Heat and enthalpy change of neutralization of naoh and hcl essay

AIM AND HYPOTHESIS: My aim in this experiment is to compare the enthalpy change of neutralisation by titration, for each reaction between the following 3 acids: Sodium hydroxide (NaOH) and hydrochloric acid (HCl) – pH 1Sulphuric acid (H2SO4) and NaOH – pH 1NaOH and Ethanoic acid (CH3COOH) – pH 2. 88 – 3I predict the reaction between the above-mentioned acids would be exothermic because heat will be given off during the reactions and the temperatures will be rising due to the heat evolved.

I also predict the reaction between the chemicals is exothermic because the energy content of the products is less than that of the reactants, resulting to heat being given out from the system. These predictions show that the stronger the acid used in neutralization, the more energy is released per mole of water. I will be able to compare these predicted energy changes with my actual results after my experiment. When I have my results- the temperature change from beginning to end of the experiment – I can use the equationEnergy change = mass of solution x temperature change x specific heat capacity of water to work out the actual energy change. In neutralization, we assume that the density of the acid/alkali is the same as that of water, so volume of acid = mass of acid.

We know that the specific heat capacity of water is always 4. 2 Jk – 1 g -1 (Joules per Kelvin per gramme) so the equation will end up as ? H = volume x temperature x specific heat capacity. As the mass and specific heat capacity will stay constant and the temperature change will increase depending on the strength of the acid, the energy change each time will be the same. Therefore, the energy changes for each of the acids rounds up to the same amount of energy per mole of water, -1. 4, thus supporting the Standard

Enthalpy Theory. Linking prediction to theory: The collision theory describes how the rate of reaction (the speed in which a reaction takes place) will increase as the concentration of hydrochloric acid increases.

This is due to the knowledge that particles are closer together in a concentrated solution. The closer the particles are, the more often the particles collide. With more collisions comes a greater chance of the reactants reacting. This also explains why I can predict that the greatest rate of reaction will be found as the reactants have come into contact, as they are both at their highest concentrations, and the rate of reaction decreases as the reaction continues as the concentration of the reactants decreases. BACKGROUND INFORMATION. The heat absorbed by a system at a constant pressure equals the change in enthalpy.

Very often, chemical changes are accompanied by changes in the heat content of the materials, which are reacting. The correct term for heat content is enthalpy, H. Usually, this change in the heat content or enthalpy is shown by a change in temperature. Indeed, the change in temperature when substances react often provides evidence that a chemical change has taken place. The experiment technique used for the determination of enthalpy is calorimetry, which is being used for this experiment.

The standard molar enthalpy of neutralisation is the enthalpy change per mole of water formed in the neutralisation between an acid and alkali at 298 K and one atmosphere pressure. For the neutralisation of a strong acid such as HCl and H_2SO_4, and a strong alkali such as NaOH, the standard molar enthalpy of neutralisation is almost invariably -57. 1 kJ mol-1. The reason is

that the following ionic reaction is common to all neutralisations of strong acids and alkalis: H+(aq) + OH -(aq) ? H2O ? H ? n, m (298 K) = -57. 1 kJ mol-1Thus, an exothermic reaction is taking place.

However, this is different for ethanoic acid because it is a weak acid and does not fully dissociate in water (therefore there will be no complete reaction) compared to the strong acids, which dissociate in water. Also, the pH level (acidity) of ethanoic acid is lower than hydrochloric acid and sulphuric acid. While hydrochloric acid and sulphuric acid have a pH of 1, which is acidic, (the solution contains free roaming H+ ions. It usually contains hydrogen ions that dissolve in water to produce hydrogen ions but these do not exist on their own in the solution), ethanoic acid has a pH range of 2. 88-3, which is alkaline.

This shows that hydrochloric acid and sulphuric acid are more reactive than ethanoic acid, which is a very weak acid. This makes the ? H of ethanoic acid slightly lower than that of the strong acids. Thus, the standard molar enthalpy of neutralisation of ethanoic acid is -55. 2 kJ mol-1. This is considered to be an exothermic reaction. Neutralisation reaction is the reaction between an acid (hydrochloric acid) and a base (alkali) to produce a salt (sodium chloride) and water only.

