Planning experimental procedures

Business

Aim: To investigate the heat evolved, temperature rise, and heat of neutralization that takes place with different volumes. As seen above the aim of my coursework is to find the heat of neutralization reaction, the heat evolved due to the reaction along with the temperature rise when the reaction takes place. The neutralization reaction is defined as the reaction between an acid and an alkali.

Thus I decided to choose hydrochloric acid for the acid and sodium hydroxide for the alkali. NaOH + HCl NaCl + H2OTo get a better understanding of the neutralization reaction I decide first to understand the difference between an acid and an alkali (base) and their properties. An acid is a compound which when dissolved in the water to produce hydrogen ions as the only positive ions. An acid is decided is strong or weak by how is it ionized in water thus a strong acid is one, which is almost completely ionized in water. An alkali is a compound that reacts with water to produce hydroxide ions as the only negative ions. As I said above the neutralization reaction takes place between the hydrogen ions, which are acidic, and the hydroxide ions, which are alkaline, and below is the ionic equation showing the neutralization reaction, which is going to produce water as a result.

Na + OH + H + Cl Na + Cl + H2OThus givingH + OH H2O – 58 Kj / moleThe following model diagram can represent this: H + OH H2O – 58 Kj / moleThe reaction above is the neutralization reaction. There are two types of reaction one is endothermic and exothermic. The endothermic reaction is one which takes in heat to form bonds for the reaction as they need energy to form those bonds this heat can be taken from the surroundings or you apply heat this heat is called the activation energy. This because that the separated particles can then react with each other to give the products of the reaction. This takes place in all substances, in an ionic compound, the bond between the ions are broken to separate the ions and then these ions react with other ions to form other compounds. Exothermic reaction gives out heat as a result of bonds breaking which occurs when substances are broken to make out another substances the heat given out from this reaction is given to the atmosphere surrounding The difference between the activation energy and the heat given out is expressed as ? H or the temperature change.

In endothermic reactions, the temperature change is positive and in exothermic reactions, it is negative. This is because the energy given out is subtracted from the activation energy and since the energy given out is greater, the value is negative. The following figures show the energy level diagrams for an exothermic and an endothermic reaction: Coming backing to the aim of the coursework, which is the heat of neutralization evolved. The heat of neutralization it is the formation of water molecules from 1 mole of hydrogen ions and I mole of hydroxide ionsNaoH + HCl NaCl + H2O1 mole 1 mole1000 + 1000 58000JBefore carrying on the experiment I decided to use three different volumes for the experiment, which are (15 cmï¿½, 30 cmï¿½, 45 cmï¿½) for both the acid and the alkali. After that I decide to predict the heat evolved by the reaction of each volume and see if they are going to match when I carry on the experiment and find the results15 cmï¿½NaoH + HCl NaCl + H2O1 mole + 1 mole1000 cmï¿½ +1000 cmï¿½ 58000 J15 cmï¿½ + 15 cmï¿½ ? I can use the value 58 KJ or 58000 J as it is the value for the heat of neutralization per mole and it is fixed to find the value of energy released using 15 cmï¿½ of alkali with 15 cmï¿½ of acid.

2000 cmï¿½ 58000 J30 cmï¿½ ? 30 x 58000 / 2000 = 870 J30 cmï¿½2000 cmï¿½ 58000 J(30 cmï¿½ + 30 cmï¿½) 60 cmï¿½ ? 60 x 58000 / 2000 = 1470 J45cmï¿½2000 cmï¿½ 58000 J(45 cmï¿½ + 45 cmï¿½) 90 cmï¿½ ? 90 x 58000 / 2000 = 2610 JIf the results of the experiment match those values then I know that I carried the experiment successfully. I also decided that I plot a graph of the results I am going to find and the graph below shows what I expect my graph to be: From the graph we could see that if the acid and the alkali were exactly of the same concentration then 15 cmï¿½ of hydrochloric acid would require exactly 15 cmï¿½ of sodium hydroxide to neutralize it. As the acid is added a little at a time more and more heat is evolved. the highest temperature is recorded at the exact and the point. This maybe a little lower or higher. After the neutralization the temperature gradually drops because the excess acid absorbs the heat added.

After finishing finding the heat evolved from each volume I decided to calculate the rise of temperature for each volume by the formulaeQ= mc?? Q = Heat Evolved. M = for the mass or the volume used. C = is the specific heat of capacity of water which is the same for the acid and the alkali (4. 2 KJ)?? = is the rise in the temperatureand then see if my results are going to match the predicted rise in the temperature. Below is the calculation that I am going to carry theoretically and then when carrying on the experiment I will see if the results are going to match. 15 cmï¿½Q = m x c x ?? 870 = (15 cmï¿½ + 15cmï¿½) x 4.

