Iodine Clock Reaction

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INTRODUCTION

A chemical reaction is a process in which one or more molecules react with each other and are changed into other molecules. These are a part of many of the things we use or benefit from every day. For example, batteries, car engines, and plastics all require chemical reactions. Since chemical reactions are so significant in our lives, understanding how we can control them is very important. For example, this would help with product safety and for getting the most out of the products that use chemistry. The iodine clock reaction is a chemical reaction that can teach the basic principles of controlling chemistry. The iodine clock reaction is when two clear liquids are mixed, resulting in another clear liquid. After a few moments, the liquid instantaneously turns dark blue. The reason that the solution remains clear momentarily is because there are two competing reactions: Reaction A and Reaction B (Figure 1).

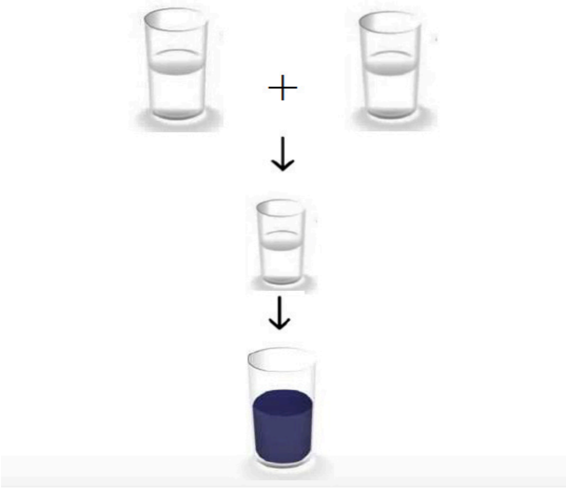

Figure 1.

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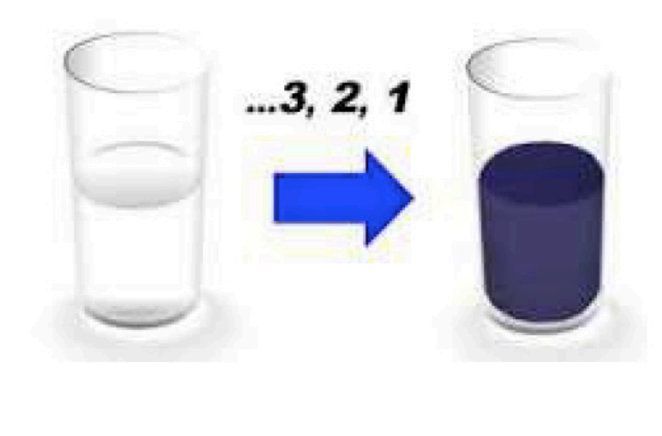

the seawater reacted with the calcium carbonate of the shell, Reaction A is a slow reaction in which hydrogen peroxide reacts with iodine that produces a chemical that looks like this: I3. This is called triiodide. As soon as each triiodide chemical is produced, it immediately gets consumed by Reaction B.

Reaction A: Hydrogen Peroxide + Iodine → Triiodide + Water

Reaction B is a fast reaction that uses vitamin C to change the triiodide back to iodine, which keeps the solution clear.

Reaction B: Triiodide + Vitamin C → Iodine + Sulfur Derivative

Eventually, the vitamin C that is keeping the solution from turning blue runs out, and the triiodide chemicals are not being consumed by Reaction B anymore. Now triiodide reacts with the starch, and this results in the solution turning a dark blue.

Triiodide + Starch Starch → Complex (blue)

The competing reactions (Reactions A vs. B) explain the delayed colour change in the experiment.

PURPOSE

The purpose of this experiment is to determine how changing different variables can affect the rate of the iodine clock reaction. The variables to be tested are:

1) Temperature
2) Concentration of vitamin C
3) Stirring

HYPOTHESES

My prediction for the effect of temperature is that the solution will turn blue faster when it is warmer because, according to the particle theory, particles will move faster in higher temperatures. My prediction for the concentration of vitamin C is that more of it will cause a delayed reaction in the solution, because there will be more chemicals to try and keep the solution clear. My prediction for the effect of stirring is that the solution will turn blue more quickly, because particles are constantly in motion, so if you make them move faster (which I will be doing while stirring), they will complete their "battle" more quickly. My prediction for the effect of concentration is that the solution will turn blue faster because the particles are closer together.

MATERIALS:

- Clear plastic cups
- 1000 mg Vitamin C
- Iodine (2%)
- Hydrogen peroxide (3%)
- Liquid starch
- Safety goggles
- Measuring spoons
- Measuring cup

METHODS

Note: Each experiment was repeated two times. The final result is the average of the two separate experiments.