An equal amount of hydrogen and hydroxide ions react and form together to form a neutral solution. Acid + base salt + water(Hydrochloric acid +Sodium hydroxide Sodium chloride + Water). Neutralization is the process in which an acid and a base/alkali react with one another and nullify the acidity or alkalinity of each other. This reaction produces two by-products, which are

created in all neutralization occurrences. This process can be equated as: Acid + alkali ? salt + waterOr in terms of ions as: H+(aq) + OH- (aq) = H2O(I)Neutralization is a common event and is utilized by many things; some essential to our existence, such as bile's neutralization of stomach acids so that enzymes in the small intestine can function.

Neutralization is used in every day life as well; indigestion or heart burn caused by a build up of hydrochloric acid in the stomach are neutralized by bases (indigestion tablets) containing alkalis such as magnesium oxide. Acidic lakes or fields can be neutralized and hence improved by applying calcium hydroxide (lime) to the surface. Acids And Alkalis. Acids and alkalis are substances found everywhere in our daily lives. They both have different properties that can be both harmful and advantageous.

Some examples of substances containing alkaline are toothpaste, which is used to fight acid in the mouth built up by bacteria in the mouth digesting sugar, and antacids, which are tablets used to combat acid indigestion. A base is any substance that can neutralize an acid, so an alkali can be called a soluble base as it also dissolves in water. There are other known compounds that can neutralize acids such as zinc carbonate. Acidic solutions are often found in the kitchen and include cleaning products to fight lime scale build up, and stronger oven spray. All these examples of acidic and alkaline solutions are also examples of neutralization, which occurs equal in our daily lives.

A neutral substance is neither an acid nor an alkali and shares no properties with them. Neutral substances such as pure water tend not to be toxic and

corrosive and generally are much safer to handle than acids and alkalis. When a neutral substance is formed water and salt are always two of the resulting products. The type of salt which is formed is derived from the type of acid used e.

g. sulphide makes sulphate salts, nitrogen makes nitrate salts, and chloride makes chlorine salts. This should mean hydrochloric acid and sulphuric acid should leave chloride and sulphide salts as well as pure water. Some examples of neutralization and its products found in labs are:

- Nitric acid + magnesium oxide magnesium nitrate (salt) + water
- Hydrochloric acid + calcium hydroxide calcium chloride (salt) + water

Some properties of acids: They have a sour taste.

- They react with metals to form hydrogen and salt.

- Some are corrosive.
- They have a pH of less than 7.

Some properties of alkalis.

- They are toxic ï¿½
- They have a pH greater than 7.

- They have a bitter taste.

Some examples of acids are:

- Hydrochloric acid, HCl.
- Sulphuric acid, H2SO4.
- Nitric acid, HNO3.

Some examples of alkalis are:

- Sodium hydroxide, NaOH

- Potassium hydroxide, KOH

- Calcium hydroxide, Ca(OH)2.

Exothermic reaction: When an exothermic reaction occurs, heat is given out and the temperature of the products rises above room temperature. Eventually, the temperature of the products falls to room temperature again as the heat produced is lost to the surroundings. Thus, the heat content (enthalpy) of the products (H2) is less than that of the reactants. Since the materials have lost heat, we can say that the enthalpy change for reaction, ? H.

is negative. For example, when magnesium reacts with oxygen, heat is evolved: 2Mg(s) + O2(g) ? 2mgO(s) ? H = -1204 KjChemical energy in the magnesium and in the oxygen is partly transferred to chemical energy in the magnesium oxide and partly evolves as heat. Thus, the magnesium has less energy than the starting materials, magnesium and oxygen. The value of ? H, the enthalpy change of the reaction, relates to the amounts shown in the equation: 2 moles of Mg atoms, 1 mole of oxygen molecules and 2 moles of MgO. Endothermic reaction: When an endothermic reaction occurs, the heat required for the reaction is taken from the reacting materials.

At first, the temperature of the products fall below the initial temperature again as heat is absorbed from the surroundings. In this case, the heat content of the products is greater than that of the reactants and the enthalpy change (heat of reaction), ? H is positive. We can summarise these

ideas as: Enthalpy change = heat of reaction.? H = H2 – H1Since the enthalpy change manifests itself as heat, the term ' heat of reaction' is often used in place of ' enthalpy of reaction'. It should be noted that ? H refers only to the energy change for the reacting materials.

