

TABLES \Rightarrow

1) Determination of EDTA.

Sr. No.	Volume of hardwater	Burette reading		Volume of EDTA	Indicator
		I	F		
	ml	ml		ml	
1.	20.0	0	19.8	19.8	erichrome - black - T.
2.	20.0	0	19.8	19.8	

2) Determination of Total Hardness.

Sr. No.	Volume of sample hard water	Burette reading		Volume of EDTA	Indicator
		I	F		
	ml	ml		ml	
1.	20	0	10.4	10.4	erichrome - black - T.
2.	20	0	10.4	10.4	

3) Determination of Permanent Hardness.

Sr. No.	Volume of boiled water	Burette reading		Volume of EDTA	Indicator
		I	F		

ESTIMATION OF TOTAL HARDNESS, PERMANENT HARDNESS AND TEMPORARY HARDNESS BY EDTA METHOD.

To estimate the amount of total hardness, permanent hardness and temporary hardness of a given sample of water by EDTA method by using ammonium buffer ($\text{pH} = 10$) and erichrome - black - D indicator.

APPARATUS REQUIRED \implies

Burette, pipette, conical flask, standard volumetric flask, funnel, beaker (250 ml), etc.

REAGENTS \implies

- 1) EDTA solution.
- 2) Standard hardwater.
- 3) Sample water.
- 4) Erichrome - black - D indicator (EBT).
- 5) $\text{NH}_3\text{NH}_4\text{Cl}$ buffer solution ($\text{pH} = 10$).

PRINCIPLE \implies

Disodium salt of ethylene diamine tetra acetic acid (EDTA), is used to determine the total hardness of the given hardwater where EDTA is added, the indicator is replaced by EDTA and stable complex is formed. This is the endpoint for the titration between EDTA and hardwater. EDTA is a tetra-carboxylic acid which has following formula:

	m1	m1	m1	
1.	20	0	5.2	erichrome -
2.	20	0	5.2	black - T.

CALCULATIONS \Rightarrow

1)

Table 1: DETERMINATION OF EDTA.

1ml of standard hardwater = 1mg of CaCO_3

Volume of standard hardwater = 20 ml
taken

now, 20ml of standard hardwater = 20 ml of CaCO_3 .

\therefore Volume of EDTA solution = 20 mg of CaCO_3 .

so, Volume of EDTA consumed = V_1 ml (from table 1)
= 19.8 ml

\therefore 1ml EDTA will be = $\frac{20}{V_1}$ mg of equivalent CaCO_3

$$= \frac{20}{19.8} = 1.0101 \text{ mg of } \text{CaCO}_3.$$

2)

Table 2: DETERMINATION OF TOTAL HARDNESS.

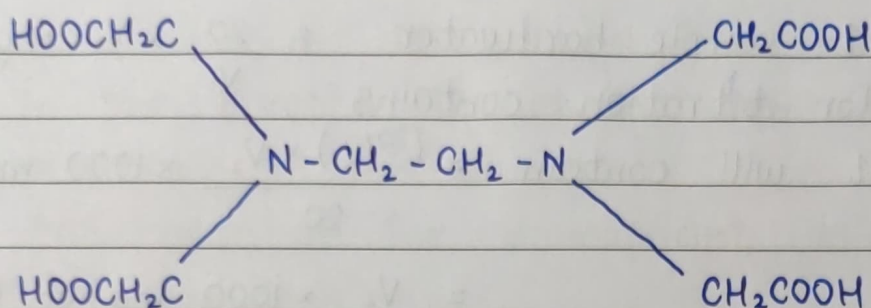
Volume of EDTA consumed = V_2 ml (from table 2)
= 10.4 ml

