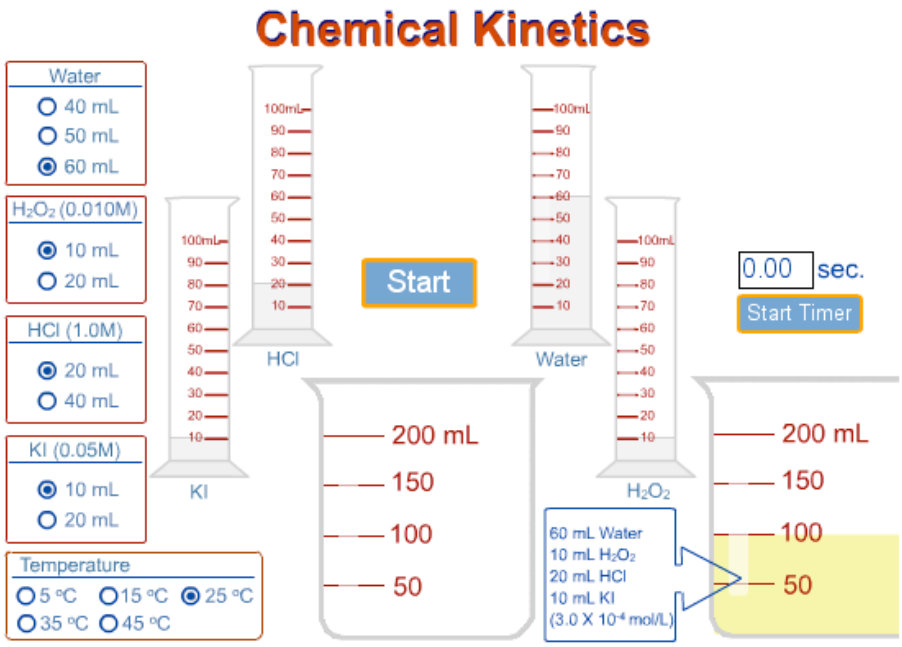
Concentration/Temperature Effects

Name_____ Lab Section_____

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

I. Data Collection:

A. Go to http://cheminfo.chem.ou.edu/~mra/home.html and open the Concentration/Temperature Effects Simulation. 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.

The chemical interactions that takes place is:

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

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 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.

B. If necessary, use the buttons to adjust the volume of the reactant solution to the amounts shown in the following table. Notice that the volume of water is adjusted so that sum of all the solutions when combined equals 100 mL. Make sure the temperature is set at 25ºC. Click on the start button. When the last solution is added, Click to start the timer. Pause the timer when the reaction solution changes to a color that matches the color of the standard solution. Record your data.

Trial	H_2O (l)	0.010 M H_2O_2 (aq)	1.0 M HCl (aq)	0.050 M KI (aq)	Time @ 25 ºC
1	60 mL	10 mL	20 mL	10 mL	
2					
3					
4					
5					
6					
7					
8					

C. Design trials to test the effect that changing the concentration of each of the reactants has on the rate of the reaction by varying the amounts of the reactants. Try and minimize the number of trials tried. Record the conditions of each trail in the table above. Remember to adjust the amount of water so that each trial has 100 mL of total solution. 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 the above table.

II. Data Analysis and Interpretation

A. From the data you collected in the table from section I. B. calculate the molar concentrations of H_2O_2, $[H_2O_2]$, H^+, $[H^+]$, and I^-, $[I^-]$, for each trial and record your results in the following table.

Trial	$[H_2O_2]$	$[H^+]$	$[I^-]$	Rate @ 25 ºC
1				
2				
3				
4				
5				
6				
7				
8				

B. The rate of a chemical reaction is inversely proportional to the amount of time it takes for the reaction to happen. (If it takes half the amount of time its rate is twice as big.) Calculate the average rate of each trial ($time^{-1}$) and record your results in the preceding table.

C. Relate the change in $[H_2O_2]$ to the change in average rate. How are they related? Are the changes directly proportional? What trials did you use to come to your conclusions?

D. Relate the change in $[H^+]$ to the change in average rate. How are they related? Are the changes directly proportional? What trials did you use to come to your conclusions?

E. Relate the change in [I^-] to the change in average rate. How are they related? Are the changes directly proportional? What trials did you use to come to your conclusions?