The surroundings will necessarily gain whatever heat the reacting materials lose, and vice-versa. Thus, the total energy is unchanged during a chemical reaction. Energy may be exchanged between the materials and the surroundings but the total energy of the materials remain constant. The important concept is known as the law of conservation of energy and also the first law of thermodynamics.

THE STANDARD CONDITIONS FOR THERMOCHEMICAL MEASUREMENTS. In order to compare energy changes, it is important to state the conditions under which a reaction is performed. Furthermore, we must assure that the conditions of the system are the same before and after the reaction. In particular, the temperature and pressure should be stated.

The standard conditions of temperature and pressure for thermochemical measurements are 298 K (250C) and 1 atmosphere (atm), respectively. An enthalpy change measured under these conditions is described as standard enthalpy change and given the symbol ? H ? or ? H ? 298 with a special superscript and subscript. The symbol ? H ? 298 also implies that: All the substances involved in the reaction are in their normal physical states at 298 K and 1 atmosphere and thatAny solutions involved have a concentration of unit activity. This is effectively one per cubic decimetre for our purposes. Thus, ? H ? 298 for the reaction2H2 (g) + O2 (g) ? 2H2O (l)must relate to

gaseous hydrogen, gaseous oxygen and liquid water (not steam). In the case of elements, which exist as different allotropes, and compounds, which exist as different polymorphs, the most stable form at 298 K and 1 atm is chosen as the standard.

Consequently, ? H ? 298 values for reactions involving carbon should relate to the allotrope graphite rather than diamond. We can therefore define the standard enthalpy change of a reaction as the amount of heat absorbed or evolved when the molar quantities of reactants a stated in the equation react together under certain conditions. i. e., at a pressure of 1 atmosphere, at a temperature of 298 K, with substances in their normal physical states under these conditions and solutions having unit capacity (effectively 1.

0 dm-3). STANDARD ENTHALPY CHANGES OF FORMATION AND COMBUSTION. The standard change of formation of a substance is the heat evolved or absorbed when one mole of the substance is formed from its elements under standard conditions. The standard heat of formation of a substance is given the symbol ? Hf?.

The superscript ? indicates standard conditions and the subscript f refers to the formation reaction. Thus, the statement ? Hf?(MgO (s)) = -602 Kj mol -1 relates to the formation of 1 mole of magnesium oxide from 1 mole of Mg atoms and 1/2 mole of O2 molecules, i. e. Mg (s) + 1/2 O2 (g) ? MgO (s)One important consequence of the definition of standard enthalpy change of formation is that the enthalpy change of formation of an element in its normal physical state under standard conditions is zero, since no heat change is involved when an element is formed from itself.

This involves atomisation, i. e. the conservation of H2 molecules to single H atoms. In fact, the standard enthalpy change of atomisation of an element is defined as the enthalpy change when one mole of gaseous atoms is formed from the element under standard conditions. Thus, the standard enthalpy change of atomisation of hydrogen (? H ? at H2 (g)) refers to the process1/2 H2 (g) ? H(g) ? H ? at (H2 (g)) = +218 Kj mol -1One other enthalpy change of considerable importance is the standard enthalpy change of combustion.

The standard enthalpy change of combustion of a substance, ? H c?, is defined as the enthalpy change when one mole of the substance is completely burnt in oxygen under standard conditions. PREDICTING WHETHER REACTIONS WILL OCCUR. The enthalpy change of a reaction is sometimes used a rough guide to the likelihood that the reaction will occur. If ? H 0 for a reaction is negative, energy is lost when the reaction occurs.

The products are more stable than the reactants. Thus, exothermic reactions are more likely to occur than endothermic reactions. Reactions, which occur spontaneously, are often very exothermic.* ? H 0 shows the relative energetic stabilities of the reactants and products for a reaction. It says nothing about the kinetic stability of the products relative to the reactants.

Thus, ? H 0 is no guide to the rate of a reaction. It cannot tell us whether the reaction is fast or slow. A reaction may be enormously exothermic, yet nothing happens. This is because the reaction rate is immeasurably slow and the reactants are kinetically stable with respect to the products. (For example, a mixture of hydrogen and oxygen at room temperature).