now, if 1ml EDTA = $\frac{20}{V_1}$ mg of equivalent CaCO_3

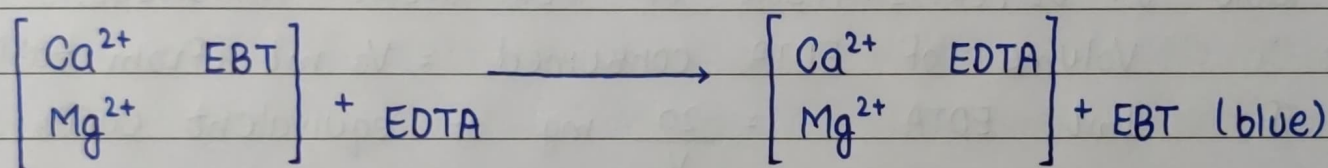
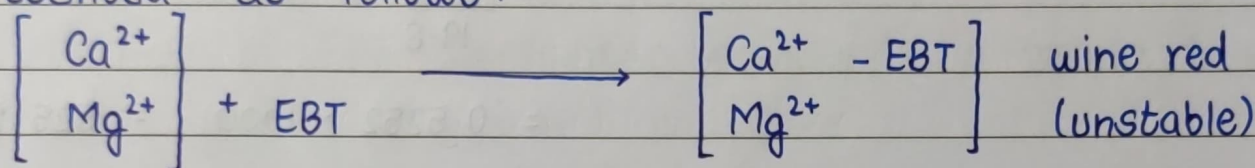
$$= 1.0101 \text{ mg of } \text{CaCO}_3.$$

then, V_2 ml EDTA = $\frac{20}{V_1} \times V_2$ mg of CaCO_3

$$= 1.0101 \times 10.4 = 10.50 \text{ mg of } \text{CaCO}_3.$$



The entire reaction between Ca, Mg ions and EB-T is represented as follows:



stable colourless complex

When the sample water is boiled, bicarbonates of calcium and magnesium are converted into carbonates and hydroxides which can be removed by filtration.

The permanent hardness which is not removed by boiling is once again estimated by EDTA using Erichrome - black - D indicator.

PROCEDURE \implies

• STANDARDIZATION OF EDTA:

- 1) Pipette out 20ml of standard water into a clean conical flask.
- 2) Add 5ml of the buffer and 3 or 4 drops of two Erichrome - black - D indicator. The solution turns to wine red in colour.

If 20ml sample hardwater taken for titration contains $= \frac{20}{V_1} \times V_2 \text{ mg CaCO}_3$

then, 1000ml will contain $= \frac{(20/V_1) \times V_2}{20} \times 1000 \text{ mg CaCO}_3$

$$= \frac{V_2}{V_1} \times 1000 \text{ mg of CaCO}_3$$

$$= \frac{10.4}{19.8} \times 1000$$

$$= 0.5252 \times 1000 = 525.2 \text{ ppm}$$

3) Table 3: DETERMINATION OF PERMANENT HARDNESS.

Volume of EDTA consumed = $V_3 \text{ ml}$ (from table 3)

if, 1ml EDTA = $\frac{20}{V_1} \text{ mg of equivalent CaCO}_3$

$$= 1.0101 \text{ mg of CaCO}_3.$$

then, $V_3 \text{ ml EDTA} = \frac{20}{V_1} \times V_3 \text{ mg of CaCO}_3$

$$= 1.0101 \times 5.2 = 5.2525 \text{ mg of CaCO}_3.$$

The boiled water sample is equivalent to permanent hardness $= \frac{20}{V_1} \times V_3 \text{ mg CaCO}_3$

then, 1000ml will contain $= \frac{(20/V_1) \times V_3}{20} \times 1000 \text{ mg CaCO}_3$

$$= \frac{V_3}{V_1} \times 1000 \text{ mg of CaCO}_3$$

$$= \frac{5.2}{19.8} \times 1000$$

$$= 0.2626 \times 1000 = 262.6 \text{ ppm}$$

- 3) Titrate the wine red coloured solution against EDTA taken in the burette. The change from wine red to steel blue colour is the endpoint.
- 4) Repeat the titration for concordant value. Let the titre value be V_1 ml.

• DETERMINATION OF PERMANENT HARDNESS :

- 1) Take 100ml of the hardwater sample in a 250ml beaker. and boil gently for about one hour.
- 2) Filter into a 100ml standard flask and make the volume upto the mark.
- 3) Take 20ml of this solution and proceed the titration in the same way. The volume of EDTA used corresponds to permanent hardness of the water sample.

∴ The temporary hardness of the given water sample:

$$= \text{Total hardness} - \text{Permanent hardness}$$

$$= 525.2 - 262.6$$

$$= 262.60 \text{ ppm}$$

RESULT \Rightarrow

- 1) The total hardness of sample hardwater = 525.2 ppm
- 2) The permanent hardness of sample hardwater = 262.6 ppm
- 3) The temporary hardness of sample hardwater = 262.60 ppm