Standard Clock Reaction Procedure

1. Put on the safety goggles and put the vitamin C (powder form) in the first cup. Add 60 ml of warm water. Stir for at least 30 seconds. This will be LIQUID A.
2. Now put 2.5 ml of LIQUID A into a new cup and add 60 ml of warm water and 5 ml of iodine. This is LIQUID B. You will no longer need LIQUID A.
3. In the last cup, mix 60 ml of warm water, 15 ml of the hydrogen peroxide and 15 ml of the liquid starch. This is LIQUID C.
4. Pour all of LIQUID B into LIQUID C. Pour them back and forth five times. Place the cup down, start the timer and observe. Stop the timer when the colour changes to dark blue.

Testing the Effect of Temperature

Follow the standard procedure but test three different water temperatures: ice-cold, room temperature, and hot (boiled). Once LIQUIDS B and C have been mixed, time how long it takes for the solution to turn blue.

Testing the Effect of Vitamin C concentration

Follow the standard procedure but double the amount of vitamin C. Once LIQUIDS B and C have been mixed, time how long it takes for the solution to turn blue.

Testing the Effect of Stirring

Follow the standard procedure but once LIQUIDS B and C have been mixed, stir the solution until it turns blue. Time how long it takes.

Testing the Effect of Solvent Volume

Follow the standard procedure but LIQUIDS B and C are dissolved into 30 ml of water instead of 60 ml.

OBSERVATIONS

During the original experiment (standard procedure), after I had combined LIQUID B and LIQUID C, it was approximately three minutes until the mixed solution turned a burnt-orange colour, which, in a matter of seconds, changed to the deep blue colour that was expected. The next experiment, which was to double the amount of vitamin C, had the same results as the standard procedure, but it took almost 7 minutes. In the experiment where I tested the effect of temperature, the colour change occurred differently. When boiled hot water was used, the colour changed to blue on the second pour before even starting the timer. For the cold water experiment, the reaction occurred from the top of the glass to the bottom. It also took approximately 4.5 minutes, which was longer than when warm water was used. The next experiment, in which I tested the effect of stirring, had the same observations as seen for the standard procedure, but took only about 1.5 minutes. In the final experiment, where I only used ½ the amount of water, the colour changed to blue on the third pour, before starting the timer.

ANALYSIS

Please see Appendix for all figures.

DISCUSSION

This project demonstrates various ways that chemical reactions can be controlled. This was done by using the classic iodine clock reaction as an example. The first experiment variation that I did was the effect of the concentration of vitamin C. The purpose of this experiment was to find out if the concentration of vitamin C affected the final result. My hypothesis was that more vitamin C would cause a delayed reaction, which was correct. My timing results may not be completely accurate because the vitamin C did not completely dissolve in solution (LIQUID A). Although I stirred the vitamin C mixture before taking the 2.5 ml of LIQUID A to mix with LIQUID B, it is possible that a different amount of undissolved vitamin C was taken each time. This would affect the time that it takes for the final mixture to turn blue. This might have affected the results of all my experiments. The next experiment was testing the effect of temperature. The purpose of this experiment was to see if temperature has an effect on the speed of a reaction. My hypothesis was that cold water would delay the reaction and hot water would speed it up, and my data supports my hypothesis. In the variation when I had used cold water, the blue colour appeared from the top to the bottom. The reason for this is that, according to the particle theory, particles will move faster in higher temperatures. Also, cold water sinks, making the warmer water on the top of the solution, and therefore beginning the reaction on the top. When I used boiling water, the reaction began and finished before I had had the chance to start the timer. This is because, once again, the higher the temperature of a solution, the faster the reaction will occur. The third experiment variation was testing the effect of stirring. The purpose of this experiment was to see if stirring has an effect on the speed of a reaction. My hypothesis was that it would speed up the reaction, and, according to my results, that is true. In this variation of the original experiment, there were no deviations from what I expected. The reaction was sped up with stirring because, according to the particle theory, the faster particles move, the more quickly they react and the more often they bump into each other. The fourth and final experiment variation that I did was to test the effect of solvent concentration. The purpose of this experiment was to see if the concentration of a solution affects the speed of a chemical reaction. My hypothesis was that the solution would turn blue more quickly, which was proven correct. Once again, there were no deviations from what I had expected from this experiment. The reaction was sped up with less water because, according to the particle theory, the closer the particles are together, the faster they move and the more often they bump into each other, making them react to each other more quickly. These experiments that I have done demonstrate controlling a chemical reaction. The

importance of controlling chemical reactions in everyday life is astounding. For example, making fire. In order to do this, we have to have harnessed and gained control over the reaction between

wood and oxygen. Some other examples are: how to fumigate rooms, making bread dough rise, and how to release metals from their ores.

