Archbishop Mitty

Chemistry Honors

Iodine Clock Reaction Lab

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1 Purpose

The purpose of this lab experiment is to:

- Help students understand the effects of concentration and temperature on solutions with respect to reactions

The chemical reactions that take place in this lab are:

- I_2 (aq) + $H_2C_6H_6O_6$ (aq) $\rightarrow$ $2H^+$ (aq) + 2 I^- (aq) + $C_6H_6O_6$ (aq)
- $2H^+$ (aq) + 2 I^- (aq) + H_2O_2 (aq) $\rightarrow$ I_2 (aq) + $2H_2O$ (l)

2 Materials and Safety

2.1 List of Materials

- Solution A (pre-prepared)

  Vitamin C (1 ml) $\times$ 5

  Tincture of Iodine (2%,1 ml) $\times$ 5

  Distilled water (1 ml) $\times$ 60

- Solution B (pre-prepared)

  Hydrogen peroxide (1 ml) $\times$ 15

  Laundry Starch (1 ml) $\times$ 2

  Distilled water (1 ml) $\times$ 60

- Glass test tube (50 ml) $\times$ 4
- Deionized water squirt bottle $\times 1$
- Digital thermometer $\times 1$
- Digital stopwatch $\times 1$

2.2 Safety Information

2.2.1 Vitamin C

This substance can be dangerous if it comes into contact with skin or eyes. Flush affected eyes with water for at least 15 minutes and seek medical attention. Wash affected skin with soap and water, and cover with an emollient. If irritation develops, seek medical attention[1].

2.2.2 Tincture of Iodine

This substance can be dangerous if it comes into contact with the skin or eyes. Flush the affected area with water for at least 15 minutes and get medical attention[2].

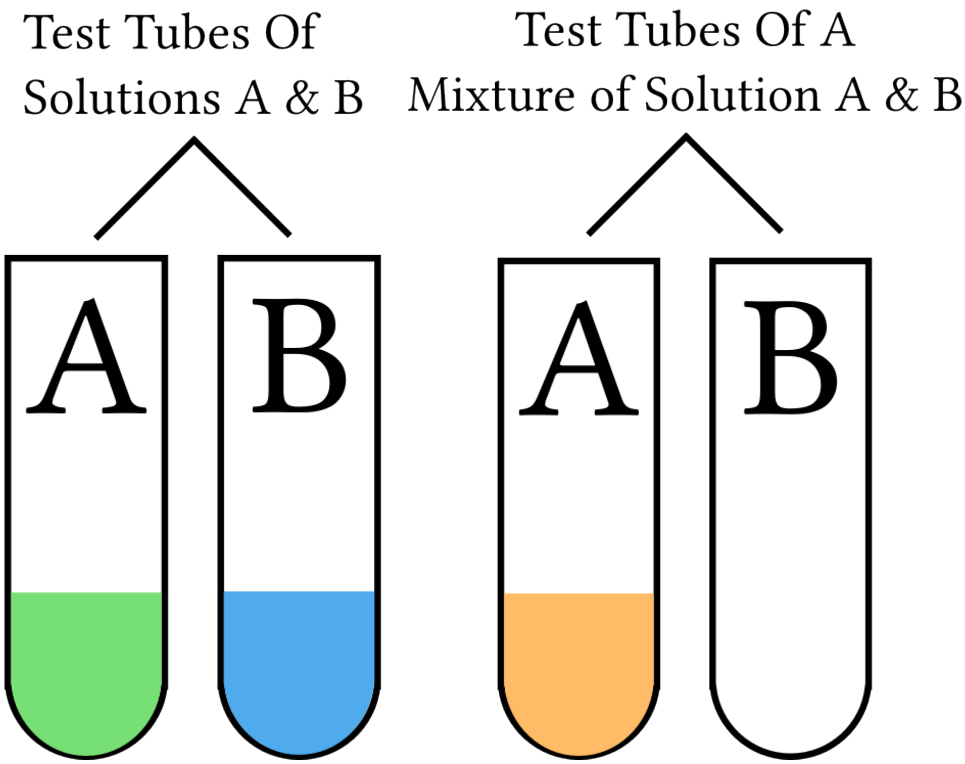
2.2.3 Hydrogen Peroxide

This substance can be dangerous if it comes into contact with the skin or the eyes. Flush the affected area with water for 15 minutes and get medical attention[3].

