Experiment 7

Complexometric titration using EDTA (Chelatometry)

In Complexometric titration

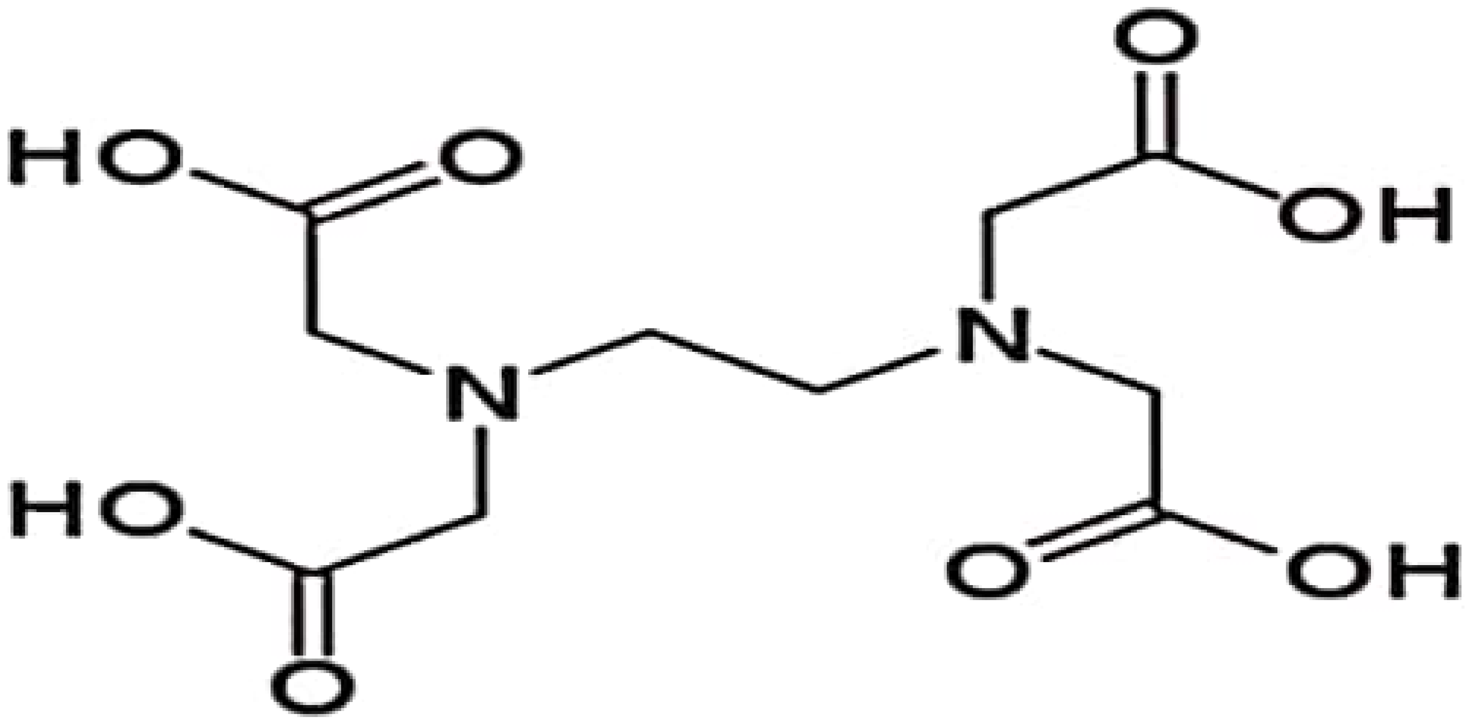
** The formation of a colored complex is used to indicate the end point of a titration.

** It's particularly useful for the determination of a mixture of different metal ions in solution.

** A simple ion is transformed into a complex ion and the equivalent point is determined by using metal indicators

What is EDTA ?

- **Ethylenediaminetetraacetic acid**



What is EDTA ?

** The most titrant used.

** It has four carboxyl groups and two amine groups that can act as electron pair donors.

**EDTA is tetraprotic and hexadentate ligand

**EDTA forms stable, water soluble 1:1 ratio complex with metal.

**EDTA can be obtained as H_4Y or H_2Y^{2-}

**H_2Y^{2-} can form only 4 coordinate covalent bonds.

** EDTA is extensively used to standardize metal (2+) cations

- $M^{n+} + H_2Y^{2-} \rightleftharpoons MY^{n-4} + 2H^+$

- as stability of the complex decreases the pH of the solution needs to be higher.
- It's advisable to use buffer solution (a mixture of weak acid and it's conjugate base OR vice versa)
- Using buffer will control pH to be nearly constant value

For reactions with M^{2+}

- H_4Y needs NaOH to be added in aqueous solution to make it dissolved.
- Na_2H_2Y is dissolved in aqueous solution
- $M^{2+} + H_4Y \rightleftharpoons MH_2Y + 2H^+$

** If the formation constant is very high and thus equilibrium lies to right

What is the media of reaction?

- ** The reaction should be in a buffer medium (WHY?)