2 x ???? = 6. 9ï¿½ C30 cmï¿½Q = m x c x ?? 1470 = (30 cmï¿½ +30 cmï¿½) x 4. 2 x ???? = 6. 9ï¿½C45 cmï¿½Q = m x c x ?? 2160 = (45 cmï¿½ + 45 cmï¿½) x 4. 2 x ???? = 6.

9ï¿½Cfrom the values above we can observe an interesting feature and that is thought the volume is doubled and tripled the rise in temperature remains the same and this can be explained that even when the volume is doubled or tripled the temperature remains the same because the heat given is absorbed by a larger volume of solution. In another words the temperature is distributed on a larger volume. The representation below would explain what I said above in a simple manner. When we double that is what happens30 cmï¿½ + 30 cmï¿½ 2 X J (60 cmï¿½)60 / 2 = 30 cmï¿½ which is sameThe rise in temperature can be represented in two graphs one which is a theoretical graph just for the understanding and the other is the one which is going to result due the obtaining of results of the experiment which is going to show the second graph when plotted. In the graph, the representation of the rise in temperature means change in temperature – this will also be used in the energy formula that I'll use to calculate what I expect the values for heat of neutralization and energy to be.

Also from the above we can deduce two observations: 1) That the heat evolved is directly proportional to the volume of acid but only up to the point of neutralization. 2) After that, the temperature becomes inversely proportional to the volume of acid. After finishing explaining all of this I am going now the list the apparatus and how I am going to carry on the coursework. Apparatus* Burette : Which is going to be used to measure the in the correct amounts as it offers a good reading* Plastic cup: This is where the reaction is going to take place and the reason I choose it is because plastics are poor conductors of heat thus I have time to record the temperature.* Measuring cylinder: This is where I am going to measure the alkali used for the reaction* Thermometer: It is going to be used for recording the initial temperature and the rise in the temperature.* Stirrer: Is going to be used so that on can mix the mixture and make sure that everything is has reacted.

* Clamps: I am going to use it for support of the suspended apparatus. MethodFirst I am going to show the experiment setup as shown below to make the understanding of how I am going to use it easy: Carrying on the experiment is not hard, first I am going to measure 15 cmï¿½ of NaOH in the measuring cylinder then pour them in the plastic cup. Then I am going to fill the burette up to the zero mark of it (N. B When carrying on the process of filling and measuring I am going to make sure that lower meniscus is perpendicular to the line of my sight) I am going then to record the temperature of the alkali and note it down. Then I am going to let the acid from the burette 5 cmï¿½ at a time. Thus finding the temperature first when the total is 20 cmï¿½ then I am going to throw the mixture and then I will note the temperature when the total is 25 cmï¿½ and then note the temperature and so on.

When adding the acid I am going to stir it with the stirrer to make sure everything reacted. I am going to follow this method for the other two sets of readings which are 30 cmï¿½ and 45 cmï¿½. I am going to obtain 6 sets of readings with difference of 5 cmï¿½ between each of them. Factors to be kept constant: The volume of the NaOH is going to be kept constant only the volume of acid which going to be kept constant. Other factors like the concentration, temperature and the pressure are to be kept constant so that the only varying constant is the volume of the acid.

Precautions when carrying on the experiment:* First of all I am going to clean all the apparatus so as to make sure that there is no undesirable substances in the apparatus.* Then as I said above I have to make sure the line of my sight is correct.* I have to make sure that I do not spill any acid or alkali on my hands so that I will not burn them or ware gloves. I have shown below the table in which I am going to record the observation. 15 cmï¿½Vol. of NaOH (cm3)Vol.

of HCl (cm3)Initial Temperature (ï¿½C)Final Temperature (ï¿½C)?? (ï¿½C)150155151015151520152515 30AnalysisAfter finishing drawing the graphs and carrying out the experiment and tabulating down the results. Now I am going to discuss the graph and the pattern in the graph. I am also going to check and see if the results are going to match what I got are going to match the values I got in the planning section which I got by the theoretical equations. And the trends and the patterns I predicted in the planning section. Temperature riseFirst of all I have got to calculate the heat rise from the graph and how much acid was needed in the following table, which I have created: Vol.

Of NaOH (cm3)Vol. Of HCl (cm3)?? (ï¿½C)1513. 063025. 564536. 06As we can from the above table it is clearly shown that my experiments did not match the expected results that I have shown in the planning where I expected all of them to have the same temperature rise which was 6.

9ï¿½C. the only thing which came true was that the volume of HCl needed to neutralize the 15 cmï¿½ of NaOH was the same which is 15 cmï¿½. All the other volumes were the same also. I am also aware that there are different reasons behind this which are listed below:* The reason due to the difference in the temperature rise is may be because I made mistakes while taking down the temperature from the thermometer or noting down the temperature in the note book* It may be also due to me waiting for too long to note down the temperature or waiting less time thus not giving the thermometer a chance to adjust to the temperature of the solution* The solution could have also lost some of the heat to the surrounding while recording the temperature.* It could have been also due to that my hand raised the temperature as the cup absorbed it.* A parallax error could have occurred in the form that my line of sight was not perpendicular to the thermometer scale.