[1] https://www.sciencelab.com/msds.php?msdsId=9922972
[2] http://www.sciencelab.com/msds.php?msdsId=9924377
[3] http://www.sciencelab.com/msds.php?msdsId=9924298

3 Apparatus and Procedure

3.1 Apparatus



3.2 Procedure

3.2.1 The Effect of Concentration Changes

1. Use a dial volumetric dispenser attached to a plastic serological pipet, measure the given volume of distilled water, and pour it into a clean, dry test tube that you have labeled “A”.

Group Number	Distilled Water
All Groups	0.0 mL
1 - 2	5.0 mL
3 - 4	10.0 mL
5 - 6	15.0 mL
7 - 8	20.0 mL

2. With the pump dispenser at the prep table, add 5.0 mL of Solution A to test tube “A” that already contains the distilled water. Swirl to mix.

3. With the pump dispenser in the fume hood, measure 5.0 mL of Solution B into a separate clean, dry test tube that you have labeled “B”. In each case, the temperature (room temp.) will be kept constant.

4. Using a stopwatch, press the “start” button as you pour solution A into solution B, then pour them back and forth quickly three times to obtain a uniform mixing. Time should be recorded from the instant at which both solutions are in contact.

   Observe the reaction carefully, and stop the timer **immediately** at the first sign of a color change.

5. Record your reaction time in the appropriate box in the data table for your class (which you will later transfer to your lab notebook, along with detailed observations). Then, empty the contents of each test tube into the labeled hazardous waste container. Rinse each test tube with distilled water, and dry each tube to the best of your ability.

6. Each group has been assigned two different combinations in the above chart (the top row, and one other). Repeat steps 1-4 for your second combination.

7. As a class, record the room temperature at which all of these reactions have been conducted. This temperature will be used for your Analysis section later.

3.2.2 The Effect of Temperature Changes

1. Using the same techniques as in Part 1, dispense 5.0 mL of Solution A into your clean, dry "A" test tube, and dispense 5.0 mL of Solution B into your clean, dry "B" test tube.

2. These solutions must be brought to the desired temperature before they are mixed. Put both the "A" and "B" test tubes into a 250-mL beaker that is about two-thirds full of water at the temperature you were assigned to investigate. Let them stand for about 10 minutes, so the solutions will come to the temperature of the "water bath".

Group Number	**Approximate Temperature of Solution**
All Groups	Room Temperature
1 - 2	1° C
3 - 4	10° C
5 - 6	35° C
7 - 8	50° C

3. Using a stopwatch, press the "start" button as you pour Solution A into Solution B, then pour them back and forth quickly three times to obtain a uniform mixing. Time should be recorded from the instant at which both solutions are in contact.

   Observe the reaction carefully, and stop the timer immediately at the first sign of a color change.

4. Record your reaction time in the appropriate box in the data table for your class (which you will later transfer to your lab notebook, along with detailed observations). Then, empty the contents of each test tube into the labeled hazardous waste container. Rinse each test tube with distilled water, and dry each test tube to the best of your ability. Place both test tubes upside down in your test tube rack, return all materials to your lab bin, and wash your hands.

4 Data Table

Substance	**Property**	**Value**	**Unit**
Room	Temperature	24.4	°C
Vitamin C	Amount	1.000	g
Stock Solution	Volume	5	mL
Solution A	Volume	70	mL

5 Observations

5.1 Before Reaction

Solution A is a translucent yellowish liquid that seems to have a viscosity that is approximately equal to water. Solution B is a transparent and colorless liquid that seems to have a viscosity that is approximately equal to water.

5.2 During Reaction

When the two solutions react, the mixture in the tube moves toward a dark purple color from a translucent yellowish color.

5.3 After Reaction

When Solution A and Solution B are combined, we find that the result is an opaque royal purple liquid with a viscosity approximately equal to water. When we disposed of the mixture, the jar which contained it all was an opaque black color.

