

Subject Name - Chemistry

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Division - 11

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Batch - K3

Experiment No. 1

Estimation of total hardness of water



\* Aim - To estimate total hardness of water by EDTA method by double burette method.

\* objective - To determine the hardness of a water sample by complexometric titration method. Ethylene diamine tetra acetic acid (EDTA) is used as chelating agent. It forms complex with divalent cations such as  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  ions in stoichiometric amount and thus hardness can be determined as ppm of  $\text{CaCO}_3$ .

\* Apparatus: Burette, conical flask, 100ml volumetric flask, beaker, watch glass, Burette stand etc.

\* chemicals:  $\text{Na}_2\text{EDTA}$  solution, 0.01M  $\text{ZnSO}_4$ , Buffer solution (pH=10), Hard water sample, Eriochrome Black-T [EBT] etc.

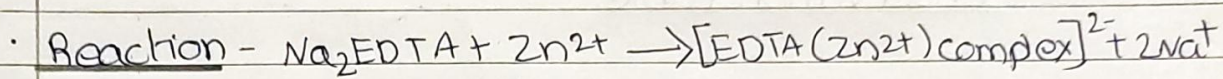
\* Part B - standardization of  $\text{Na}_2\text{EDTA}$  solution by double burette method.

observation table.

Burette 1 - $\text{Na}_2\text{EDTA}$ solution (0.01M) approx
Burette 2 - $\text{ZnSO}_4$ solution (0.01M)
Indicator - Eriochrome
Black-TEnd point - wine red to blue



\* Part B - Standardization of  $\text{Na}_2\text{EDTA}$  solution by double burette method.



Burette 1	$\text{Na}_2\text{EDTA}$	$x_1 =$	$x_2 =$	$x_3 =$
Burette 2	$\text{ZnSO}_4$	5ml	6ml	7ml

• calculations:-

To calculate exact molarity of EDTA (0.01M)

$$M_1 \times V_1 = M_2 \times V_2$$

$$\text{EDTA} = \text{ZnSO}_4$$

$$\therefore M_1 \times V_1 = 0.01 \times 5$$

$$M_1 = 0.01 \times 5 / 4.9$$
$$= 0.0102 \text{ M}$$

$$M_2 = 0.0103 \text{ M}$$

$$M_3 = 0.0101 \text{ M}$$

$$\therefore \text{Molarity of EDTA} = M' = \frac{M_1 + M_2 + M_3}{3}$$

$$= 0.01 \text{ M}$$

$\therefore$  Exact molarity of EDTA is 0.01M

\* Part C - To find out total hardness of given water sample.

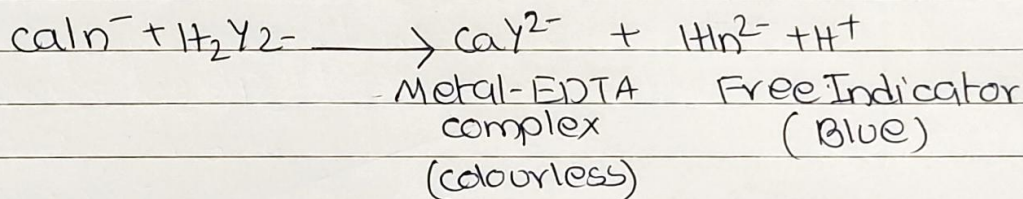
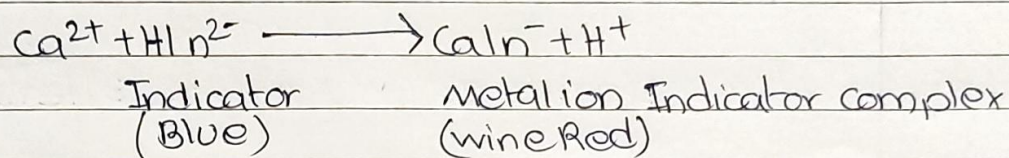
Observation table:-

Burette 1 - $\text{Na}_2\text{EDTA}$ solution (0.01 M)
Burette 2 - Hard water sample
Indicator - Eriochrome
Black - T Endpoint - wine red to blue



\* Part C:- To Find out total hardness of given water sample.

