**Name of exp.**

Titration of a hydrochloric acid solution using a standard solution of sodium carbonate

Theory

Laboratory grade hydrochloric acid is not sufficiently pure to be used as a primary standard. In this experiment, a standard solution of sodium carbonate is used to determine the exact concentration of a hydrochloric acid solution. The neutralisation reaction that occurs is as follows:

$$Na_2CO_3 + 2HCl \quad \text{--------}\rightarrow \square 2NaCl + H_2O + CO_2$$

1 mole   2 moles   2 moles   1 mole   1 mole
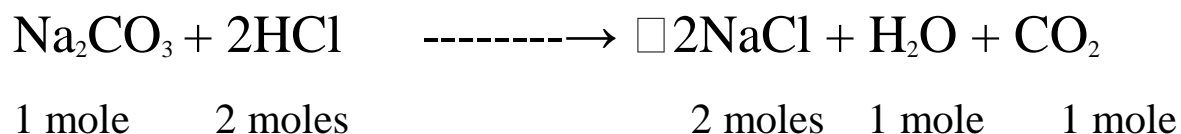
Methyl orange indicator solution is used. At the end-point – when neutralisation just occurs – the indicator changes colour from yellow to peach/pink.

Procedure

Pour approximately 50 ml of the hydrochloric acid solution into a clean dry beaker. Rinse the burette with deionised water, and clamp it vertically in the retort stand. Using the funnel, add a little of the hydrochloric acid solution to the burette; rinse the burette with this solution and discard it. Fill the burette with hydrochloric acid solution above the zero mark. Remove the funnel. Using the tap at the base of the burette, allow the acid to flow into a beaker until the level of liquid is at the zero mark. Ensure that there are no air bubbles in the nozzle of the burette. Hold a piece of white card behind the burette in order to see the level of liquid more clearly. Record the level of liquid in the burette in your notebook. Remember to record the lower level of the meniscus at eye level. Rinse the pipette with some deionised water and then with some of the sodium carbonate solution. Rinse the conical flask with deionised water only. Using the clean pipette and a pipette filler, transfer 25ml of the sodium carbonate solution into the clean conical flask. Add 2-3 drops of methyl orange indicator. Note the colour of the solution. A white tile underneath the conical flask will make the colour more obvious. Carry out a rough titration by adding hydrochloric acid solution from the burette in approximately 1 ml lots to the conical flask, swirling the flask constantly, until the colour of the solution in the conical flask changes. During the titration, any solution adhering to the sides of the conical flask during the titration should be washed down with deionised water.

Note the burette reading and calculate how much acid was used. This is only a trial titration and gives the approximate value of the end point. Wash out the

conical flask with water. Pipette 25 ml of sodium carbonate solution into the flask and add 2-3 drops of methyl orange indicator.
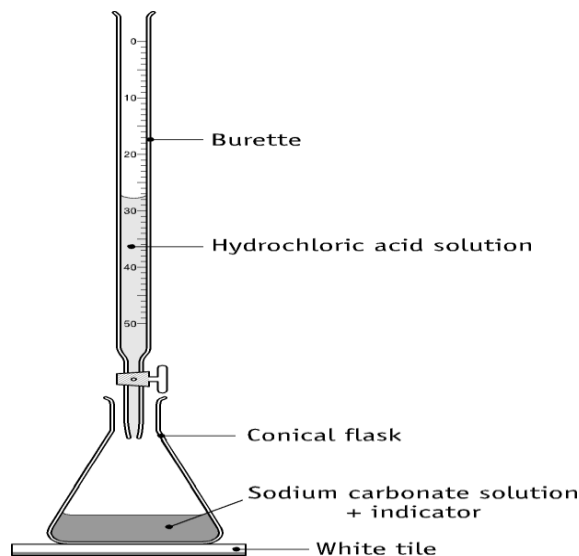
Repeat the titration for a more accurate reading, by adding in hydrochloric acid solution from the burette rapidly to within 2 ml of the end point. Swirl the conical flask vigorously, and, while continuing to swirl, add the hydrochloric acid solution dropwise from the burette. When a definite permanent colour change occurs,. Calculate the concentration of the hydrochloric acid solution.

Specimen Results

First titre   = 27.0 ml

Second titre   = 26.6 ml

Third titre   = 26.7 ml

Average of accurate titres = 26.65 ml

Volume of sodium carbonate solution used in each titration = 25.0 ml

Concentration of sodium carbonate solution = 0.1 M

Specimen Calculations

Formula method = VA x MA x nB = VB x MB x nA

26.65 x MA x 1 = 25.0 x 0.1 x 2

MA = 25.0 x 0.1 x 2 / (26.65 x 1) M   = 0.19 M

Concentration of hydrochloric acid solution = 0.19 M

student questions

1-Why is a conical flask, rather than a beaker, used in the experiment?

To allow easy mixing of the contents, by swirling.

2-In using a burette, why is it important

(a) to rinse it with a little of the solution it is going to contain, (b) to clamp it vertically, (c) to have the part below the tap full?

a) To remove any residual water, and so avoid dilution of the acid solution when it is poured into the burette.

b) To enable the liquid level to be read correctly.

c) To ensure that the actual volume of liquid delivered into the conical flask is read accurately.

3- The following procedures were carried out during the titration:

(a) The sides of the conical flask were washed down with deionised water. (b) The conical flask was frequently swirled or shaken.

Give one reason for carrying out each of these procedures.

a) To ensure that all of the acid added from the burette can react with the base.

b) To ensure complete mixing of the reactants.

4- Why is a rough titration carried out?

To find the approximate end-point. This information enables the subsequent titrations to be carried out more quickly.

5-Why is more than one accurate titration carried out?

To minimise error by getting accurate readings within 0.1 ml of each other.

6-Explain why hydrochloric acid is not used as a primary standard.

The exact concentration of any hydrochloric acid solution is not known, unless it is prepared from standard ampoules. Laboratory grade hydrochloric acid is not sufficiently pure.

7-Can any of the following be used as primary standards:

NaOH, H_2SO_4, HNO_3? Explain your answer.

A primary standard should be available in a highly pure state and stable. None of these substances are available pure because:

a) NaOH readily absorbs water and carbon dioxide from the air

b) concentrated H_2SO_4 readily absorbs water from the air

c) HNO_3 breaks down, releasing NO_2 gas.