Investigation Into The Relationship Between Temperature Of Acid And The Rate Of Reaction In The Reaction Of Caco3 And Hcl Essay, Research Paper

Background Information The speed at which reactants are converted into products during a reaction is referred to as its rate. Usually in a reaction, the amount of the product of the reaction is measured to work out the rate of the reaction. In this reaction, the rate will be calculated by the equation: Rate = 1 Time. The Collision Theory states that the rate of reaction depends on how often and how hard the reacting particles collide with each other. In order for a molecular collision to be effective it must have sufficient impact energy to overcome the amount of activation energy needed. (The activation energy is the minimum energy necessary for product to form). The mole theory tells us, by knowing the molarity of the reactants, you can predict how much gas will be produced. We are working with 2M HCl and CaCO3 we are wishing to produce 100cm2 of CO2 we need to work out how many moles in this. One mole of CO2 weighs 44g so 100cm2 will have 2.27 moles. We need the reactants to produce this much gas. The calculations for the mole theory say we would only need 1.42cm2 of the acid in this experiment and 0.44g of CaCO3.The rate of the reaction can be affected by several factors which can be considered variables.Concentration: An increase in concentration means there are more particles. More particles means there will be more collisions. This should increase the reaction rate. Surface Area: When one of the reactants is a solid, the reaction can only take place at the surface of the solid. Breaking the solid into smaller pieces will increase the surface area exposed to the other reactant. This should increase the reaction rate. Temperature: Since temperature is a measure of the motion of particles, increasing the temperature will cause the particles to move faster, giving them more energy. When particles move faster, more collisions occur and the collisions are more violent. This should increase the reaction rate. Catalysts: Catalysts are substances that change the rate of a chemical reaction without being changed in the reaction. Catalysts are most often used to speed up a chemical reaction. They do this by changing the steps needed between the reactants and the formation of the products. If the number of steps can be reduced, the reaction rate should increase. Higher temperatures increase the energy of the collisions, because the particles are made to move faster. Increasing the temperature increases the average kinetic energy of the molecules. Faster collisions are only caused by increases in temperature. Reactions only happen if the particles collide with each other with enough energy at impact. At a higher temperature there will be more particles colliding with sufficient energy to make the reaction occur. This initial energy is known as the activation energy required to break the initial bonds. Equation for this experiment CaCO3(s) + 2HCl(aq.) ————– CaCl2(aq.) + H2O(l) +CO2(g)PlanIn this experiment I intend to do two experiments, in each the apparatus will be set out as shown below. Firstly the acid shall be weakened to only 1M and suitable adjustments to the quantities of these reactants made based on the mole theory. From this we decided to use 10cm3 of acid and an excess of 1g of the marble chips as so the lowering temperature does not affect the amount of gas produced, because, as temperature falls, the molecules have less energy so, the chances of . The acid shall be heated up on the Bunsen burner until it reaches the desired temperature. It will be allowed to rise slightly above the necessary temperature so it is exactly on the correct temp for when it is used. 10cm3 of hydrochloric acid will be measured out and placed into a boiling tube. One gram of calcium carbonate will be added to the boiling tube and the rubber bung stuck into the top. At this the stopwatch will be started. All of the gas produced by this reaction will be taken to the gas syringe by the delivery tubes, where it will gather and push out the plunger as more gas enters. This experiment will be done in two different ways: 1/ with temperatures every 10oC between 10oC and 80oC to investigate the relationship between rate of reaction and acid temperature; 2/ with temperatures doubling each time starting at 5oC going upto 10oC then 20oC etc . This will be to see if the rate time is proportional to temperature. Either way, the experiment shall be done twice and averages taken for the graph as this minimises chance on anomalous results. I will minimise the risk if anomalous results by keeping all the other variables constant by: trying to have all of the calcium carbonate chips the same size; keeping the concentration of acid the same each time and by using the same amounts of each of the reactants for each experiment. To get to the temperatures below room temperature (20oC, 10oC and 5oC) the 10cm3 of acid will be placed in the boiling tube and then into a beaker of ice to lower the temperature. The experiment will be done the same from there onDiagramPredictionI think that the temperature will cause the rate of reaction to increase as it, itself, increases. This is because, as the temperature rises, the molecules become increasingly active and start to become more free they move around at greater speeds causing the chance of an effective collision occurring greater for two reasons: They are moving more and have a greater chance of colliding. They are moving quicker and therefore with more energy, causing the chance of achieving a collision that creates the activation energy needed greater. I also think that each temperature will create the same amount of CO2 but in different times. I think that the higher the temperature, the quicker the CO2 will be produced. Also I would guess that, because of this, as the temperature falls, there will be a point where there is not enough energy to produce all of the possible CO2. The quantities have been calculated so that we should get 100 cm3 of CO2 from each experiment. But when the temperature reaches a point which I believe to be somewhere between 40oC and 60oC there will not be enough energy in the reaction to use up all of the reactants and so we will begin to make less and less CO2 as the temperature falls. Bibliography+ Mole theory info gathered from Class notes