6 Analysis and Results

6.1 Analysis and Results

6.1.1 Overall Results

There were two chemical reactions that took place during this experiment:

- I_2 (aq) + $H_2C_6H_6O_6$ (aq) $\rightarrow$ $2H^+$ (aq) + 2 I^- (aq) + $C_6H_6O_6$ (aq)
- $2H^+$ (aq) + 2 I^- (aq) + H_2O_2 (aq) $\rightarrow$ I_2 (aq) + $2H_2O$ (l)

The molarity of the Vitamin C solution pre-prepared for this experiment is:

$1.000\ \cancel{\text{g}}\ \text{Vitamin C} \times \frac{1\ \text{mol}}{176.12\ \cancel{\text{g}}}$ = 0.005678 moles / 0.0700 L = **0.0811 M**

We can determine the molarity of Vitamin C in Solution A to be:

$0.0811\ \text{M} \times \frac{5.0\cancel{\text{mL}}}{70.0\ \cancel{\text{mL}}}$ = **0.0058 M**

6.1.2 Effect of Concentration

The molarity for each of the trials was:

- 5.0 mL added water:

  $0.0058\ \text{M} \times \frac{5.0\ \cancel{\text{mL}}}{15.0\cancel{\text{mL}}}$ = **.0019 M**

- 10 mL added water:

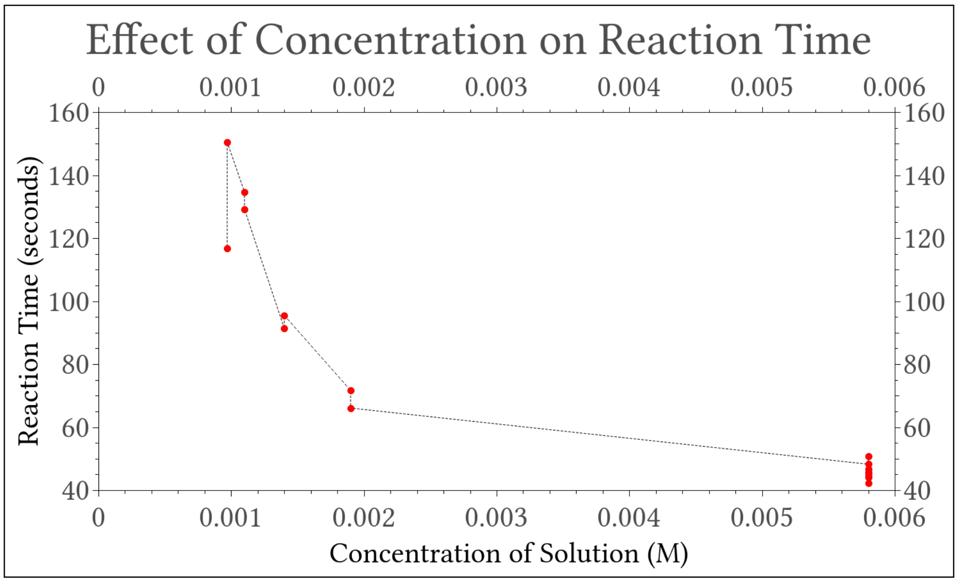
  $0.0058\ \text{M} \times \frac{5.0\ \cancel{\text{mL}}}{20.0\cancel{\text{mL}}}$ = **.0014 M**

- 15 mL added water:

  $0.0058\text{ M} \times \frac{5.0 \cancel{\text{mL}}}{25.0\cancel{\text{mL}}}$ = **.0011 M**

- 20 mL added water:

  $0.0058\text{ M} \times \frac{5.0 \cancel{\text{mL}}}{30.0\cancel{\text{mL}}}$ = **.00097 M**



The main thing that this lab teaches me is that as the concentration of a solution decreases, it takes far longer for the reaction to complete. The main reason behind this is that the particles in a certain amount of the solution are decreased, so they are less likely to bump into each other, and thus react.

