Preparation of different types of solutions

Volumetric (Titrimetric) analysis:

Volumetric analysis (or Quantitative chemical analysis): Titration is the slow addition of one solution of a known concentration (called a titrant or titrator) to a known volume of another solution of unknown concentration (called a titrand or analyte) until the reaction reaches neutralization, which is often indicated by a color change.

- The standard solution is usually added from a graduated vessel called a burette.
- The process of adding the standard solution until the reaction is just complete is termed a titration.
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- The reagent of known concentration is called the titrant, and the substance being titrated is termed the titrand.
- Equivalent point is the point in a titration where the amount of standard titrant added is chemically equivalent to the amount of analyte in sample.
- End point is the point in a titration when an observable change that signals of the titrant's amount added is chemically equivalent to the amount of analyte in sample.
- Indicator is a reagent used to indicate when the end point has been reached.
- A primary standard is a highly purified compound that serves as a reference material in all volumetric titrimetric methods.

Important Explanation:-

Chemical analysis addresses interesting questions in the world around you and the nature of these questions is boundless. Is on our water safe to drink? Is the correct amount of medication present in the prescription I received from the pharmacist? These are just two examples of the type of questions that are answered every day by analytical chemists.

Titration describes a process where the concentration of an unknown substance is determined by comparing it with a solution of known concentration. The concept that makes titrations possible is finding the equivalence point, i.e., identifying when the quantity of the unknown substance is equal to the quantity of the known substance.

The equivalence point is found in a titration by adding trace amounts of a substance, called an indicator, which turns color when the equivalence point is reached. When a strong acid is titrated with a strong base, or vice versa, the pH of the solution will be about 7.0 at the equivalence point. Phenolphthalein is the indicator used in this experiment. Phenolphthalein is colorless in acidic solutions and turns pink in alkaline solutions.

Experiment (6)

Standardization of sodium hydroxide NaOH solution with standard solution of hydrochloric acid HCl

Important requirements for primary standard compounds are:

- Extremely pure
- Highly stable
- Anhydrous
- Less hygroscopic
- High molecular weight relatively
- Can be weighed easily
- Should be ready to use and available
- Should be preferably non toxic
- Should not be expensive

Objectives

- Standardize a sodium hydroxide solution
- Determine the molarity of an unknown hydrochloric acid solution
- Understand the use of indicators in titrations
- Learn proper pipetting technique
- Learn to titrate a strong acid with a strong base

Preparation of standard solution of Na_2CO_3 (0.lN):

1- Weigh out accurately 1.325gm of Na_2CO_3.

2- Dissolve in small quantity of distilled water and transfer quantitatively to 250ml measuring flask.

3- Complete to the mark and shake well.

4- Calculate the exact normality of Na_2CO_3 solution.

$$N = \frac{Weight}{eq.wt} * \frac{1000}{Volume(mL)}$$

Weight required = Normality x eq.wt. x volume in (1000 ml (liter)).

(I) Determination of the normality of hydrochloric acid by a standard solution of sodium carbonate (0.1N).

Theory:

Sodium carbonate reacts with hydrochloric acid according to the following equation:

$$Na_2CO_3 + 2HCl = 2NaCl + CO_2 + H_2O$$

In other words, to neutralize all the carbonate, two equivalent of HCl should be used and as such the equivalent weight of sodium carbonate = M.wt/2 =53 When one equivalent of HCl is added to the carbonate it is transformed into bicarbonates.

$$Na_2CO_3 + HCl = NaHCO_3 + NaCl \qquad \text{ph.ph.}$$

And the pH of the solution changes form 11.5 (alkaline) to 8.3. When phenolphthalein is used, it changes to colorless at the end of this stage as its color range falls within the same zone. ph.ph (8.3-10).

When another equivalent of HCl is added to the solution of bicarbonate, complete neutralization takes place and it is transformed into sodium chloride and CO_2 gas is evolved.

$$NaHCO_3 + HCl = NaCl + H_2O + CO_2 \qquad \text{M.O.}$$

The pH of solution changes from 8.3 to 3.8, which is near enough to the color range of M.O. (3.1-4.4). If methyl is used at this stage, the color of the solution changes from yellow to red. It thus follows that ph.ph. is used in the neutralization of HCl with sodium carbonate, the volume of acid used will be equivalent to half of the carbonate, when methyl orange is used in this titration the volume of acid used will be equivalent to all carbonate. Methyl orange is generally used in this as ph.ph. is sensitive to carbon dioxide.

Materials:

Sodium carbonate solution (standard).

HCl solution of unknown normality.

Procedure:

1- Transfer 10 ml of the sodium carbonate solution with a pipette to a conical flask then add one or two drops of M.O. to this solution.

2- Add the acid (HCl) from the burette gradually with continuous stirring of the solution in the conical flask, and near the end point, the acid is added drop by drop. Continue the addition of the acid till the color of the solution passes from yellow to orange.

3- Repeat the experiment three times and tabulate your results then take the mean of the three readings.

4- Repeat the experiment using ph.ph. which changes its color from red to the colorless at the end point. Compare the results in this case with those in the case of M.O.

Calculations:

- **In case of M.O.**

Suppose that the volume of HCl is V_1 and its normality is N_1 while V_2 is the volume taken from sodium carbonate and N_2 is its normality.

The volume of HCl (from burette) ≡ all carbonate = V_1

$$N_1\, V_1(HCl) = N_2\, V_2(Na_2CO_3)$$

$$\text{Or} \qquad N_1 = N_2\, V_2/V_1$$

- **In case of ph.ph**.

The volume of HCl (from burette) ≡ 1/2 carbonate

The volume of HCl ≡ all carbonate = $2V_1$

$$N_1 2V_1 = N_2 V_2$$

Or $$N_1 = N_2 V_2 / 2V_1$$

And as the strength in gm/L = normality x eq. wt.

Strength of HCI = $N_1 \times 36.5$ *g/L*

(II) Determination of the strength and normality of sodium hydroxide solution by a standard solution of hydrochloric acid

Theory:

HCl reacts with sodium hydroxide according to the following equation:

$$HCl + NaOH = NaCl + H_2O$$

The eq.wt. of both the HCl and NaOH is equal to their molecular weights and so both the acid and alkaline are strong, any indicator may be used.

Materials:

HCl solution (standard).

NaOH solution of unknown normality.

Procedure:

a- Prepartion of sodium hydroxide solution:

1- Weigh about 4.0 gm of A.R. NaOH.

2- Dissolve in small volume of distilled water and transfer to one-liter measuring flask.

3- Complete to the mark with distilled water, place the stopper on the bottle and thoroughly mix the solution by shaking the bottle.

b- Standardization of the resulting NaOn solution:

1- Transfer with a pipette 10 ml of NaOH solution to a conical flask then add one or two drops of M.O., add the standard HCl solution from the burette till the end point. (the color changes from yellow to reddish orange)

2- Repeat the experiment three times and tabulate your results.

3- Repeat the experiment using ph.ph. and Compare the result with those obtained With M.O.

Calculations:

In both cases of M.O. and ph.ph.

use the relation :

$N_1V_1(HCl) = N_2\ V_2(NaOH)$

In order to deduce the normality of NaOH

Strength of NaOH = N_2 *x 40 (eq.wt.) = g/L.*