Concentration And Reaction Rate Essay, Research Paper

How concentration affects reaction rate.The aim of this investigation is to see how the concentration of a reactant in ratio to the reactor affects the rate of a reaction. When hydrochloric acid and Thiosulphate react together sulphur is liberated this means that as the reaction goes on the solution will become yellow and will change from being transparent to translucent to opaque. The sulphur is formed as a solid but not in the usual precipitation way.

Na2 + S2 + 2HCL 2NaCl+SO2 + S2 +H2O

To time the reaction I will draw a black cross on a piece of plain paper on which the beaker of reactants will be placed (HCL and Thiosulphate). When the chemicals come into contact with each other I will start timing with a stopwatch and will stop timing when the cross is longer visible through the beaker from above.

A reaction:A chemical reaction between to chemicals can only happen if their molecules can collide into each other. Out of many collisions there will be a few successful collisions, which means that the two molecules will exchange electrons and that means that they have reacted. These molecules have to hit each other in the right direction and at the right speed; in short the rules for a ?successful collision? are specific and complex. But if the number of collisions per second increase so will the number of successful collisions increase. This means that the rate of the reaction has increased. For a reaction to occur you also need the required activation energy which means that if there isn?t enough the reaction won?t take place although catalysts can lower this.

Input Variables:Catalyst

Concentration of acid or thiosulphate

Temperature

Light

Temperature:If you increase the amount of energy in a group of molecules the reaction rate will increase. When you give energy to molecules they tend to move about a bit more. And this means that if they are moving rapidly from place to place they are going to have a lot more collisions and because they are having lots of collisions the chances are that they will have a successful collision a lot more quickly than if they weren?t.

This basically means that reaction rate is increased as temperature increases.

I believe that temperature is directly proportional to reaction rate.

As you can see the graph is partly true to the above statement but gradually starts to curve off, this is because at a point the intense temperature will start to boil the liquids which means they will start to evaporate and concentration will be affected.

Catalyst: Activation energy is usually the amount of energy required to start a chemical reaction. A catalyst is a substance able to increase reaction rate whilst itself undergoes no change is mass or chemical composition. It does this by offering an alternative route for the reaction by lowering activation energy.

The result is that a greater proportion of the unsuccessful collisions become successful collisions because they can meet the lower energy requirement.

So there is an increase of ?successful collisions? and the rate increases without increases in temperature.

In some cases this can mean a lower temperature can be employed. An example could be hydrogen peroxide and catalase, catalase helps breakdown hydrogen peroxide into water and oxygen.

Concentration:Concentration of a reactant affects reaction rate because there are more frequent successful collisions.

Assume a person has two chemicals x and y, which react when put together.

If all input variables remained constant apart from concentration then fastest reaction rate possible would be to mix (in equal quantities which means 1 mole of x reacts with 1 mole of y) x and y together in their purest forms. This is because every time an x molecule collides into a molecule it has a 50% chance of it being a y molecule. But if you removed half of y and replaced it with a neutral chemical such as z the chances of a x molecule bumping into a foreign molecule decreases from 50% to about 25%.

This means that as concentration of y decreases so does reaction rate. This could be true for x. The same theory applies with HCL acid and Thiosulphate, so as thiosulphate concentration increases so will reaction rate. I believe that if you plotted percentage of thiosulphate against rate of reaction you would get a straight line, which also means that I predict that they are directionally proportional to each other.

Percentage of thiosulphate reaction rate \* k (k being constant such as the input variables).

As you can see only 2 molecules can react with 2 HCL molecules. But if there was less water this happen:

Now 4 molecules of Mg. The reaction would be quicker than the above because:

What happens is that water molecules tend to get in the way of collisions, so if there are more water molecules in between two chemicals those two chemicals can?t really get to each other, so really water tends to ?clog up? the collisions like sawdust may clog up machinery.

Light:I am not sure if light does affect the rate of reaction in this case but it may be absorbed as heat in which case it could quicken reaction rate. Light tends to affect experiments that involve salts such as silver nitrate. In some cases it helps to lower activation energy like a catalyst. But light intensity can be absorbed as heat so as light intensity increases so does temperature, and temperature does affect reaction rate so through ?out the entire experiment I will treat light as an input variable to be controlled. See temperature as to how heat affects reaction rate.

Output variable:The best way to measure the rate of reaction is by taking advantage of the sulphur being produced. Because the reaction liberates sulphur the solution goes form being transparent to opaque. This means that we could use an LDR or light dependent resistor and lamp to measure reaction rate. This could be done by placing and LDR to a voltmeter and having a lamp shine through the beaker on to the LDR. As the experiment goes on the LDR should have a lower resistance because there should now be little light shinning through onto the LDR form the lamp. You could time how long the resistance takes to go down to 6 Ohms, or what ever you decide to do from your preliminary results. Unfortunately we do not have access to these kinds of apparatus for this experiment so we will have to use different methods. We could place a piece of white paper under the beaker of reactants with a black cross underneath it. And time how long it takes so you can no longer see the cross from under the beaker.