* Predictions from ? Hf? values relate only to standard conditions, i. e. 298 K and atmospheric pressure. The situation may be very different under different conditions or in the presence of a catalyst.* In order to make accurate predictions concerning the relative energy levels of reactants and products, it is necessary to consider the energy lost or energy gained by the reacting system, and also any energy changes inside that system.

For example, when a gas is produced in a reaction, or a solid dissolves in a liquid, there is a marked increase in the disorder of the system itself and an increase in the number of ways in which the energy is distributed in the system. How alkalis and acids are measured, and how they do vary. Acids and alkalis are compounds, which dissolve in water to form hydrogen or hydroxide as their only positive and negative ions. However within acids and alkalis the composition of hydrogen or hydroxide ions can give different strengths of acids and alkalis.

When we refer to an acid as weak or strong we are referring to the amount of hydrogen ions concentrated within every mole of the substance when it is pure. Concentration means the amount of H+ or OH- ions in acids/alkalis. The more hydrogen ions there are per mole of acid, the more acidic it is. Similarly when we refer to an alkali as weak or strong we are referring to the concentration of hydroxide ions. Co-ordinated Science defines the strength of an acid: " in a strong acid, nearly all the acid molecules form ions. In a weak acid, only some of the acid molecules form ions".

.. This means that in a weak acid/alkali not all the molecules are strong enough to form into ions and the result is a substance with less ions meaning

a lower concentration of ions, and therefore a weaker ionic structure with weaker acidic/alkaline properties. The concentration of an acid or an alkali is measured on something called the pH scale, which runs from 0-14 with 1 being the strongest acid and 14 being the strongest alkali.

For my investigation, I should use one strong acid and one strong alkali. I should use extremes like this so I can get strong results which are easy to test for and therefore very conclusive. I will use hydrochloric acid, HCl, Sulphuric acid, H_2SO_4 , sodium hydroxide, NaOH, and Ethanoic acid, CH_3COOH as the acid and alkali for my investigation. I choose these three substances because they vary in terms of their strength and were they are on the pH scale- this should give me a range of results, which test the accuracy of the pH scale.

Hydrochloric acid has a pH of 1, while sodium hydroxide has a pH of 14. This means that a neutral pH of 7 lies exactly in-between them and so they should have an equal concentration of hydrogen and hydroxide ions, and should than react to form a salt (which is always a product of neutralization along with water), because the positive and negative ions are of equal strength and therefore cancel/remove each other leaving a substance with no charged ions. Sulphuric acid has a pH reading of 3. 5, meaning it is exactly half as strong as sodium hydroxide.

Hydrochloric acid and sodium hydroxide have an ratio of 1: 1 which means they are monobasic substances which should neutralize in equal quantities only if they are both of the same concentration (in this case pure). If the hydrochloric acid was placed in a neutral substance which was the same

volume as itself, it's strength would half and it would therefore have a ratio of 2: 1 with pure sodium hydroxide, as two moles of hydrochloric acid would be of the same strength as one mole of sodium hydroxide and therefore twice as much hydrochloric acid would be needed to neutralize sodium hydroxide. The reaction of acids and alkalis to each other to form water and salt can be compared to the reactions elements from the periodic table have with each other. Sodium and Sulphide react with each other strongly because they both need to share electrons in order to gain full outer shells. They are at a large distance from each other in the periodic table (groups 1 and 6) and therefore are both very reactive. However, sodium is more reactive than sulphate because it only needs to lose one electron, while sulphide needs to gain two electrons.

This means that in the compound that is formed consists of two sulphide ions for every one sodium ion. The ionic relation of the sodium and sulphide is the same as the ionic relation between sulphuric acid and sodium hydroxide. If the substances are pure than the ratio of sulphuric acid to sodium hydroxide is 1: 2 and so for neutralization to occur there needs to be twice as much sulphuric acid as sodium hydroxide. Acids that form one H+ ion from each acid molecule are called monopratic acids, two acid molecules- diprotic, and three- triprotic.

