CLASS X : NOTES : CH-2 : ACIDS, BASES AND SALTS : SCIENCE (CHEM)

ACIDS: Those substances which turn blue litmus red are called Acids. Acids are sour in taste. They give H^+ ions in aqueous solution.

e.g., Hydrochloric acid(HCl), Sulphuric acid(H_2SO_4), Nitric acid(HNO_3), Acetic acid(CH_3COOH), Carbonic acid(H_2CO_3), Sulphurous acid (H_2SO_3), Hydrocyanic acid(HCN), Boric acid(H_3BO_3), Phosphoric acid(H_3PO_4), Oxalic acid($(COOH)_2$), Hydrobromic acid(HBr), Hydroiodic acid(HI), Hydroflouric acid(HF).

BASES: Those substances which turn red litmus solution blue are called Bases. They are bitter in taste and they are present in bitter substances like baking soda solution, neem extract, cucumber extract, washing soda solution, soap solution. They give OH- ions in aqueous solution. Soluble bases are called Alkalis. e.g., NaOH, KOH, NH_4OH, $Ca(OH)_2$.

ACID –BASE INDICATOR: Those substances which change their color in Acidic & basic solutions are called Acid – Base Indicator. e.g., Litmus-purple dye-extracted from Lichen, red cabbage leaves, turmeric colored petals of some flowers.

Synthetic Indicators: Synthetic Indicators are manmade Indicators, which give test for the presence of acids & bases in a substance. e.g., methyl orange, phenolphthalein, methylene blue, gentian violet, methyl red etc.

Olfactory Indicators : Those substances whose odour changes in acidic & basic media are called Olfactory Indicators. E.g., Vanilla, Onion, Clove.

REACTION OF METALS WITH ACIDS:

Acid + Metal → Salt + Hydrogen gas

(i) $2Na(s) + 2HCl(aq) \rightarrow 2NaCl + H_2(g)$

(ii) $Ca(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2(g)$

(iii) $Cu(s) + HCl(dil) \rightarrow$ No Reaction

(iv) $Au(s) + HCl(dil) \rightarrow$ No Reaction

Cu, Ag, Au, Hg, Pt do not liberate H_2 gas from dil HCl or dil H_2SO_4 because they are less reactive than Hydrogen.

REACTION OF METALS WITH BASE:

Base + Metal → Salt + Hydrogen gas

(i) $2NaOH + Zn \rightarrow Na_2ZnO_2 + H_2$

REACTION OF METAL CARBONATES & METAL HYDROGEN CARBONATES WITH ACIDS:

(i) $Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$

(ii) $NaHCO_3(s) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l) + CO_2(g)$

REACTION OF BASES WITH ACIDS:

Acid + Base → Salt + Water

(i) $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

REACTION OF METAL OXIDES WITH ACIDS:

Metal Oxide + Acid →Salt + Water

(i) $Na_2O + H_2SO_4 \rightarrow Na_2SO_4 + H_2O$

(ii) $CaO + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2O$

REACTION OF NON-METALLIC OXIDE WITH BASE:

Non-metallic Oxide + Base → Salt + Water

(i) $2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$

(ii) $Ca(OH)_2 + SO_2 \rightarrow CaSO_3 + H_2O$

(iii) $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

$\downarrow +H_2O, +CO_2$

$Ca(HCO_3)_2$

ACIDS IN WATER(SOLUTION):

Process is Exothermic, heat is released.

(i) $H^+ + H_2O \rightarrow H_3O^+$

(ii) $HCl + H_2O \rightarrow H_3O^+ + Cl^- + heat$

(iii) $H_2SO_4 + 2H_2O \rightarrow 2H_3O^+ + SO_4^{2-} + heat$

(iv) $HNO_3 + H_2O \rightarrow H_3O+ + NO^{3-} + heat$

BASES IN WATER(SOLUTION):

(i) $NaOH(s) + H_2O \rightarrow Na^+(aq) + OH^-(aq)$

(ii) $KOH(s)+ H_2O \rightarrow K^+(aq) + OH^-(aq)$

(iii) $Mg(OH)_2(s) + H_2O \rightarrow Mg^+(aq) +2OH(aq)$

STRONG ACIDS & WEAK ACIDS:

Acids which are almost completely ionized in aqueous solutions are strong acids e.g., HCl, HNO_3, H_2SO_4. Acids which are weakly ionized in aq solution are called weak acidse.g., HCN, CH_3COOH.

STRONG BASES & WEAK BASES:

Bases which are almost completely ionized in aq solutions are strong bases e.g., NaOH. KOH. Bases which are slightly ionized in aq solution are weak bases e.g., NH_4OH, $Ca(OH)_2$

pH SCALE: pH is defined as the negative logarithm of Hydrogen ion concentration in moles per litre. It is a scale for measuring H^+ concentration.

$pH = -\log_{10}[H^+] = -\log_{10}[H_3O^+]$

pH of a neutral solution:

for neutral solution, $[H^+] = [OH^-] = 1*10^{-7}mol/l$

$pH = -\log_{10}[H^+] = -\log_{10}[H_3O^+] = -\log_{10}[1*10^{-7}] = 7$

pH = 7(for neutral solution)

pH>7(solution is basic or alkaline)

pH<7(solution is acidic)

Universal Indicator: It is a mixture of indicators which shows a gradual but well-marked series of colour changes over a wide range of change in concentration of H^+ ions.

pH Paper: The paper which is coated with Universal Indicator is called pH paper.

