Virtual Lab Report

Aim → To determine the total hardness of the hard water sample by EDTA metho (provided standard hardwater).

Theory → Water hardness is expressed in mg/l or ppm (parts per million). EDT is most commonly used complexant. EDTA is chelating agent. Buffer solution has composition of NH_4Cl & NH_4OH used to maintain pH value about 10.5.

(i) Indicator to Hard Water is added then it combines with free metal ions

$HIn^{-2} + M^{+2} \longrightarrow MIn^{-} + H^{+}$ {M = Mg or Ca} (Wine Red)

(ii) When EDTA solution is added to the titration flask it combines with the free metal ions giving metal EDTA complex, which is stable and colourless.

$$H_2Y^{2-} + M^{2+} \longrightarrow MY^{2-} + 2H^{+} \text{ (colourless)}$$

(iii) When all the free metal ions are exhausted, ~~and~~ next drop of EDTA removes the metal ion engaged with indicator and the original blue colour of indicator is restored.

$$H_2Y^{2-} + MIn^{-} \longrightarrow MY^{2-} + HIn^{2-} + H^{+} \text{ (Blue)}.$$

Procedure →
1.) Select the titrant
2.) Adjust the speed of the drops from the burette
3.) Adjust the molarity of titrant
4.) Select a definite volume of water sample
5.) Choose the indicator and start the titration
6.) When colour changes from wine red to blue click the "stop" button & note the volume of EDTA used.
7.) Then calculate the hardness of water sample in ppm using the

equation as follows.

$$\text{Total hardness as } CaCO_3 \text{ (ppm)} = \frac{\text{Vol of EDTA (mL)} \times 0.1 \times \text{molarity of EDTA} \times 10^6}{\text{Vol of sample (mL)}}$$

Calculations → Volume of EDTA used = 2.7 mL
Molarity of EDTA = 0.01 M
Volume of water sample = 10 mL

$$\text{Total hardness} = \frac{2.7 \times 0.1 \times 0.01 \times 10^6}{10}$$

$$= 270 \text{ ppm}$$

Results → The total hardness of water is = 270 ppm.

The determination of water hardness is a useful test that provides a measure of a quality of water for households and industrial uses. Originally, water hardness was defined as the measure of the capacity of the water to precipitate soap.

Precautions → (i) The burette, pipette and conical flask should be washed and then rinsed with distilled water.
(ii) Redistilled water should be employed for preparing the EDTA solution.
(iii) The colour change near the end point is very slow and thus should be observed very carefully.

Objective → To determine the alkalinity of a given water sample.

Theory → Alkalinity is the measure of ability of water to neutralize added acid. The alkanity of a water sample is due to carbonates (CO_3^{2-}) bicarbonates (HCO_3^-) and hydroxide (OH^-) ions. Thus in a given water sample the possible combination of ions causing ~~alkanity~~ alkalinity are as follows :

(i) OH^- alone
(ii) CO_3^{2-} alone
(iii) HCO_3^- alone
(iv) OH^- and CO_3^{2-} together
(v) CO_3^{2-} and HCO_3^- together

The possibility of OH^- and HCO_3^- ions together in the same solution is ruled out as they react to establish the following neutralization equilibrium.

$$HCO_3^- + OH^- \longrightarrow CO_3^{2-} + H_2O$$

To understand the basis of two consecutives titrations at different pH range : OH^-, CO_3^{2-} (caustic alkalinity) and HCO_3^- can be estimated seperately by titration against standard acid using phenolpthalein and methyl orange as indicators. The determination is based on the following reactions.

$$\left.\begin{array}{l} (i)\ OH^- + H^+ \longrightarrow H_2O \\ (ii)\ CO_3^{2-} + H^+ \longrightarrow HCO_3^- \end{array}\right] P$$
$$(iii)\ HCO_3^- + H^+ \longrightarrow H_2O + CO_2 \quad \Big] M$$