A strong acid or alkali is always strong even if it is diluted, e. g. hydrochloric acid mixed with water would be called a strong dilute substance. A base like ammonia will always be a weak one because it has a sparse ionic arrangement. The concentration of a substance and the strength of them are only relevant when relating to ionic concentration- not the amount of

substance dilution. A pH scale looks like this: The numbers from 0-6 means it is an acid, and the stringer the acid the lower the number is.

Number 7 means it is Neutral and number 8-14 means it is an alkali, and the stronger the alkali the higher the number. HEAT OF REACTION (BOND MAKING AND BOND BREAKING). Neutralisation reactions are also exothermic, meaning they emit heat. In this reaction, bonds are formed between the acid and alkali, and bond making is exothermic. This is because the energy needed to break the bonds is less than energy given out when bond is formed.

Energy needed to break bonds < Energy given out when bond is formed = Exothermic. All chemical reactions take place with either an absorption or release of energy. Generally, this energy is in the form of heat, nut in some processes it may take the form of mainly light, or a mixture of forms including some mechanical energy such as sound. However, we could draw from this aspect of chemical change that energy is in some way stored in the chemicals and during a transformation, there is sometimes excess energy (in which case it will be released) or sometimes not enough energy (in which case it will be absorbed from the surroundings). The change in energy is due mainly to bond rearrangement during a reaction. Whether there is a net absorption or release of energy depends on the number of bonds broken and formed as wall as the strength of those bonds.

For example, in the combustion of methane: $CH_4(g) + 2O_2(g)$? $CO_2(g) + 2H_2O(g)$We could imagine the reaction taking place by all of the reactant bonds breaking to make individual atoms and then these separated atoms

later recombining to form the products. While it is unlikely that the actual chemical process happens in this way, theory and experiment show that the net energy difference between reactants and products is the same regardless of the pathway. Therefore, using bond energy values, we have: 4(C-H) + 2(O= O) = 4(414Kj) + 2(499Kj) = energy to break bonds (+) and2(C= O) + 4(H-O) = 2(799Kj) + 4(460Kj) = energy to make bonds (-)The sum of these two values is -784 Kj. In other words, 784 Kj is released when one mole of methane is burned. The experimental heat of combustion is -803 Kj. So it is possible to estimate the energy change using a table of experimentally determined bond energies, but such estimates are limited by a number of factors.

The most important limitation is the fact that the bond energies have been measured or calculated for gaseous species. In addition, the energy required to break similar bonds in a molecule is not the same. For example, the energy required to break one of the hydrogen-carbon bonds in methane is not the same as the energy needed to break the second, third, or fourth one (although they are similar). While bond energy calculations give an estimate of heats of reaction, it is also possible to measure the energy change during a reaction in the laboratory. Such measurements are generally done in an insulated container (a calorimeter) that is otherwise open to the atmosphere so that the pressure remains constant during the reaction.

The heat that is absorbed or released under such conditions is known as qp. When this number is scaled to a molar quantity, it is called the enthalpy change of the reaction, ? H. Reactions between liquids and solids are easily carried out in such a device or a reaction may be carried out externally (as in

the experiment) and the heat conducted to the calorimeter containing the reactants. A thermometer can be used to follow the heat flow during the reaction. If the temperature is observed to rise, this means that the heat is flowing from the system into the thermometer (and other surroundings). Such a reaction is said to be exothermic and the enthalpy change is given a negative (-) sign.

If the temperature falls, this means that heat is being absorbed from the surroundings into the system, indicating an endothermic reaction and making ? H positive (+). PERFORMING THE EXPERIMENT. In a neutralisation reaction between an acid and an alkali, water is formed. This is shown in the word equation: Acid + Alkali = Salt + WaterWe can prove this using an experiment. I will investigate the effect of changing the concentration of alkali has on the volume of acid needed to neutralise it. I will use a titration method to investigate this.

For this experiment, I will be using: Sodium hydroxide (NaOH) and hydrochloric acid (HCl). Sulphuric acid (H_2SO_4) and NaOH. NaOH and Ethanoic acid (CH_3COOH). There must be equal amounts of hydrogen ions (from the hydrochloric acid) and hydroxide ions (from the sodium hydroxide) for the solution to be neutral. I believe that as the concentration of alkali increases the amount of acid needed to neutralise it will increase.