**using basic solution (buffer) will remove H+ as it's formed so equil. goes to right favoring EDTA-metal complex.

**higher the acidity of the solution leads to reduce the stability of formed complex

Complexometric Indicators:

- Organic dyes form complex with metal weaker than the complex formed by the metal with EDTA
- These indicators possess acid-base indicator properties
- At the end point indicator will be displaced completely by EDTA, thus the free indicator serves as end point indicator
- Example: Murexide and Eriochrome black T

Indicator that will be used in our exp.:

**Eriochrome black T :

the color changes from wine red to pure blue

**Murexide :

the color changes from pink to purple

Objectives:

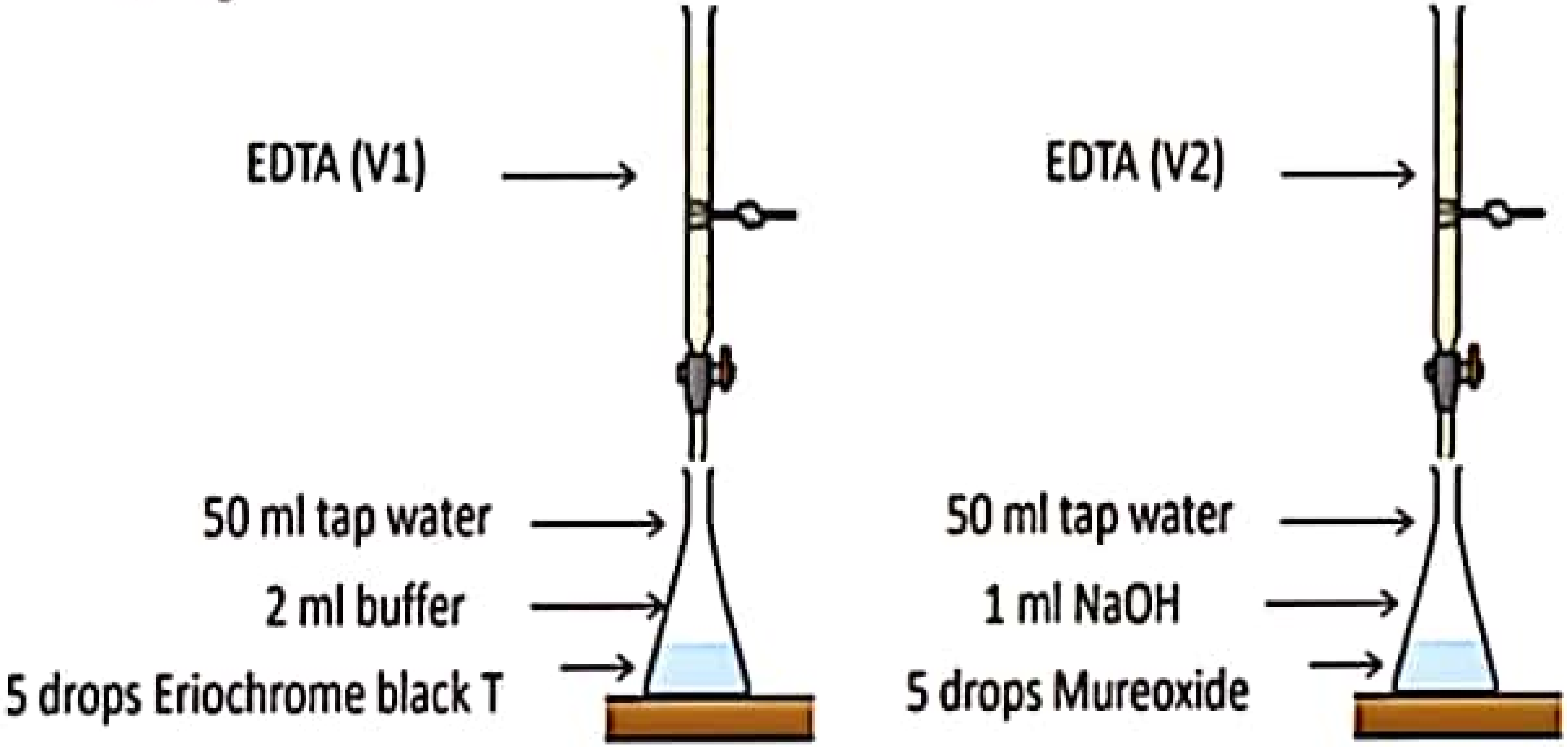
- Calculate of water hardness (amount of dissolved Ca^{2+} and Mg^{2+} in water
- Calculate conc. of Ca^{2+} and Mg^{2+} in an unknown sample in ppm (mg/L)

a) Standardization of EDTA against $ZnSO_4.7H_2O$ as primary standard

$$M\,ZnSO4.7H20 = \frac{\frac{m}{Mw}}{v}, \quad v = 0.1\,L$$

$$(M \times V)\ EDTA = (M \times V)\ ZnSO_4.7H_2O$$

b) Determination of water hardness due to presence of $CaCO_3$ and $MgCO_3$



The color changes from wine red to pure blue

The color changes from pink to purple

V1=volume of EDTA corresponding to Ca^{2+} and Mg^{2+}

V2= volume of EDTA corresponding to Ca^{2+} only

V1-V2 =volume of EDTA corresponding to Mg^{2+} because $Mg^{2+} + OH^- \longrightarrow Mg(OH)_2$

$(M \times V_1)$ EDTA = $(M \times V)$ Ca^{2+} and Mg^{2+}

$(M \times V_2)$ EDTA = $(M \times V)$ Ca^{2+}

$M \times (V_1 - V_2)$ EDTA = $(M \times V)$ Mg^{2+}

Conc g/L= M x Mw

Water hardness   In terms of $CaCO_3$

= M Ca^{2+} mol/L   x 100 x 1000

c) Determination of the concentration of Ca^{2+} and Mg^{2+} in an unknown solution

$(M \times V_2)$ EDTA = $(M \times V)$ Ca^{2+}

$M \times (V_1 - V_2)$ EDTA = $(M \times V)$ Mg^{2+}

Conc g/L= M x Mw