Thus titration of a given water sample in a presence of

phenolphthalein (pink colour above pH 8.5 and below it become colourless) as an indicator indicates completion of reaction 1 and 2 whereas the same water sample, if titrated in presence of Methyl Orange (yellow colour above pH 4.5 and sharply changes to red-orange below pH 3.1) as an indicator indicates the completion of reaction 1, 2 and 3. The water sample when titrated with an acid solution using phenolphthalein indicator gives End point = P; as ml volume of titrant for phenolphthalein indicator and with methyl orange indicator gives End point = M; as ml volume of titrant for methyl orange indicator. The relation between P and M points gives the type of and extent of alkalinity is established as follows:

Sr. no.	Result of titration	Hydroxide ion	Carbonate ion	Bicarbonate ion
1	P = 0	Nil	Nil	M
2	P = M	P or M	Nil	Nil
3	P = 1/2 M ($V_1 = V_2$)	Nil	2P	Nil
4	P > 1/2 M ($V_1 > V_2$)	2P - M	2(M - P)	Nil
5	P < 1/2 M ($V_1 < V_2$)	nil	2P	M - 2P

Calculations → Volume of HCl corresponding to phenolphthalein end point (A) = 8.9 mL
Normality of acid = 0.01 N
Volume of water sample = 10 mL.

Normality of water corresponding to phenolphthalein end point

$$PA = \frac{A \times \text{Normality of acid} \times 50000}{\text{Volume of sample (mL)}} = \frac{8.9 \times 0.01 \times 50,000}{10}$$

$$= 445 \text{ ppm}$$

Volume of HCl corresponding to methyl orange end point (B) = 15.7 mL
Normality of acid = 0.01 N
Volume of the water sample = 10 mL

Normality of water corresponding to methyl orange end point (TA) =

$$\frac{B \times \text{Normality} \times 50000}{\text{Volume of sample (mL}} = \frac{15.7 \times 0.01 \times 50000}{10} = 785 \text{ ppm}$$

PA $> \frac{1}{2}$ TA $\longrightarrow$ OH^- alkanility as $CaCO_3$ $\Rightarrow$ 105 ppm.

CO_3^{2-} alkanility as $CaCO_3$ $\Rightarrow$ 680 ppm

HCO_3^- alkanility as $CaCO_3$ $\Rightarrow$ 0 ppm.

Results $\longrightarrow$ Alkanility is due to OH^- = 105 ppm.
Alkanility is due to CO_3^{2-} = 680 ppm.

Precautions $\longrightarrow$ (i) The burette, pipette and conical flask should be washed properly and then rinsed with distilled water.
(ii) Redistilled water should be employed for preparing the alkaline solution.
(iii) The colour change near the end point is very slow and thus should be observed very carefully.

Aim → To determine the amount of substance in a solution of unknown conc. using various titrimetric methods

Theory → It involves the estimation of a substance in solution by neutralization, precipitation, oxidation or reduction by means of another solution of accurately known strength. This solution is known as standard solution.

Volumetric analysis depends on measurements of the volume of solutions of the interacting substances. A measured volume of the solution of a substance A is allowed to react completely with the solution of definite strength of another substance B. The volume of B is noted. Thus we know the volume of the solutions A and B used in the reaction and the strength of solution B; so the strength of other solution A is obtained. The amount (or concentration) of the dissolved substance in volumetric analysis is usually expressed in terms of normality. The weight in grams of the substance per litre of the solution is related to normality of the solution as,

$$\text{Weight of the substance (g/L)} = \text{Normality} \times \text{gram equi. weight of the substance}$$

Calculations →

N_1 = Normality of NaOH = 0.1 N

V_1 = Volume of NaOH = 10 mL

N_2 = Normality of HCl = N

V_2 = Volume of HCl = 1 ml.

$$N_1V_1 = N_2V_2$$

$$0.1 \times 10 = N \times 1$$

$$\boxed{N = 1\ N}$$

$$\text{Mass} = \frac{\text{Equivalent weight} \times \text{Normality} \times \text{Volume}}{1000}$$

$$= \frac{36.5 \times 1 \times 1}{1000} = 0.0365\ g.$$

Result → Normality of HCl is 1N
Mass of HCl is 0.0365 g.

Precautions → 1.) Titrations is carried out at room temperature.
2.) All the volumetric apparatus should be washed with distilled water before use.
3.) Rinse the burette with a solution of oxalic acid to be taken in the burette.
4.) Wash the conical flask with distilled water after every ~~minute~~ titration.
5.)