Vitamin C Clock Reaction: Integrated Rate Laws

Objective: In this experiment you will determine the rate order in H_2O_2 and the rate constant for the reaction of H_2O_2 with iodide. The concentration of reagent and reaction times will be calculated/measured. Plots of integrated rate laws will be performed to indentify the best fit for the data and assign the order in H_2O_2.

$$H_2O_2 + 3I^- + 2H^+ \rightarrow I_3^- + 2H_2O$$

Starch is present in the reaction mixture as an indicator for the product, I_2. When I_3^- binds to starch you see a dark blue-black color.

The reaction in this experiment is called a clock reaction because instead of observing the gradual appearance of the product (I_3^-), you will add another reagent, vitamin C, to use up I_2 (see reaction below) as fast as it is formed by the reaction with H_2O_2. As soon as vitamin C is gone, however, the I_2 will persist and you will see the expected dark blue-black starch-iodine color.

$$I_3^- + C_6H_8O_6 \text{ (vitamin C)} \rightarrow 2H^+ + 3I^- + C_6H_6O_6$$

For a "clock experiment" to work, the process that uses up the product of the reaction of interest must be much faster than the reaction under study. Additionally, the reagent that reacts with the product must be present in limiting amount so that once the reagent is consumed an indicator (like starch) will change color.

Materials:

0.25 M H_2O_2
1.25 M NaI
0.11 M vitamin C
1 M Acetic acid with starch
distilled water
3 5 ml syringes
2 1 ml syringes
6 large test tubes
a stopwatch

Data: Over the course of this experiment, you will fill out the data table below by mixing the appropriate amount of each reagent in a large test tube and recording the time it takes from the addition of the hydrogen peroxide until a color change is observed.
Add the reagents in the order listed from left to right and start the timer immediately after adding the H_2O_2.

Do you notice any trends as you change the amount of vitamin C?

Trial	Vitamin C (ml)	Acetic Acid (ml)	Iodide (ml)	H_2O (ml)	H_2O_2 (ml)	Time (sec)
1	3	0.5	3	0	1.5	
2	2.5	0.5	3	0.5	1.5	
3	2	0.5	3	1	1.5	
4	1.5	0.5	3	1.5	1.5	
5	1	0.5	3	2	1.5	
6	0.5	0.5	3	2.5	1.5	

Calculations:

1. Calculate the actual concentration of H_2O_2, I^- and Vitamin C at the beginning of each run [M*(# of ml/total # of ml). Calculate how much H_2O_2 and I^- are left at the end-point (after Vitamin C is consumed, when you see a color change).
2. Plot [H_2O_2] vs t.
3. Plot ln[H_2O_2] vs t.
4. Plot 1/[H_2O_2] vs t.
5. Determine the order in H_2O_2 and the apparent rate constant.