APPARATUS NEEDED:

- Clamp stand.
- Burette.
- Measuring cylinder.

- Calorimeter cup.

- Thermometer.

- Stirrer.

- Stop clock.

Chemicals needed for the experiment.

- Solution of sodium hydroxide (200cm3 of 1 molar)

- Solution of hydrochloric acid (200cm3 of 1 molar).

HEALTH AND SAFETY.

- General Health and Safety in the laboratory – Personal Protective Equipment.

- Lab coat (preferably long sleeved) and closed toed shoes must be worn at all times to prevent chemicals from spilling on your clothes.

  Additional protective clothing should be worn if the possibility of skin contact is likely.

- Safety goggles/glasses must be worn to prevent chemicals getting into your eyes.

- Hand gloves must be worn when handling corrosive chemical and must be disposed after use.

- Long hair must be tied back to prevent burning, as acid is corrosive in nature.

- Never interfere with equipment or chemicals during experiment.

- If you get something in you mouth, spit it out at once and wash your mouth with lots of water and call for medical assistance.

- If you get burnt or a splash on your skin, wash the affected part(s) at once with lots of water and call for medical assistance.

- Remove any jewellery in the laboratory to prevent chemicals from coming in contact with them.

HEALTH AND SAFETY MEASURES WHEN DEALING WITH CHEMICALS.

- The following are proper procedures when handling and using highly corrosive concentrated chemicals such as Sodium hydroxide and hydrochloric acid.

- These acids should only be available and used when absolutely necessary.

- When using highly corrosive acids, wear appropriate personal protective equipment (safety splash goggles, gloves and lab coats) and work in a clean, spacious laboratory in case of fire incident.

- Use only the amount needed for immediate use and never store mixtures of highly corrosive acids and never put it in a sealed container, since pressure from evolving gases accumulates and possibly cause an explosion.

- Corrosive chemicals cause visible destruction or permanent changes in human skin tissue at the site of contact so it is better to avoid chemicals spilling on the skin to avoid skin burn.

- Do not store or keep corrosive chemicals on high cabinets or shelves to avoid them falling on someone.

- All corrosive chemicals must be clearly labelled with the correct chemical name.

- Specially designed corrosion resistant cabinets should be used for the storage of large quantities of corrosive materials.

- Separate acids and bases. Liquids and solids should also be separated.

- Waste disposal: most corrosive chemicals are hazardous wastes; therefore used chemicals must be disposed of the sink after use.

DIAGRAM. PROCEDURE.

1. Set up the apparatus by clamping the burette to the clamp stand.

2. Pour 50cc of Sodium hydroxide into the burette (1 molar).

3. Pour 25m of Hcl (200cm3 of 1 molar) into the measuring cylinder (making sure it is dried).

4. Slowly pour the Hcl into the calorimeter cup.

5. Write down the temperature for 5 minutes at 30 seconds interval. Digital thermometer may be used to get an accurate reading of the temperature.

6. Stir it and measure the temperature for every 30 seconds.

7. Pour 5m of NaoH (200cm3 of 1 molar) into the calorimeter cup and continue to measure every 30 seconds using a stop clock.

8. Pour another 5m of NaoH into the calorimeter. Continue to do so until the 50cc of NaoH is finished (emptied into the calorimeter cup).

9. Repeat each experiment three times to get an average reading and result.

METHOD.

The experiment was carried out in the laboratory. The apparatus was set up

by clamping the burette (1 molar) to the clamp stand. I had to wash the

burette to take out any particles in it. For the first experiment, 50cc of Sodium hydroxide was carefully poured into the burette.

On washing the measuring cylinder, 25m of Hcl (200cm3 of 1 molar) was carefully poured into the cylinder. The Hcl was then slowly poured into the calorimeter cup. Putting the thermometer into the calorimeter cup, I recorded the temperature for 5 minutes at 30 seconds interval while stirring. 5m of NaoH (200cm3 of 1 molar) was carefully poured into the calorimeter and I continued to read the temperature every 30 seconds using a stop clock. Another 5m of NaoH was poured into the same calorimeter and 5m of NaoH was continuously added every 30 seconds until the 50cc of the chemical was emptied into the calorimeter cup. The same method was used for experiments 1 and 2 respectively, using the chemicals required for both experiments accordingly.