• Equations:-



Burette 1	$\text{Na}_2\text{EDTA}$	$V_1 =$	$V_2 =$	$V_3 =$
Burette 2	Hard Water sample	5ml	6ml	7ml

• Calculations:

EDTA and  $\text{Ca}^{2+}$  (or  $\text{Mg}^{2+}$ ) ions form 1:1 complex

1 mole of EDTA = 1 mole of  $\text{Ca}^{2+}$  (or  $\text{Mg}^{2+}$ ) = 1 mole of  $\text{CaCO}_3$

1 mole of EDTA = 100g of  $\text{CaCO}_3$

Thus 1000ml of 1M EDTA = 100g of  $\text{CaCO}_3$

1ml of 1M EDTA = 100 mg of  $\text{CaCO}_3$

1ml 0.01 M EDTA = 1mg of  $\text{CaCO}_3$



$$\therefore V_1 \text{ ml of } M^1 \text{ Na}_2\text{EDTA} = \frac{V_1 \times M^1}{0.01} = A_1 \text{ mg CaCO}_3$$

$$\therefore A_1 = \frac{2.1 \times 0.01}{0.01} = 2.1 \text{ mg}$$

$$H_1 = 200 \times 2.1 = 420 \text{ ppm}$$

$$\therefore A_2 = 2.6 \text{ mg}$$

$$\therefore H_2 = 167.33 \times 2.6 = 435.06 \text{ ppm}$$

$$\therefore A_3 = 3.1 \text{ mg}$$

$$\therefore H_3 = 142.85 \times 3.1 = 442.83 \text{ ppm}$$

$$\text{Hardness of given sample} = \frac{H_1 + H_2 + H_3}{3} = \frac{1297.89}{3}$$

$$= \underline{432.63 \text{ ppm of CaCO}_3}$$

### \* Results:

Exact molarity of EDTA solution = 0.0102 M

Total hardness of given sample of water = 432.63 ppm of CaCO<sub>3</sub>

### \* Conclusion -

The total hardness of a given sample of water was estimated to be 432.63 ppm of CaCO<sub>3</sub> by EDTA method by double burette method.



### \* Questions -

Q. 1) Explain the significance of determination of hardness of water.

Ans → For determining suitability of water for domestic and industrial purpose. type of hardness and determination of magnitude of hardness is important.

Q. 2) why is the end point of titration is wine red to blue?

Ans →

- ① In this titration EBT is used as an indicator
- ② It forms less stable wine red coloured complex with metal ions But when  $\text{Na}_2\text{EDTA}$  is added, metal indicator complex dissociates setting metal ions free.
- ③ They immediately form stable colourless complex with EDTA.
- ④ As a result, solution appears blue.
- ⑤ Appearance of blue colour is taken as end point of titration.

Q. 3) why and how is the pH value adjusted to about 10?

Ans → The EDTA forms a stable complex in basic medium, thus the alkaline buffer of  $\text{Na}_2\text{CO}_3$  and  $\text{NaHCO}_3$  of pH-10 is used.



Q 4) As per WHO norms, what is the standard value of hardness for drinking water?

Ans → According to WHO, hardness is in the range 10-500mg of  $\text{CaCO}_3$  per litre for drinking water.

Q 5) what is portable water, deionized water, saline water, brackish and mineral water?

Ans → ① Portable water is fresh water that is sanitized and safe for drinking.

② Deionized water is water that has been treated to remove all ions and dissolved mineral salts.

③ Saline water is water that contains a high concentration of dissolved salts.

④ Brackish water is water occurring in natural environment having more salinity than freshwater but less than seawater.

⑤ Mineral water is water from a mineral spring (spring) that contains various minerals such as salts and sulfur compounds.