WATER :

Water is called as **universal solvent** because it is an excellent solvent for ionic compounds and polar covalent compounds.

3/4th of earth's surface is covered by water.

Purest form of natural water is rain water.

Potable water means which is for drinking.

Hardness of water:

- Chemically soap is sodium stearate.
- Water which gives good lather readily with soap is known as soft water.
- Water which does not give lather readily with soap but precipitates soap is known as hard water.
- When soap is added to hard water Na^+ of soap are replaced by Ca^{2+} or Mg^{2+} ions and precipitates as Ca or Mg soap.
- The disadvantages of using hard water are
  a) It produces boiler scales
  b) It causes wastage of soap in laundries
- Hardness of water is expressed in terms of ppm of $CaCO_3$. That means the number of grams of $CaCO_3$ (or) its equivalent part present in 1 million grams of water is known as **hardness.**
- Hardness is of two types. They are
  1) Temporary hardness
  2) Permanent hardness
- Temporary hardness of water is due to the presence of the bicarbonates of Ca and Mg.
- Permanent hardness of water is due to the presence of the chlorides and sulphates of Ca, Mg, Fe.
- Temporary hardness of water can be removed by
  1) Boiling 2) Clark's Method
- Boiling removes the temporary hardness as soluble bicarbonates convert into insoluble carbonates

  $Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3\downarrow + H_2O + CO_2\uparrow$

  $Mg(HCO_3)_2 \xrightarrow{\Delta} MgCO_3\downarrow + H_2O + CO_2\uparrow$
- In Clark's method temporary hardness can be removed by adding a calculated quantity of milk of lime

  $Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3\downarrow + 2H_2O$

  If excess of lime is added it will cause permanent hardness.

Using Na_2CO_3 both temporary and permanent hardness can be removed.

- The methods used for removing permanent hardness are
  a) Permutit method b) Ion exchange method
  c) Calgon method
- a) Permutit is an artificial zeolite. Chemically permutit is hydrated sodium aluminum ortho silicate. Its formula is $Na_2\ Al_2\ Si_2\ O_8.\ x\ H_2O$.
  b) Gan's permutit process is also known as Base exchange process.

  $Na_2Al_2Si_2O_8.xH_2O + Ca^{2+} \rightarrow$

  $CaAl_2Si_2O_8.xH_2O + 2Na^+$
- The exhausted permutit is regenerated by treating 10% NaCl solution [Brine solution]
- Calgon is sodium hexameta phosphate. Its formula is $Na_2\ [Na_4(PO_3)_6)]$ or $(NaPO_3)_6$
- Calgon removes hardness by forming complex compounds with the Ca^{2+} and Mg^{2+} ions of hard water or by adsorption.

Ion exchange method:

- Deionised water is obtained in ion exchange method. It is free from all ions. It can be used in place of distilled water.
- Cation exchange resin is RCOOH or RSO_3H and anion exchange resin is RNH_3OH.
- In cation exchange resin, the cations of hard water get replaced by H^+ ions.

  $2RCOOH + Ca^{2+} \rightarrow (RCOO)_2\ Ca + 2H^+$

  Resin (from hard water)
- In anion exchange resin the anions of hard water get replaced by OH^- ions.

  $(RNH_3)OH + Cl^- \rightarrow (RNH_3)Cl + OH^-$

  Resin (from Hard water)
- The exhausted cation exchange resin can be regenerated by moderately concentrated H_2SO_4 solution.

Degree of hard ness:

It is expressed in PPM in terms of $CaCO_3$.

It is the number of parts by weight of $CaCO_3$ in one million parts by weight of water

Degree of hardness in PPM= $\frac{\text{weight of } CaCO_3}{\text{weight of } H_2O} \times 10^6$

100g $CaCO_3$ = 162 g $Ca(HCO_3)_2$

= 111g of $CaCl_2$

= 136 g of $CaSO_4$

= 95 g of $MgCl_2$

= 120 g of $MgSO_4$

= 146g of $Mg(HCO_3)_2$