I could not repeat each experiment three times because I was short of time to carry out each experiment thrice as required in the procedure. TABLE OF RESULTS. Blank result table. mls of (acid) addedTemperature in degrees centigrade00000510152025303540455050The factors that might affect the results of this experiment are: 1.

Volume. 2. Concentration. 3. Type of substance used. 4.

Catalyst. 5. Pressure. Volume can affect the experiment because if it is not kept constant them results will be varied and there would be no proof that concentration can effect this exothermic neutralisation reaction, as the test would not be fair.

Also if substances used were different this could affect the end result produced in this case a salt and water, as more reactive acids and alkalis can perhaps can produce a more vigorous reaction and therefore a higher temperature rise as more thermal energy is produced. The input variable that I will change will be concentration. Concentration increases the number of collisions because there are more particles in the solution to collide with each other. So if a solution is more concentrated more particles are bumping into each other. Which makes more collisions so there are more reactions between particles, therefore more reactants that produce more water.

When water is produced there bonds release energy therefore the more water produced by the reacting OH- and H+ ions the bigger the temperature rise. This is called collision theory. I will record the temperature change of each experiment to find out how concentration can affect the output variable. I will keep the concentration of the alkali constant and change the concentration of the acid. I will be able to do this by recording the temperature before the start of the experiment and the temperature at the end of the experiment and then subtracting the two results away from each other.

So as there will be different concentrations in different reactions this will mean different temperature changes. Therefore a different number of atoms in substances when volume is constant so different number of atoms react with each other. This means thermal energy produced by ions in different reactions will produce different temperature changes caused by formation of water. Prediction.

I predict that the experiment with the highest concentration of acid used will produce the highest temperature rise once reacted with alkali. This is because there are more ions in the higher concentration acid solution than the lower concentration solution, in the same volume. For example if I reacted 2 mol/l of NaOH with 2 mol/l Hydrochloric acid there will be an equal amount of ions that will react to form an exothermic neutralisation reaction likewise with 1 mol/l of each. But the 2 mol/l solution will produce the biggest temperature rise, as there will be double thermal energy produced in the volume of liquid, as the solution is more concentrated and there are more H+ and OH- ions to produce water. But if the concentrations reacted were different then this too would affect the exothermic neutralisation reaction. For example if I reacted 2 mol solution of NaOH with 1 mol of HCl like diagram two, only half of the OH- ions would be able to react to form water as the acid is at half the concentration to the alkali, therefore producing less of a temperature rise.

As shown by the second diagram as water is produced but there is an OH- ion left in the solution so complete neutralisation has not occurred, which is the case in diagram one. Moreover I predict that the most energy released will be when complete neutralisation occurs meaning that most water is produced will be 2 mol of acid and alkali. This leads me to think that if 2M of alkali were reacted with 1M of acid only half the ions are reacted to form the neutralisation reaction so less energy is produced. So 2mol/l of both substances will produce double the temperature rise as double the amount of ions are reacting in the same volume of solution. I know this because according to Avagrado's law, one mol of any element is 6. 02×1023.

So if I react equal volumes of the same molar concentrations of NaOH and HCl I am reacting the same number of atoms together therefore equal concentrations produce the highest temperature rise. EXPERIMENT 1: Sodium hydroxide (NaOH) and hydrochloric acid (Hcl). The equation for the reaction is as follows: Hcl + NaoH ? Nacl + H2O ? H = -57. 9 kJ mol-1In this reaction, exothermic reaction is taking place. Data result table.

1 ml of NaOH addedTemperature in degrees centigrade0220220220220225231025152720272528302935294029452750 26CALCULATION.? H = m x c x ? TWhere ? H = enthalpy changem = mass in grammes (assumption: 1 ml = 1grammes because of density). c = specific heat capacity of water in JK -1 g -1 (Joules per Kelvin per gramme).? T = change in temperature in oC= (25 + 24) x 4. 2 x (30 – 22)= 49 x 4.

2 x 8= 1646. 4 JMoles of Hcl = 25 x 11000? H = 1646. 4 J0. 025= 65856mol -1To convert to Joules = 65856 J1000= -65.