CONCLUSION

The purpose of these experiments was to examine how different variables can be changed to have an effect on a chemical reaction. My overall results show that chemicals react faster if they are heated, stirred, or have higher concentration, and that they react slower if they are cold, not stirred, or have competing molecules in the reaction.

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APPENDIX

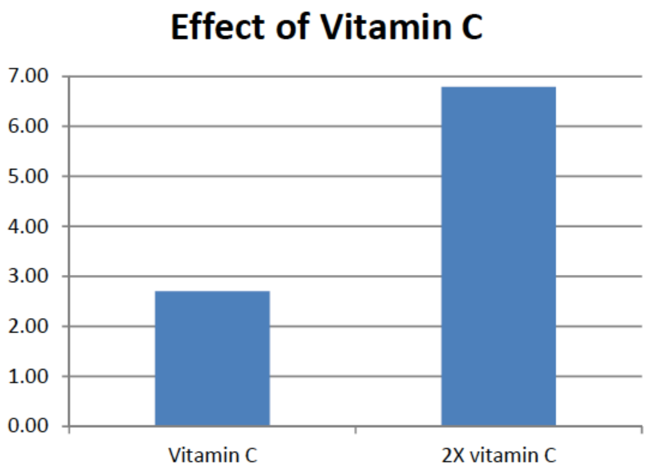

Figure 1.

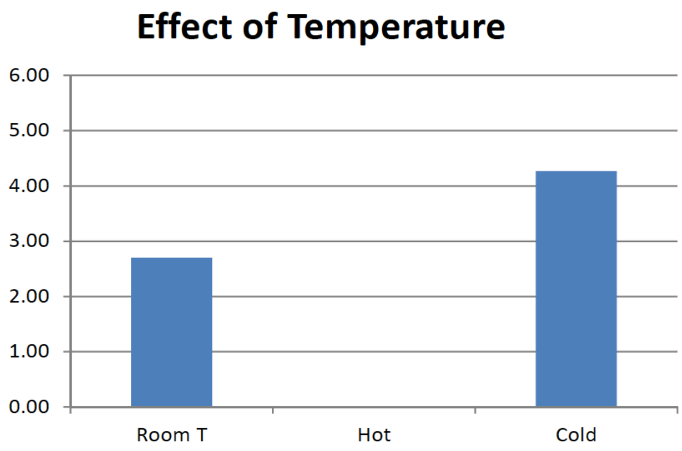

Figure 2.

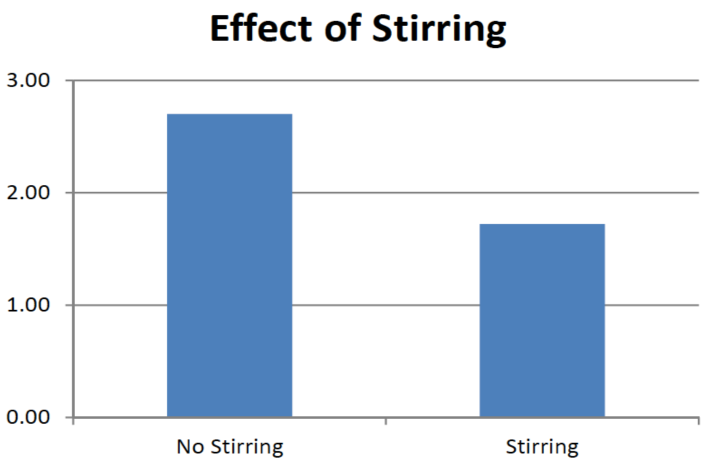

Figure 3.

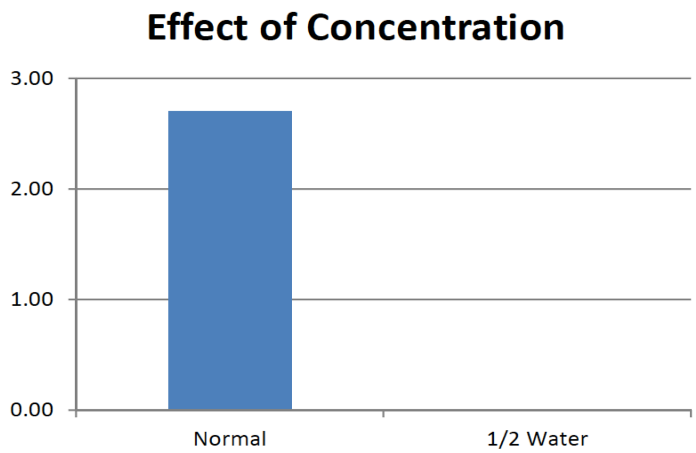

Figure 4.