Apparatus:Stop-watch – So I can accurately time the rate of a reaction to 1/100th of a second.

Measuring cylinder – With accurate enough scales I can easily determine the amount of HCL or thiosulphate to a good degree of accuracy.

Separate measuring cylinders – This is so I don?t contaminate either of the liquids, which may start the reaction, before I?m actually ready to time it.

Different sized measuring cylinders – It would be foolish to measure to measure 5ml of HCL into a large measuring cylinder because the smallest mark on that scale would be 10ml and I would have to guess where the 5ml mark is which isn?t very accurate.

So for small measurements I will use a small measuring cylinder.

Preliminary method.I will alter the concentration of thiosulphate because I find it easier to alter the concentration of thiosulphate rather than HCL, but mainly because there are larger amounts of thiosulphate to HCL so it would be much more convenient.

In to a small measuring cylinder I will pour 10ml of HCL (see table above as to why a small measuring cylinder is used). I will then pour this into a 100ml beaker. I will then pour the desired amount of thiosulphate in to the different beaker (so I don?t contaminate the thiosulphate with HCL). The measuring cylinder will be large because of the desired amount of thiosulphate. If water is needed to alter the concentration of HCL it would be measured in the thiosulphate measuring cylinder because the two chemicals do not react together.

I will get a piece of plain white A4 paper and draw a distinctive black cross in the middle. I will place the beaker maybe containing the HCL on the cross. Using a stop-watch I will start timing as I pour the thiosulphate into the beaker.

Because the solution gets cloudier and then opaque I will stop timing when I no longer see the cross. I will obviously keep my head in the same position and use the pair of eyes to establish when I stop timing.

I think it would be suitable to make5 observations with the following constituencies of HCL and thiosulphate.

HCL volume in cm cubedVolume of H20 in cm cubed Thiosulphate volume in cm cubed

100 50

105 45

1020 30

1030 20

1040 10

Precision and accuracy:Unreliable evidence is evidence that is faulty or was obtained by a faulty method. There are various ways to prevent this:

Do not look at the meniscus sides when measuring a liquid, look at the plain in the middle.

Do check readings so any anomalous results will become obvious.

Refrain from contaminating either chemical with another.

Keep head always at same height just before deciding when to stop timing, and always use the same pair of eyes, and keeping on any glasses.

Fair test.I will use separate measuring cylinders for both chemicals so I don?t contaminate either of them until I?m ready to time the reaction. Because I? am (always) measuring 10ml of HCL I will use a small measuring cylinder, i.e. 100ml so I can accurately identify where the 10ml mark is. I will always use my eyes to tell me when to stop timing because the quality of eyes varies from person to person. For my big measurements of liquid I will use a large measuring cylinder.

I will not introduce a catalyst to the experiment neither will I increase the temperature of the liquids by holding their containers too long, and I will keep the area?s temperature in which I?m working in constant.

To be on the safe side I will try to keep the light intensity the same throughout the entire experiment by working in the shade.

Prediction:I predict that as concentration of thiosulphate increases so will reaction rate.

Concentration of a reactant affects reaction rate because there are more frequent successful collisions.

Assume a person has two chemicals x and y, which react when put together.

If all input variables remained constant apart from concentration then fastest reaction rate possible would be to mix (assuming there isn?t an excess) x and y together in their purest forms. This is because every time an x molecule collides into a molecule it has a 50% chance of it being a y molecule. But if you removed half of y and replaced it with a neutral chemical such as z the chances of a x molecule bumping into a foreign molecule decreases from 50% to about 25%. This in effect lowers reaction rate by lowering amount of ?successful collisions?

This means that as concentration of y decreases so does reaction rate. This could be true for x. The same theory applies with HCL acid and Thiosulphate, so as thiosulphate concentration increases so will reaction rate. I believe that if you plotted percentage of thiosulphate against rate of reaction you would get a straight line, which also means that I predict that they are directionally proportional to each other.

Percentage of thiosulphate reaction rate \* k (k being constant such as the input variables).

As you can see only 2 Mg molecules can react with 2 HCL molecules. But if there was less water this happen:

Now 4 molecules of Mg can react with 4 molecules of HCL.

The reaction would be quicker than the above because:

What happens is that water molecules tend to get in the way of collisions, so if there are more water molecules in between two chemicals those two chemicals can?t really get to each other, so really water tends to ?clog up? the collisions like sawdust may clog up machinery.

If you did plot reaction rate vs. concentration of thiosulphate and got a straight line when you plot

Time (time taken for reaction to go cloudy) vs. Volume of Na2 S2 O2 added you would get a downwards curve. I know this because I drew a hypothetical graph and then worked backwards to find out what the graph of reaction rate vs. concentration of thiosulphate and found out it would be a curve like the one explained above.