To calculate the average deviation, first we add together all of our reaction times with a concentration of 0.0058 M:

42.21 seconds + 44.08 seconds + 46.6 seconds + 45.61 seconds + 44.44 seconds + 45.26 seconds + 50.68 seconds + 48.23 = **367.11 seconds**

Now we divide that value by the total number of times to get:

$\frac{367.11 \text{ seconds}}{16 \text{ total times}}$ = **45.88875 seconds per time**

Next, we take each element, calculate its distance from the average, and add the differences to get:

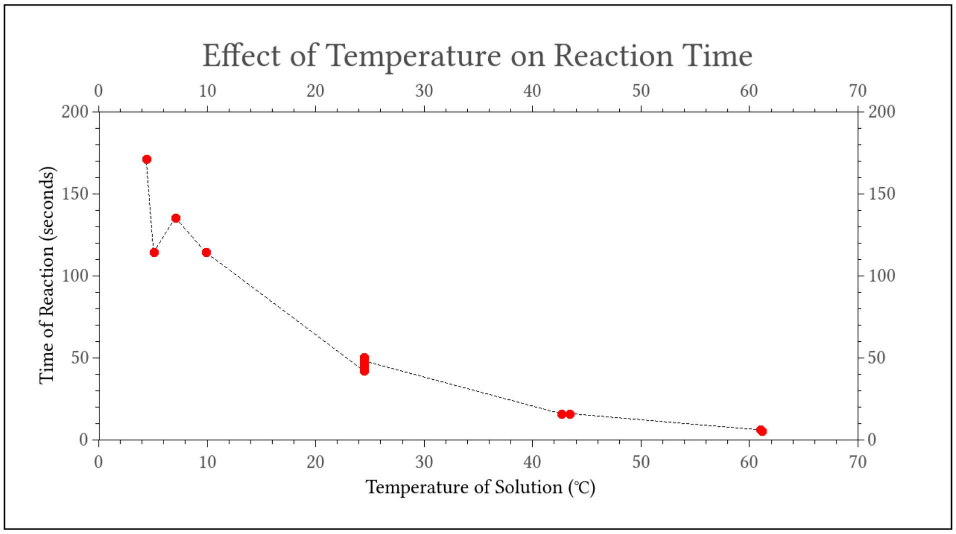
3.67875 seconds + 1.80875 seconds + 0.71125 seconds + 0.27875 seconds + 1.44875 seconds + 0.62875 seconds + 4.79125 seconds + 2.34125 seconds = **15.6875 seconds**

Now we divide that value by the total number of times to get:

$\frac{15.6875 \text{ seconds of deviation}}{16 \text{ total times}}$ = **1.961 seconds of average deviation**

This average deviation is a relatively small value. It is equal to about 4.273% of the average reaction time, and therefore I believe that the method used to determine the reaction time was precise. However, there is an inherent imprecision in the fact that the starting and stopping points of time measurement were controlled by human reaction time, which is fundamentally limited. If this footage was instead videotaped and then timed by using reference points in the resulting video file, I believe that the precision of time measurement would be higher.

6.1.3 Effect of Temperature



The main thing that this lab has taught me is the fact that as the temperature of a solution increases, the speed at which a reaction occurs is increased. As the temperature of the particles in the solution goes up, the average amount of energy, and thus the speed at which they move, goes also rises, and thus they are far more likely to bump into one another and thus react.

Another possible way to increase the speed of reaction would be to use elements which are more reactive because then the reaction occur far quicker because the particles in those elements would be moving far faster at the same temperature more, and thus increase the speed at which the reaction occurs.

6.2 Results Table

Total Volume of Solution (mL)	Molarity of Vitamin C (M)
10.0 mL	.0058
15.0 mL	.0019
20.0 mL	.0014
25.0 mL	.0011
30.0 mL	.00097

Property	Value	Units
Average Deviation	1.961	seconds
Average Reaction Time (10mL, Room temperature)	45.89	seconds

7 Conclusions

7.1 Conclusions

This lab teaches students about the catalysts that can affect the speed of a reaction, as well as about the concentration and dilution calculations necessary to determine the molarities of solutions. Although there is no percent error because there was no definitive time known for the used elements, several sources of error can nevertheless be obtained and analyzed. One of the more likely sources of error stems from the fact that these tubes used to perform the experiment were not pure - they had been cleaned with water, and thus there might have been more water in the solution than there should have been. This would have increased the concentration, and thus icnreased the time of reaction, thus classifying it as a positive error. Another likely source of error stems from the fact that Some of either Solution A or Solution B could have been spilled in the process of being poured back and forth between the two test tubes. If some liquid fell out, the concentration would again decrease, thus increasing the time, and thus also classfying this source of error as a positive error.