The Identification of a Group 2 Hydroxide

Appreciation of Scale

The equation for this reaction:

The scale for this experiment will be in cm^3 for this allows for accurate measurements to be taken for the titration, which will improve the accuracy of the investigation being carried out and so will provide a more accurate molecular formula for the group 2 metal hydroxide. The equation for this reaction states that 2 moles of hydrochloric acid reacts with 1 mole of the group 2 metal hydroxide solution, so this shows that the concentration of the hydrochloric acid needs to be twice that of the group 2 metal hydroxide solution, for the acid to fully react with the alkali. In this investigation the group 2 metal hydroxide solution could either contain calcium, strontium or barium, which means for the investigation there, needs to be an average molecular mass calculated to ensure the molecular formula is accurate. For this titration appropriate concentrations are 0.01M, for the group 2 metal hydroxide and 0.02M, for the hydrochloric acid which is provided as a standard solution, because for the equation of this reaction, 2 moles of hydrochloric acid reacts with 1 mole of the group 2 metal hydroxide, to ensure a complete neutralisation. A sensible volume for the group 2 metal hydroxide solution is 10
$0cm^3$, so the titration can be repeated again without a new batch of the solution begin made, which could alter the results of the titration and a sensible volume for the hydrochloric acid is $100cm^3$ so the titration can be repeated.

Preparation of Hydroxide Solution

1. While carrying out this method it is advisable to wear goggles, gloves and a lab coat to avoid any unnecessary accidents usually associated with alkalis due to their corrosive properties.
2. The mass of the hydroxide being used firstly needs to be calculated by using an average molecular mass of the metals added to the hydroxide group which is 122 and gives the mass needed by $122 \div 1000 \times 100 \times 0.01 = 0.122$ g then it is weighed out in a paper boat using an accurate balance, which has been zeroed.
3. Take a graduated flask and wash it out thoroughly with distilled water, because distilled water has been removed of any impurities, which could contaminate the hydroxide solution.
4. Now add the hydroxide to the graduated flask
5. Now make it up to $100cm^3$ with distilled water in the graduated flask.
6. Now shake the graduated flask to completely mix together the distilled water and hydroxide solution because stirring can lead to the loss, of some of the hydroxide solution.
7. Make sure all washings are included.

Titration Method

1. While carrying out this method it is advisable to wear goggles, gloves and a lab coat to avoid any unnecessary accidents usually associated with acids and alkalis due to their corrosive properties.
2. Set up a burette on a clamp stand, making sure that the burette has been washed out thoroughly with distilled water and then with a small amount of the acid to prevent any contamination.
3. Now clean out the conical flask with distilled water and a small amount of the hydroxide solution also for the same reason as the burette.
4. Any other equipment being used must be also cleaned out with distilled water
5. Now fill the burette up to the 0 mark, with the acid using a funnel and it is an important safety precaution to make sure that the burette is below eye level and that the tap is off, after make sure the funnel is removed; due to that drips from the funnel can alter the results of the titration.
6. Take an initial reading from the burette as the start point, making sure the start point is recorded from the bottom of the meniscus.
7. Fill the conical flask with $25cm^3$ of the hydroxide solution, for it allows for more accurate measurements, press the end of the pipette against the inside of the conical flask to make sure that the pipette is empty, also make sure that a pipette filler is used, for sucking up the hydroxide solution instead of using your mouth, for it is dangerous to ingest any of the hydroxide solution due to that it is toxic.
8. Add a few drops of methyl orange indicator to the hydroxide solution, which will turn yellow in the hydroxide solution due to it being a base and the colour will turn orange when the base has been neutralised by the acid, which will be the end point of the titration
9. Place the conical flask under the burette and on top of a white tile to allow the colour change to be seen more clearly.
10. Next turn the burette tap on, so that the acid drips in to the conical flask at a controllable speed.
11. Constantly swirl the conical flask as the acid is being added to the base, to make sure that the colour of the solution is equally distributed in the solution, so the end point of the solution will be more easily recognisable.
12. As soon as the hydroxide solution has become completely orange in colour, turn the burette tap off immediately and then record the amount of acid required for neutralisation making sure the reading is recorded at the bottom of the meniscus.
13. The result of this titration will now give a clear idea of what volume of the acid is needed to achieve neutralisation, so when the titration is repeated the accuracy of the results will be improved, so consequently the first titration should be classified as a run through and the result should not be included in the calculations.
14. Now repeat this method until 3 concordant results have been achieved, 3 concordant results will minimise the amount of error which can occur and improve the accuracy of the result of the calculation.
15. Make sure all washings are included.

Calculations

Calculations for hydroxide solution

An average mass needs to taken due to that there is 3 possible metals (calcium, strontium and barium) so there is 3 possible molecular masses for the hydroxide. The average molecular mass of the 3 group 2 metals equals

$(40+88+137) \div 3 = 88$

Now the hydroxide group needs to be added on

$88 + (2 \times 16) + (2 \times 1) = 122$

So to find out how much is needed $122 \div 1000 \times 100 \times 0.01 = 0.122g$, dividing by 1000 converts the units into dm³ which is the appropriate unit for concentration, multiplying by 100 is the volume required and multiplying by 0.01 is the concentration required, the concentration required was determined from the equation, which shows that the concentration of the hydroxide solution needs to be half that of the concentration of the hydrochloric acid.

Calculation for relative formula mass

Relative formula mass=

$$\frac{W \div 100 \times 1000}{(\text{Moles of hydrochloric acid} \times 2) \times (dm^3 \div X)}$$

In this equation the mass of the metal used is represented by W which is 0.122g, X represents the average volume of titre required for a complete neutralisation between the acid and the base. Moles of hydrochloric acid are 0.02 as already stated in the appreciation of scale and dm^3 equals 1000.

Calculation for Ar of group 2 metal

$N = x \div (16 \times 2) + (2 \times 1)$

<u>Safety Review</u>

To ensure that this experiment is carried safely the following must carried out, firstly it is advised to wear goggles, gloves and a lab coat while carrying out this experiment to minimise the chance of the acid or the base coming into contact with your skin or eyes because they are corrosive and could damage or irritate your skin or eyes, if any of the acid or the hydroxide solution come into contact with your skin or eyes immediately rinse under cold water and inform your teacher, also to minimise the chance of the acid coming into contact with the eyes make sure the burette is below eye level. Secondly when using the pipette it is important that you use a pipette filler instead of using your mouth to suck up the hydroxide solution, because using your mouth means there is a chance of you ingesting some of the hydroxide solution, which is dangerous due to the hydroxide being toxic. Thirdly in case of any spillage of the acid or the hydroxide, follow the instructions of the hazard card for that substance which will probably include placing sand over the top of the spilled substance before cleaning it up.