Experiment 22 Quantitative Titration

PART 1 – Standardisation of HCl

In this experiment you will determine the morality of a hydrochloric acid solution which has been prepared so as to be about 0.25M. The process of determining the exact morality of a solution is known as ***standardisation***. In this case the solution will be ***standardised*** by reaction with sodium carbonate solution. A known mass of sodium carbonate is made up to a known concentration. This is known as a ***primary standard***. A known volume of this solution is ***titrated*** with the hydrochloric acid solution until a change in colour of the indicator shows that the reaction is complete:

$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

The volume of the acid is noted and hence one may calculate the morality of the acid.

Procedure

1. Weigh out accurately 3.3 to 3.4 grams of pure, dry, ***anhydrous*** sodium carbonate into a weighed beaker. Dissolve the sodium carbonate in about 30 – 40 mL of distilled water, and transfer the solution to a 250 mL volumetric flask. (You may need to add a further 30 – 40 mL of water to completely dissolve the carbonate). Wash the beaker with small amounts of distilled water, then make up the solution to the graduated mark on the volumetric flask. Make sure that the flask and its contents are mixed thoroughly. Calculate the exact concentration of the solution, then label the flask appropriately.

2. Obtain some hydrochloric acid solution. Rinse a 50 mL burette with the acid solution, and then rill the burette in the correct manner (as shown by your teacher). **Make sure that the bottom of the meniscus is read when taking readings.**

3. ***Pipette*** 25 mL of the sodium carbonate solution into a 250 mL conical flask. Add two or three drops of methyl orange indicator, stand the flask on a white tile under the burette, and titrate until the indicator changes colour. Read the volume of acid delivered by the burette, and record this in your practical book.

4. Refill the burette with acid if necessary, and repeat part 3 until you obtain three volumes which differ by no more than 0.1 mL, or as many as are directed by your teacher.

Calculations

1. Find the average of the three concordant acid volumes.

2. From the equation, how many moles of acid react with one mole of sodium carbonate?

3. How many moles of sodium carbonate reacted in each of the titrations (ie. in each 25 mL)?

4. How many moles of hydrochloric acid reacted in each case?

5. From your answers to 1 and 4, determine the concentration of the hydrochloric acid solution to three significant figures.

PART 2 – Standardisation of NaOH

Procedure

1. Obtain some base (sodium hydroxide solution), and record the number and letter corresponding to the solution in your practical book. Rinse the burette with this solution, and then fill it in the correct manner.

2. Pipette 10 mL of the standardised hydrochloric acid solution into a 250 mL conical flask, and about 15 mL of distilled water, and two or three drops of phenolphthalein indicator. Place the flask onto a white tile under the burette containing the unknown hydroxide solution.

3. Titrate until the indicator changes to a **persistent** pink colour. Record the volume of base used.

4. Repeat 2 and 3 until three volumes agree to within 0.1 mL.

Calculations

1. From the concentration given and the volume used, calculate the number of moles of hydrochloric acid involved in each titration of Part 2.
2. Use the equation for the reaction to calculate the number of moles of base that are used per mole of acid in Part 2.
3. From the relationship of calculation 2, determine the number of moles of base actually used.
4. Calculate the molar concentration of the base.

PART 3 – Titration of an Unknown

Procedure

1. Pipette 10 mL of household ammonia, window cleaner or vinegar into a conical flask. Add 15 mL of distilled water, then two or three drops of the appropriate indicator. (Your teacher will tell you which one to use if you are not sure).

2. Titrate the household product with the standardised HCl or NaOH from Part 1 or Part 2,making sure that at least two volume readings agree to withing 0.1 mL.

Calculations

1. Calculate the concentration of the household product which you used in **moles per litre** using the formula $1/a\ V_A.M_A = 1/b\ V_B.V_B$

2. Using formula mass, calculate the **mass** of ammonia or acetic acid in each **litre** of product.

3. Assuming that the density of the household product is 1.00 g/mL, calculate the percentage mass of ammonia or acetic acid in each litre of product.