Importance of pH:

(i) pH of our stomach is approximately 2 due to the secretion of HCl.

(ii) pH of blood is 7.42.Even a slight change in pH lead to death.

(iii) pH of rainwater is nearly 7 because rain water is distilled water.

(iv) pH of acid rain is nearly 5.6. It lowers the pH of river water which is dangerous for aquatic life.

(v) Plants grow in soil having specific pH.

Some Naturally occurring Acids:

Natural source	Acid
Vinegar	Acetic acid
Orange	Citric acid
Tamarind	Tartaric acid
Tomato	Oxalic acid
Curd	Lactic acid
Lemon	Citric acid
Ant sting	Methanoic acid
Nettle sting	Methanoic acid

SOME IMPORTANT CHEMICAL COMPOUNDS:

(i) sodium hydroxide(NaOH)
(ii) washing soda ($Na_2CO_3.10H_2O$)
(iii) baking soda ($NaHCO_3$)
(iv) bleaching powder ($CaOCl_2$)
(v) plaster of Paris ($CaSO_4.\frac{1}{2}H_2O$)

(i)sodium hydroxide:

Preparation: When electricity is passed through an aqueous solution of sodium chloride(called brine), it decomposes to form sodium hydroxide. This process is called chor-alkali process because of the products formed-chor for chlorine and alkali for sodium hydroxide.

$2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$

Properties of NaOH:

(i) It is a deliquescent solid and absorbs moisture and CO2 finally forming solid hydrated carbonate.
(ii) a) $Zn(OH)_2 + 2OH^- \rightarrow [Zn(OH)_4]^{2-}$
b) $Al(OH)_3 + 3OH^- \rightarrow [Al(OH)_6]^{3-}$

Uses of NaOH:

(i) It is used in soap industry, paper industry, textile industry, petroleum industry.
(ii) It is used as reagent in laboratory.

(ii) Washing Soda:

Preparation: Sodium carbonate decahydrate(washing soda) is prepared by 'solvay process'. Recrystallisation of sodium carbonate gives Washing Soda.

$Na_2CO_3 + 10H_2O \rightarrow Na_2CO_3.10H_2O$

Properties: It is a transparent crystalline solid.

(i) When crystals of washing soda are left open in air, they lose nine molecules of water and form a monohydrate. This process is called 'Efflorescene'.
$Na_2CO_3.10H_2O \rightarrow Na_2CO_3.H_2O + 9H_2O$
(ii) On heating, Washing Soda does not decompose but loses all its water molecules.
$Na_2CO_3.10H_2O \rightarrow Na_2CO_3 + 10H_2O$
(iii) When washing soda is dissolved in water, it forms an alkaline solution, which turns red litmus blue.

Uses:

(i) It is used in the manufacture of glass, soap, paper, borax, caustic soda.
(ii) For removing permanent hardness of water.
(iii) Used as a cleaning agent
(iv) Used as lab reagent.

(iii) Baking Soda:

Preparation: A cold and concentrated sodium chloride is saturated with ammonia in the presence of carbon dioxide and water.

$NaCl + NH_3 + CO_2 + H_2O \rightarrow NaHCO_3 + NH_4Cl.$

Properties:

(i) White in color.
(ii) Soluble in water.
(iii) Alkaline in nature.
(iv) When Baking Soda is heated, it gives off CO_2& Water.
$2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$

Uses:

(i) Baking Soda is used in medicine to remove acidity of stomach.

(ii) Used as an additive in food and drinks. Baking Powder contains sodium hydrogen carbonate and an acid like tartaric acid.

(iii) Baking Powder is added in cakes. If tartaric acid is not present in Baking powder, the cake will taste bitter, due to the presence of sodium carbonate.

(iv) Bleaching Powder:

Preparation: Bleaching powder is manufactured by the action of chlorine on dry slaked lime.

$Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$

Properties:

(i) It is a yellowish white powder due to the presence of chlorine.

(ii) It loses its chlorine when exposed to air, by the action of CO_2, or dil HCl, or dil H_2SO_4.

$CaOCl_2 + CO_2 \rightarrow CaCO_3 + Cl_2$

$CaOCl_2 + 2HCl \rightarrow CaCl_2 + H_2O + Cl_2$

$CaOCl_2 + H_2SO_4 \rightarrow CaSO_4 + H_2O + Cl_2$

Uses:

(i) Used for disinfecting drinking water to make water free from germs.

(ii) Used as an Oxidizing agent.

(iii) Used in textile industry, paper industry for bleaching washed clothes in laundry.

(v) Plaster of Paris:

Preparation: Plaster of Paris is calcium sulphate hemi hydrate. It is obtained by heating gypsum at 373K. Heating should be controlled carefully otherwise anhydrous calcium sulphate is produced which has no properties as that of POP.

$CaSO_4.2H_2O \rightarrow CaSO_4.\frac{1}{2}H_2O + \frac{3}{2}H_2O.$

Properties:

(i) It is a white powder.

(ii) When plaster of Paris is mixed with water, crystals of gypsum are produced and they are set to form hard solid mass.

$CaSO_4.\frac{1}{2}H_2O + \frac{3}{2}H_2O \rightarrow CaSO_4.2H_2O$

Uses:

(i) Used in medical applications for setting fractured bones.

(ii) Used in making toys, decorative material, jewellery, cosmetics etc.

(iii) For making smooth surfaces.

(iv) In labs, to make apparatus airtight.