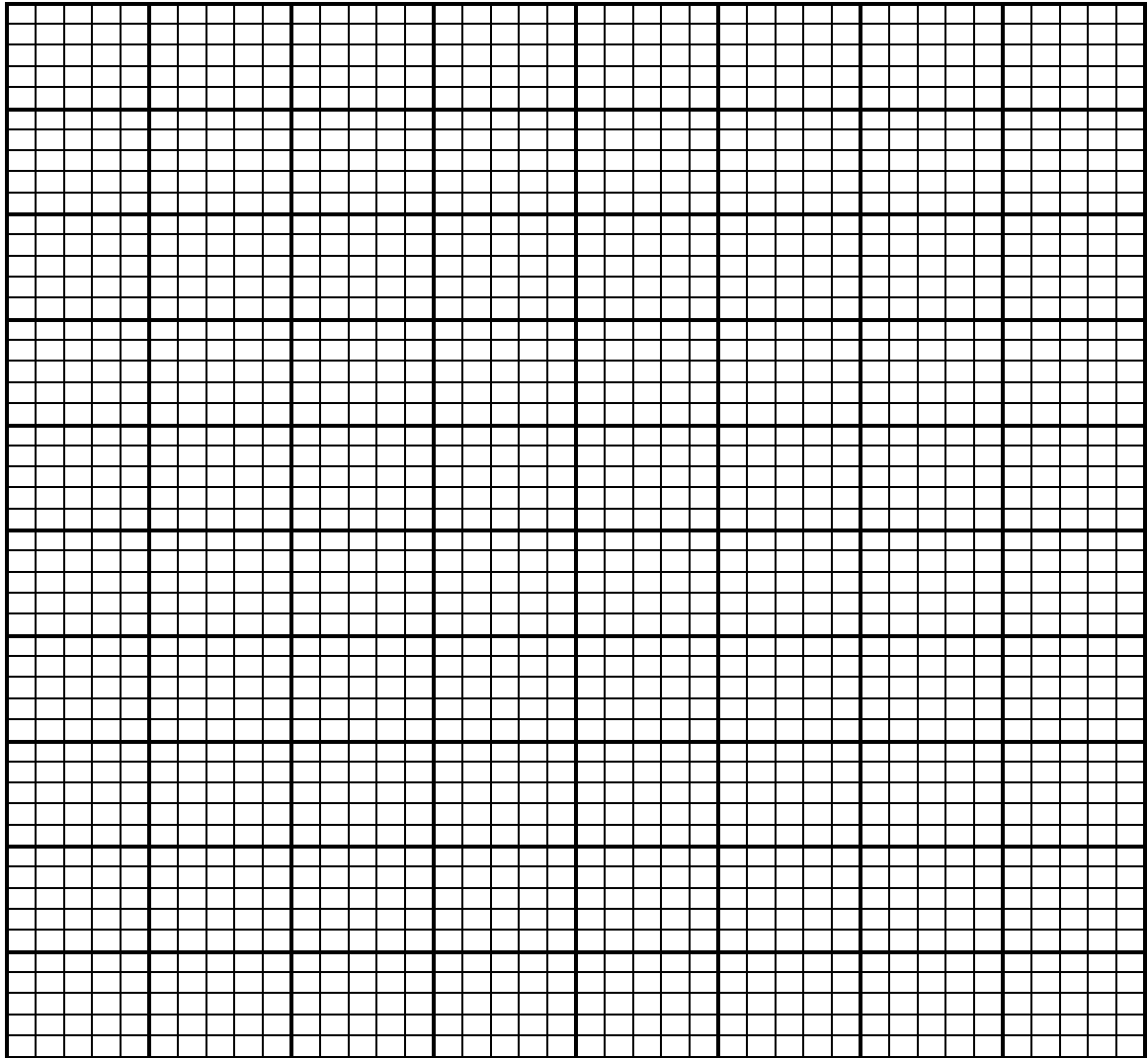
Why does the concentration affect the rate?

Plot the reaction rate and the HCl concentration data on the graph on the next page by placing the reaction rate on the y-axis and the HCl concentration on the x-axis. Adjust the scales so that the data is spread out and occupies as much of the graph as possible. When the points have been plotted, draw a best-fit straight line through them. Use the graph to determine the concentration of the unknown HCl solution. An example graph is shown below for an unknown that gave a reaction rate of 0.027 mol/sec.

Unknown Number: _____ **Concentration of HCl Unknown:** _____



Rate (mol/sec)



HCl Concentration (M)

Affect of Acid Volume upon Reaction Rate

- Place 40 mL of 1.0 M HCl in a reaction flask. Place 1 small piece of Mg into the flask and quickly stopper the flask. Gently swirl the flask as the reaction proceeds. Measure and record the time required for the HCl to react with all of the Mg. Repeat the process for trial #2. Repeat the calculations performed in the previous section.

HCl Concentration	Trial #1 Reaction Time (sec)	Trial #2 Reaction Time (sec)	Average Reaction Time (sec)	Rate of Reaction (mol/sec)
1.0 M				

- Compare your results for 40 mL of 1.0 M HCl with your previous 1.0 M results. The reaction times for this experiment and the previous 1.0 M results should be quite close, if they are not, see the instructor. **What affect does volume of the acid have on the rate of reaction?**

Affect of the Amount (Length) of Mg upon Reaction Rate

- Obtain 2 **long** strips of Mg ribbon and measure the mass of both pieces.
- Calculate the average mass by dividing #1 by 2.
- Calculate the number of moles of Mg in one long piece of Mg.

1. Mass of 2 long pieces of Mg	
2. Average mass of long Mg piece	
3. Moles Mg in one long piece Mg	

- Place 20 mL of 1.0 M HCl in a reaction flask. Place 1 **long** piece of Mg into the flask and quickly stopper the flask. Gently swirl the flask as the reaction proceeds. Measure and record the time required for the HCl to react with all of the Mg. Repeat the process for trial #2. Repeat the calculations performed in the previous section.

HCl Concentration	Trial #1 Reaction Time (sec)	Trial #2 Reaction Time (sec)	Average Reaction Time (sec)	Rate of Reaction (mol/sec)
1.0 M				

- Compare your reaction rate results for 1.0 M HCl and a long Mg strip with your previous results. **What affect does the length of Mg have on the rate of reaction?**

Affect of Temperature upon Reaction Rate

- Place 20 mL of 1.0 M HCl in a reaction flask. Using a bowl of ice, cool the flask down to near 0°C (after 3 to 4 minutes in the ice the HCl will be cool enough). Place 1 small piece of Mg into the flask and quickly stopper the flask. Gently swirl the flask as the reaction proceeds. Measure and record the time required for the HCl to react with all of the Mg. Repeat the process for trial #2. Repeat the calculations performed in the previous section.

HCl Concentration	Trial #1 Reaction Time (sec)	Trial #2 Reaction Time (sec)	Average Reaction Time (sec)	Rate of Reaction (mol/sec)
1.0 M				

- Compare your results for cold 1.0 M HCl with your previous room temperature results. **What affect does temperature of the acid have on the rate of reaction?**
- Give two reasons why the temperature has an affect on the rate.