86 Kj mol -1Note: I used 0. 025 moles because 0. 05 moles was not the value I got for the neutralisation point and I did not use 50cc to neutralise it. Percentage error = actual yield – theoretical yield x 100Actual yield 1= -57. 1 – (-65. 86) x 100-57.

1 1= 15. 33%EXPERIMENT 2: Sulphuric acid (H2SO4) and Sodium Hydroxide (NaoH). This experiment is the same as the first experiment but I will be using Sulphuric acid (200cm3 of 1 molar) and Sodium Hydroxide (200cm3 of 1 molar). The equation for the reaction is as follows: H2SO4 + NaoH ? H2O + H2SO4 + H + ? H = -32. 2 kJ mol-1In this reaction, exothermic reaction is taking place.

Data result table. 1 ml of H2SO4 addedTemperature in degrees centigrade02302302302302302352410261528202925303031353140314453250 31CALCULATION.? H = m x c x ? T= (25 + 21. 5) x 4. 2 x (3. 15 -21)= 46.

5 x 4. 2 x 10. 5= 2050. 65 JConvert Joules to kilojoules= 2050.

651000= 2. 05065 Kj mol -11 molar solution = 98g in 1000m/s= 25m/s of H2SO41000= 0. 025 molesMoles of NaOH = volume x concentration1000= 251000= 0. 025 moles? H = 2. 050650. 025= -82.

026 Kj mol -1Percentage error = actual yield – theoretical yield x 100Actual yield 1= -57. 1 – (82. 01) x 100-57. 1 1= 43. 6%EXPERIMENT 3: Ethanoic acid (CH3COOH) and Sodium Hydroxide (NaoH).

This experiment is the same as the first experiment but I will be using Ethanoic acid (CH3COOH) (200cm3 of 1 molar) and Sodium Hydroxide (200cm3 of 1 molar). The equation for the reaction is as follows: CH3COOH + NaoH ? CH3COONa + H2O ? H = -56. 1 kJ mol-1In this reaction, exothermic reaction is taking place. Data result table. Initial temperature: 26oC.

1 ml of CH3COOHTemperature in degrees centigrade02202202202202252410251527202825283027352740264525450 25CALCULATION.? H = m x c x ? T= (26. 5 + 25) x 4. 2 x (30 – 21)= -51. 5 x 4. 2 x 9= -1946 JConverted to Kilojoules= -1946 J1000= 1.

945 Kj mol -1Mole of CH3COOH = volume x concentration1000= 25 x 11000= 0. 025 moles. 1 molar solution = 60g in 1000m/s1 mole in 1000m/s = 25m/s of CH3COOH1000= 0. 025 moles= 1. 9450.

025= -77. 7Kj mol -1Percentage error = actual yield – theoretical yield x 100Actual yield 1= -57. 1 – (-77. 7) x 100-57. 1 1= EVALUATION.

I stirred the chemicals in the calorimeter cup with the thermometer so as to make an even distribution of heat. Looking at my results for the second experiment, I believe I had a high figure because the heat escaped (it made it less exothermic) because there was no cover for the calorimeter cup to prevent heat from evaporating. I also think I had a high figure for Experiment 2 because while taking the burette reading, I did not take the volume at eye level. Therefore, there was error due to parallax. I think this was a difficulty for me (constraint).

Also, for the first experiment, I had a higher result than -57. 1 kJ mol-1 and I should have repeated the experiment for an average accurate reading, but there was time to do it. The experiment was only performed once. DISCUSSION.

Experiment 1: The strong acid and the strong base gives -57. 1 kJ mol-1 because the acid and base fully disassociate in water. I believe reason I did not get -57. 1 kJ mol-1 was because my acid and base did not fully disassociate in water.

I assumed the specific heat capacity was 4. 2 but I could not check the capacity and that affected heat loss. Experiment 2 is similar to Experiment 1 because the strong acid involved (Sulphuric acid) did not fully disassociate in water. In Experiment 3, I expected a lower figure because ethanoic acid is a weak acid.

It does not fully disassociate in water (it is not completely ionized in solution). This is because it varies with concentration (and in this case, it was a low concentration) and it is neutralised completely by acid. This is also because the heats of neutralisation for reactions involving weak acids and/or weak bases are always negative than for strong acids and bases.