* The surrounding environment could have affected the experiment like by switching on the fan or air condition. I decided to present the above data in the form of a bar graph so that I t would be easier to comprehend the data. Heat energy evolved: Now that after finishing investigating the temperature rise I going now to investigate the heat evolved from the graph. I am going to find the values using the formula Q= mc??. I am going to start in order: 15cmï¿½Q = m x c x ?? Q = (28/1000) x 4. 2 x 6Q = 0.

7056 KJ of energy or 705. 6 J30 cmï¿½Q = m x c x ?? Q = (55. 5/1000) x 4. 2 x 6Q = 1. 3986 KJ of energy or 1398.

6 J45 cmï¿½Q = m x c x ?? Q = (81/1000) x 4. 2 x 6. 5Q = 2. 0412KJ of energy or 2041. 2 JSo after finding the values I am going to tabulate the above results in the following table: Vol. Of NaOH (cm3)Vol.

Of HCl (cm3)Total volume (cm3)Q (kJ)1513. 0280. 70563025. 555. 51.

39864536. 0812. 0412In the planning I mentioned that the heat evolved would be directly proportional to the total volume of the solution which means that when a doubling occurs in the volume the evolved should also double and when it is tripled the heat evolved is also tripled and I am going to see if that is correct or no by checking it below: 0. 756 x 2 = 1. 512 while I got 1. 3986 which roughly near to the value0.

756 x 3 = 2. 268 while I got 2. 0412 which is some what lower but could be considered as tripling. I decide to draw a bar graph to represent the doubling and the tripling as shown below: Heat of heat neutralizationAfter investigating the temperature rise and the heat evolved I am now going to investigate the heat of neutralization which needs the to have the values I calculated above. To achieve that I have got to calculate the number of moles in each solution first by the formula n = cv15 cmï¿½n = 1 x 15 /1000n = 0.

015 moles30 cmï¿½n = 1 x 30/1000n = 0. 030 moles45 cmï¿½n = 1 x 45/1000n = 0. 045 molesNow I am going to find the heat of neutralization: 0. 015 moles 705. 6 J1 mole ? 705.

6 / 0. 015 = 47040 J0. 030 moles 1398. 6J1 mole ? 1398. 6 / 0. 030 = 46620 J0.

045 moles 2041. 2 J1 mole ? 2041. 2 / 0. 045 = 45360 JI tabulated the above results in the following table: Vol. Of Alkali (cm3)Heat of neutralization (J)15470403046620454536 0In the planning section of the coursework I said that the heat of neutralization is going to be the same but it appears to the previous mistakes committed while doing the experiment it also affected the

heat of neutralization value and thus we could see one mistake could to lead to other mistakes.

I also decide to draw a bar chart for the results : ConclusionComing to the conclusion part, I might as well say that not all of the predictions I mentioned in the planning section came as accurate as they should have been. Most of the predictions I mentioned came roughly true. At the end we see that the doubling and the tripling of the heat evolved occurred. And that most of the results are satisfying. EvaluateAfter finishing my work and the experiment I am going to evaluate them now and comment on the obstacles that faced me and in what this experiment could have been improved to carry it successfully and obtain accurate results. Commenting on the method: On the overall the experiment was easy to carry and the method used was good to obtain accurate result if one is fast in action and careful.

* While doing the experiment one of the problems, which faced us, was the purity and concentration of acid and alkali.* Not all of the acid and alkali was poured in the plastic cup due to some of the drops sticking to the side of the burette and the measuring cylinder.* The temperature loss to the surrounding from the plastic cup thus not giving accurate results. All of these problems could have been solved by the following list and it also contains ways on improving the experiment also:* The loosing of temperature to the surrounding could have been overcome by lagging the plastic cup by a lagging material so to stop the loss.* The experiment could have been done twice and the average or the mean taken to improve the results* A digital thermometer could have been used instead of the analogue one so a more accurate results could be achieved* A pipette could have been used instead

of the measuring cylinder to achieve more accuracy.* The new technology could also be used in this case where the sensors could be used to measure the temperature where the computer records the temperature at an interval of 10 seconds, which could help the one to achieve a highest possible accuracy that could be achieved.

The experiment could have been expanded in various possible directions as seen below* The experiment could have been used to investigate different concentration thus having a wider range to improve the results.* The experiment could have been made using different kind of acids and alkalis. Strong acids and strong alkalis could be used as well as the weak acids and weak alkalis.* An indicator could have been used so that we can record at what volume the acid neutralizes the alkali and see if it matches with the results of the graph