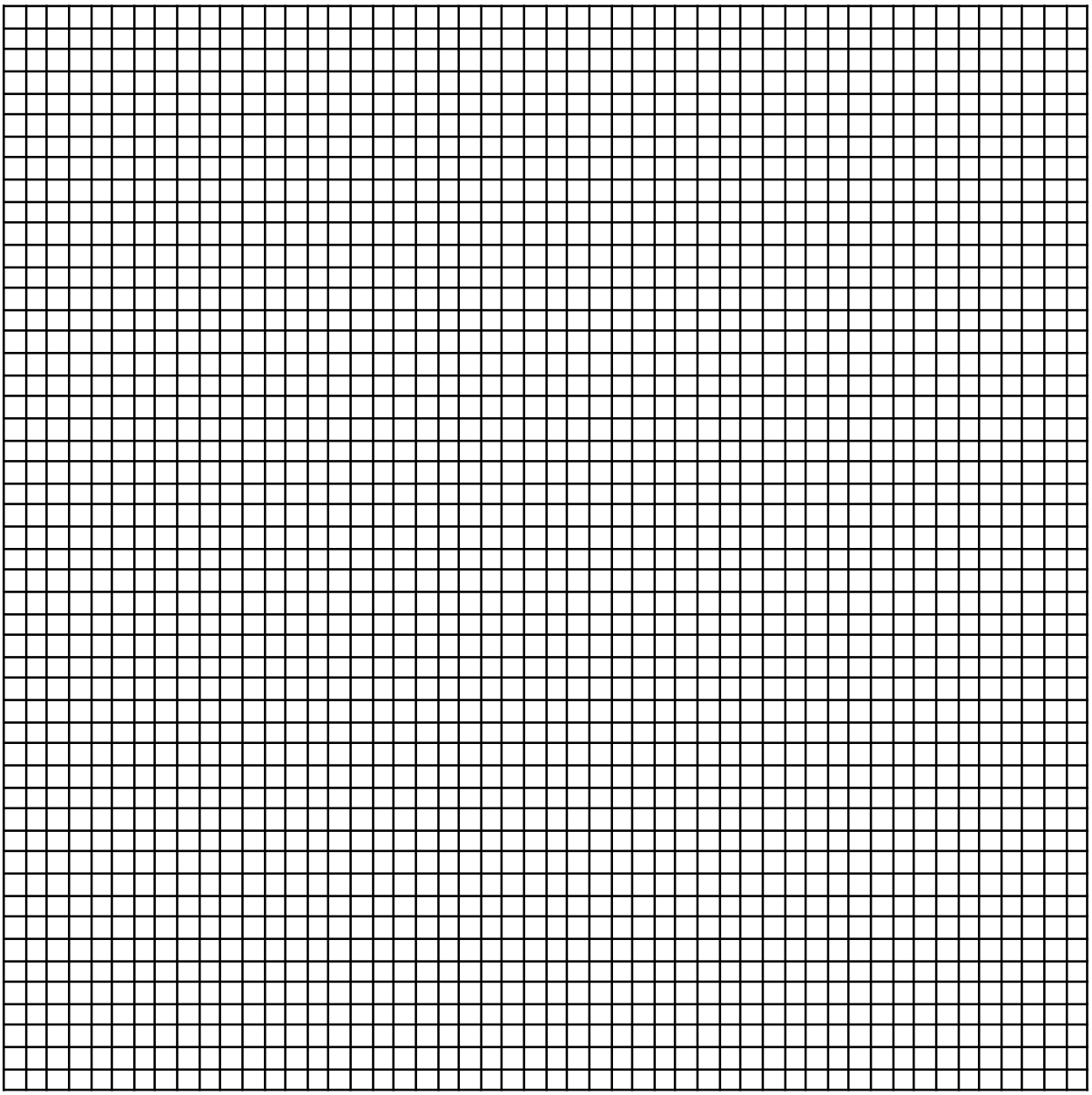
III. Data Collection:

Using the concentrations of trial 1 from section I. B. copy the rate for 25 ºC into the following table. Repeat the experiment using the trial 1 concentrations at each of the specified temperatures. Calculate and record the rates in the following table.

Trial	[H_2O_2]	[H^+]	[I^-]	Rate @ 5 ºC	Rate @ 15 ºC	Rate @ 25 ºC	Rate @ 35 ºC	Rate @ 45 ºC
1								

IV. Data Analysis and Interpretation

On the following graph, or using a graphing program, plot the relationship between the temperature of the reactants and the rate of the reaction in trial 1. 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.)



V. 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.