HCL volume in cm 3Volume of H20, cm 3Thiosulphate volume in cm 3Time taken in secondsRate of reaction (1/t)s10050320.03110545360.028102030580.0171030201000.0101040102100.004Finalizing the method:In my results graph, specifically the percentage of thiosulphate vs. over reaction time is unsatisfactory. This is because I do not have enough points to plot a graph and decide its line of best fit. More specifically I am unable to decide whether or not my graph?s line of best fit is a curve or a straight line, I am justified in drawing both because of the quality of the graph. I intend on doing more tests in my next experiment by timing the reaction for 70% and 80% thiosulphate to determine if concentration is directly proportional or exponential to rate of reaction. I would also like to do a set of check readings.

I will not use my preliminary results in my final graph (as an average) because each experiment would be done on a different day. This is because room temperature may be different and so affecting my results.

I think it would be quite suitable to test reaction rate at these different percentages of thiosulphate in solution, 83% thiosulphate, 75% thiosulphate, 50% thiosulphate, 33% thiosulphate and 16% thiosulphate, the rest being 16% HCL and if any left over it would be used up by water.

HCL volume in cm 3Volume of H20, cm 3Thiosulphate volume in cm 3Time in secondsTime 1Time 2Average TimeRate of reaction (1/t)s100503236340.029105453628320.0311020306356600.0161030209496950.0101040102112132120.005AnalysisI have found that as concentration of thiosulphate (one of the reactants) increases so does reaction rate. This is shown by my graph as a positive correlation between percentage of thiosulphate in solution and reaction rate (1/t in seconds). My prediction stated my prediction stated that as one increases so will the other, I also said when the results would be plotted I may get a straight line; meaning they are directly proportional. This is supported by my results graph because it shows a positive correlation between thiosulphate in solution and reaction rate (1/t in seconds), and it is a straight line meaning they are directly proportional.

The reason for this correlation is so:

Concentration of a reactant affects reaction rate because there are more frequent successful collisions.

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If all input variables remained constant apart from concentration then fastest reaction rate possible would be to mix (assuming there isn?t an excess) x and y together in their purest forms. This is because every time an x molecule collides into a molecule it has a 50% chance of it being a y molecule. But if you removed half of y and replaced it with a neutral chemical such as z the chances of a x molecule bumping into a foreign molecule decreases from 50% to about 25%. This in effect lowers reaction rate by lowering amount of ?successful collisions?

This means that as concentration of y decreases so does reaction rate. This could be true for x. The same theory applies with HCL acid and Thiosulphate, so as thiosulphate concentration increases so will reaction rate. I believe that if you plotted percentage of thiosulphate against rate of reaction you would get a straight line, which also means that I predict that they are directionally proportional to each other.

Percentage of thiosulphate reaction rate \* k (k being constant such as the input variables).

As you can see only 2-Mg molecules can react with 2 HCL molecules.

But if there was less water this happen:

Now 4 molecules of Mg can react with 4 molecules of HCL.

The reaction would be quicker than the above because:

What happens is that water molecules tend to get in the way of collisions, so if there are more water molecules in between two chemicals those two chemicals can?t really get to each other, so really water tends to ?clog up? the collisions like sawdust may clog up machinery. This is consistent with my results and is shown in my graph labeled Reaction rate vs. Percentage of thiosulphate in solution.

EvaluatingBecause of staring at the black cross for too long it burnt the after image in my retina, a bit like a bright bulb, so I only realized it had gone perhaps a little too late, maybe 5 seconds. I think the fact that my head wasn?t always at the same level when observing the thiosulphate. I think this had a relevant bearing on my results, but not enough to render them unusable; this was because of check readings, and the fact that that my head would have only differed in height by about 10cm. When looking at my graph I don?t see any anomalous results because they are all very close to my line of best fit, and my method is quite reliable as shall be explained later.

I think the method could have been changed to a far more suitable one as seen below:

During this set-up the room would be kept dark so as not to interfere with the LDR. The light would shine through the reactants onto the LDR. As the test goes on less light would fall on the LDR, decreasing the resistance through the component. This should be quite noticeable on the voltmeter which would be set on an appropriate level found whilst doing preliminary, at a chosen resistance the person may stop timing. This method would be a lot more accurate than the as it takes out human error by itself judging when you should timing. I think I read my measurements to a good degree of accuracy because I made sure I used the right sized measuring cylinder for each liquid, so I had a small scale for small amounts etc. etc. I also made sure I was level with meniscus whilst measuring amounts of liquid.

I think my results are reliable enough to support a firm conclusion because my method was quite accurate, and how I performed the experiment was excellent; I got the same results in my preliminary and my final set. And if my method was inaccurate it would have been the same inaccuracy for all separate tests mean I don?t really agree that my method needs criticizing or moderating seeing as it was accurate enough for my level of work, if I were a scientist and I had access to better apparatus I may moderate or criticize my method in the following way:

I don?t think there was a large enough range of results taken, it would have been useful (when plotted) to test reaction rate whilst varying concentration of HCL. It would be interesting to see if it showed the same pattern of results as my thiosulphate did. If there was a larger range of results then I could have thoroughly observed and different patterns to ones I got. Perhaps I should have got a meter rule and made sure my head was always at the same height, this is because as your height increases away from the beaker the cross becomes less visible, which means you stop timing a little earlier.