NAME: HONORS CHEMISTRY

SECTION: Design Your Own Experiment: Reaction Kinetics

We will be studying the reaction rate for the following chemical process:

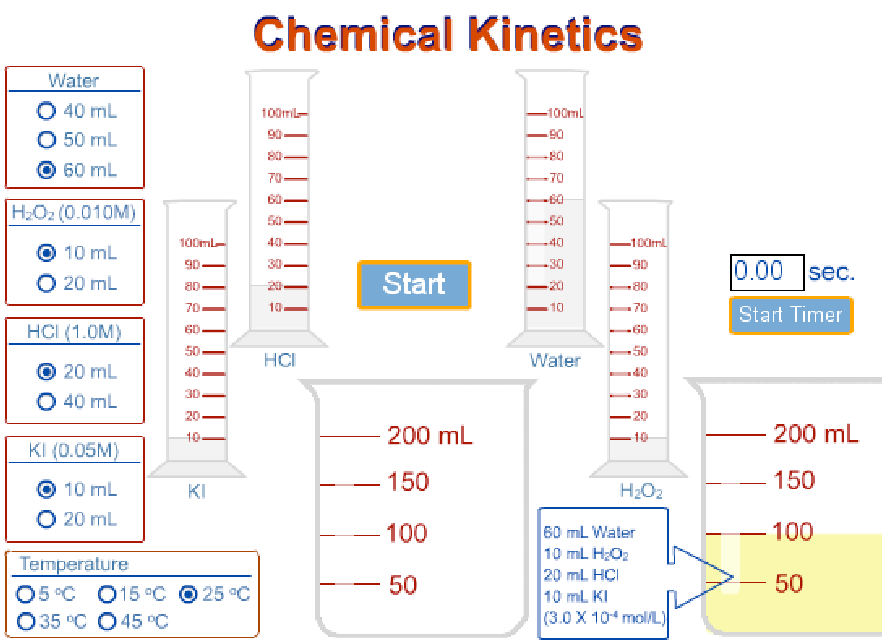
$$3\ I^-(aq) + H_2O_2\ (aq) + H^+(aq) \rightarrow I_3^-(aq) + H_2O(l)$$

The reactant solutions are colorless. The product, I_3^-, is colored. As the reaction proceeds, the intensity of the color increases, indicating that the concentration of the products is increasing. The reaction is slow enough so that the time it takes to get to a predetermined color intensity, and therefore a specific I_3^- concentration, can be conveniently timed. A standardized solution is available so that the colors can be matched.

Problem: How do concentration and temperature influence the rate of a chemical reaction?

Methods

Go to http://introchem.chem.okstate.edu/DCICLA/kinetics.html Your screen should look like the figure:



The reaction to be investigated occurs in the beaker when four colorless solutions from four graduated cylinders are mixed. Different amounts of the solutions can be added together at different specified temperatures. Radio buttons control these amounts and the temperature. A timer can be used to monitor how long it takes for the chemical reaction to proceed to the same level of completeness as the standard solution contained in a second beaker.

Do a few practice runs to get used to the simulation. How do you add reactants to the beaker? When do you start the timer? When do you stop the timer?

Planning the experiment

Part I: Concentration Effects

You need to design a procedure to determine the effects of concentration on reaction rate.

A: Effect of H_2O_2 concentration.

- Plan out a series of trials where the concentration of H_2O_2 changes, but the concentrations of HCl and KI are kept constant. Record the conditions of each trial in Table 1. Adjust the water volume so that the total volume is always 100 mL.
- What is your experimental variable?
- What variables will be kept constant?

B: Effect of HCl concentration

- Plan out a series of trials where the concentration of HCl changes, but the concentrations of H_2O_2 and KI are kept constant. Record the conditions of each trial in Table 1.

C: Effect of KI concentration

- Plan out a series of trials where the concentration of KI changes, but the concentrations of H_2O_2 and HCl are kept constant. Record the conditions of each trial in Table 1.

Part II: Temperature Effects

You need to design an experiment to test the effect of temperature changes on reaction rate.

What reactant concentrations will you choose? What temperatures will you use?

Record the conditions of each trial in Table 2.

Show your plan to your teacher before proceeding.

Doing the experiment

Part I: Enter the parameters of each trial in the simulation and determine the amount of time it takes for each trial to reach the standard color. Record your data in Table 1.

Part II: Enter the parameters of each trial in the simulation and determine the amount of time it takes for each trial to reach the standard color. Record your data in Table 2.

Data Analysis

Part 1: From the data in table 1, calculate the molar concentrations of H_2O_2, H^+ (from HCl) and I^- (from KI) for each trial. Record your results in Table 3.

$M_1V_1 = M_2V_2$

V_2 = total volume of each trial
M_1 = initial molarity of reactant solution
V_1 = volume used of each reactant solution
M_2 = final molarity of reactant solution

To calculate rates, take the inverse of the time in seconds for each trial to reach the standard color. Record your results in Table 3.

Part II: Calculate rates for each trial as you did in Part 1. Record your results in Table 4.

DATA

Table 1 Effects of Concentration

Trial	H_2O(l), mL	0.010M H_2O_2, mL	1.0M HCl, mL	0.050M KI, mL	Time (s)
1					
2					
3					
4					
5					
6					
7					
8					

Table 2 Effects of Temperature

Trial	H_2O(l), mL	0.010M H_2O_2, mL	1.0M HCl, mL	0.050M KI, mL	Temperature (^oC)	Time (s)
1						
2						
3						
4						
5						

RESULTS

Table 3

Trial	[H_2O_2]	[H^+]	[I^-]	Rate (s^{-1})
1				
2				
3				
4				
5				
6				
7				
8				

Table 4

Trial	Temperature (^{o}C)	Rate (s^{-1})
1		
2		
3		
4		
5		

Analyze and Apply Answer these questions in complete sentences on separate paper.

1. When the concentration of H_2O_2 doubled, how did the rate change? Your answer should be quantitative. (In other works, what kind of relationship did you observe between the concentration and rate? Were they directly related?) What trials did you use to come to your conclusion?
2. When the concentration of H_+ doubled, how did the rate change? What trials did you use to come to your conclusion?
3. When the concentration of I_- doubled, how did the rate change? What trials did you use to come to your conclusion?
4. Using a graphing program, or graph paper, plot the relationship between the temperature of the reactants and the rate of the reaction in Part 2 of this experiment. What happens to the rate of a chemical reaction as the temperature changes? What is the nature of this relationship? Are the changes directly proportional?

    Optional: How are they related mathematically? Using a graphing program plot the amount of rate vs. the temperature. Then use the curve fitting function of your graphing program to draw the best line through all of the points. Try each of the available functions and see which gives you the best fit. Record the equation of your best-fit line.

CONCLUSIONS

A. Make a generalization of how concentration changes affect the rate of a chemical reaction.

B. Make a generalization of how temperature changes affect the rate of a chemical reaction.