+ GCSE Chemistry Revision Guide provided info on the mole theory (P39)+ http://www.channelone.com for notes on the collision theoryResultsConclusionIt is aphoristic from my results that rate of reaction does increase with temperature. This is because the higher the temperature, the faster and more freely the molecules move giving a higher chance of effective collisions sooner. The rate of reaction drops as soon as the reaction has started, the slowly evening curve on the volume/time graphs show this. This is because once the reaction is begun, the reactants are being used up, slowing the reaction down due to less collisions being able to be made. If I were investigating time and not rate, my results for 5oC would have looked slightly wrong, as they do in the volume/time graph. This, however sorted itself our in the rate graph to form part of a straight line which is only stopped by my results for 80oC. If my expectations were to have been correct, the point for 80oC would have been around 3cm3/s. From my results I can see that, although it was calculated using the mole theory, I did not use enough of an excess for the lowering temperatures to still produce 100 cubic centimetres of gas. Because of this, I cannot use the equation 1/time to calculate rate. Instead, I must calculate the speed of the reaction and show the results as a rate.I was also correct about the cut-off temperature which was actually somewhere between 50oC and 60oC. Below this temperature, there was not enough energy to exhaust any of the reactants and so, the reaction did not actually finish. For this to have happened, the temperature must have been raised to a point where the reactants began to react again as they did not have a sufficient energy to produce the activation energy below this temperature.It is obvious from my results that, as the temperature rises above a certain (high) temperature, a temperature rise has little effect on the time taken for the reaction to end and therefore, the rate of the reaction. This is because, all the reactants become used up as there is a superfluous amount of energy there, this breaks all the bonds and uses up the reactants in a similar time each time as once the thermal energy of the reaction allows the reactants to be exhausted almost immediately, it happens like that, that quickly each time. No matter how high the temperature rises, once all the bonds are broken, the reaction is over regardless of how much extra thermal energy there is.Also, as the temperature falls, less thermal energy is provided to the molecules causing the collisions that do occur to be less effective. At these lower temperatures, there is less and less thermal energy available and after a point as the temperatures fall, there will not be enough energy to overcame the activation energy.I think that there is a visible relationship between the temp and the rate at which the reaction occurs. This is because, (other than the point for 80oC), there is just about a straight line on both of the rate graphs. From my graphs, the relationship is expressed: 0.025 cm3 increase/10oC. For every 10oC the temperature increases, the rate will increase 0.025 cm3/second. But the equation for this relationship is:Rate/cm3/s = 0.07 + (temperature/oC X 0.0025) As this works for most points on my rate graphs. I worked out this by having the line of best fit extended to a point where 0o would be (0.07), the temperature would then be added to this and multiplied by the average rise in reaction time per degree (0.0025) .EvaluationDuring this experiment I initially thought that my anomalous result was the 5oC results, but these fell into place on the graphs to compare the rates of reaction. The only result that I obtained that didn t meet my expectations was the 80oC one. I expected the points on both rate graphs to follow a straight line but the rate was much higher than I expected and so I would guess that this result is anomalous. I would say that it is, however a good job the anomalous results in my investigation was the end point of the graph as this helps me make a judgement on the rest of the graph without this result getting in the way . The evidence is enough to support a firm conclusion, as I experienced no single anomalous results, other than this and the data proved my prediction to be correct. I believe the method used was suitable for the data that needed to be collected. I used the mean as an average technique. I consider this a very accurate form of working out an average as it takes into account all results. I repeated all readings twice, and took averages to give reliable results. However, due to the fact that all my experiments below 60o didn t produce 100 cm3 of gas I would think that, although the method I used gave good enough results to support my conclusion, I would need to use a greater excess of CaCO3 so that the falling temperature did not affect the final amount of gas produced as when a reaction occurs the thermal energy in the reaction is used to help reach activation energy. When the temperature falls, so does the chance of reaching the activation energy, therefore, if I had had a greater excess of the CaCO3 this loss in thermal energy would have been counterbalanced by the greater number of molecules moving around, Thus leaving the chances of reaching 100 cm3 of gas the same as those of the higher temperatures. The results I got were correct to a degree as all other possible variables were kept the same. I took averages of my repeated results (all of them) to reduce the aberrant results but in the case of 80oC this wasn t enough. If I was given the time, I would take the results for this temperature again as this would probably give me all good results. Although this experiment worked well and my results worked well to support my conclusion, This experiment could be extended in many ways. If I were to do it again I would work every 5oC for two reasons, to help to find exactly, the cut-off point where the activation energy is not reached after certain time, and to help minimise anomalous results which were very little in this experiment anyway. After that, I would do the exact same thing, only, this time, I would use a greater excess of the marble chips so I could work out the rate using 1/time giving me much more reliable results. We could also have the use of an electronic position sensor to take readings from the syringe s plunder every 5 seconds. This would make sure that no results were missed or inaccurate.