Chapter 3. Study Of Acids, Bases and Salts

PAGE NO : 62

Solution 1:

An acid is defined as a compound which when dissolved in water produces hydronium ion (H_3O^+), the only positively charged ion and a negative ion. At first the acid furnishes hydrogen ion (H^+) in aqueous solution but this H^+ ion combines with a water molecule to form Hydronium ion.

For example: acetic acid, sulphuric acid, nitric acid.

$$CH_3COOH + H_2O \rightarrow H_3O^+ + CH_3COO^-$$

Solution 2:

1. (i) Hydrogen chloride HCl
   (ii) Nitric acid HNO3
2. (i) Carbonic acid H2CO3
   (ii) Oxalic acid (COOH)2
3. (i) Sulphuric acid H2SO4
   (ii) Hydrogen chloride HCl
4. (i) Carbonic acid H2CO3
   (ii) Acetic acid

Solution 3:

(a) A base is defined as a chemical compound which when reacts with hydronium ion or H^+ ions furnished by an acid to form salt and water only.

For example: CuO, Mg $(OH)_2$.

(b) An alkali is a base which is soluble in water but all bases are not water soluble.

For example Ferric hydroxide [Fe $(OH)_3$] and cupric hydroxide [Cu $(OH)_2$] are bases but these are not soluble in water but sodium hydroxide NaOH, calcium hydroxide $Ca(OH)_2$ are bases and are also soluble in water.

Hence it is rightly said that all alkalis are bases but all bases are not alkalis.

Concept Insight: An alkali is a basic hydroxide which when dissolved in water produces hydroxyl (OH^-) ions as the only negatively charged ions.

Example: $NaOH(aq) \rightleftharpoons Na^+ + OH^-$

Solution 4:

1. The pH of a solution is defined as the negative logarithm (base 10) of the hydronium ion concentration present in the solution.
   pH = -log10 [H3O+]
2. The three applications of pH scale are:
   - It is used to determine the acidic or basic nature of the solution.
   - It is used to determine hydronium ion concentration present in the solution.
   - It is used to find out neutrality of the solution.

Solution 5:

(a) Indicators are organic compounds which when added in small amounts to a solution; indicate the nature (acidity or alkalinity) of the solution.
(b) Universal indicators are preferred to acid- base indicators because these give different colours in different pH ranges. A solution containing a drop of universal indicator is matched against a standard colour chart to find the pH of the solution.

pH range	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Colour of universal inducator		Red		Pink		Yellow		Green		Blue		Indigo		Violet	

Solution 6:

(a) The difference between an alkali and a base is:

An alkali	Base
An alkali is a basic hydroxide which when dissolved in water produces hydroxyl (OH^-) ions as the only negatively charged ions.	A base is defined as a chemical compound which when reacts with hydronium ion or H^+ ions furnished by an acid form salt and water only.
All alkalis are water soluble.	Bases may or may not be water soluble.
Examples are NaOH, KOH, Ca $(OH)_2$.	Examples are CuO, Mg $(OH)_2$.

(b)

An alkali	Metal hydroxide
An alkali is a basic hydroxide which when dissolved in water produces hydroxyl (OH^-) ions as the only negatively charged ions.	Metal hydroxides are generally bases which have a metal atom bonded to a hydroxide ion (OH^-).
Examples NaOH, KOH.	Examples Mg $(OH)_2$

Solution 7:

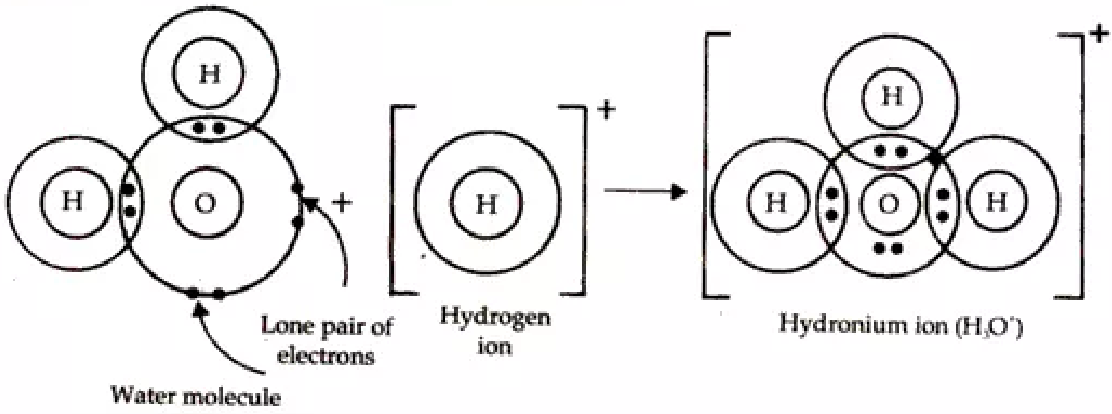
1. Base in solution furnishes the ions:
   Hydroxide ion/ oxide ion and a metallic ion.
2. A weak alkali furnishes the ions:
   Hydroxide ion and metallic ion and molecules of weak alkali./
3. An acid in a solution furnishes the ions:
   Hydronium / Hydrogen ion and a negative ion.

Solution 8:

Hydronium ion: Hydronium ion is H_3O^+. It is formed when a hydrogen ion H^+ released from an acid combines with a water molecule as:

$$H^+ + H_2O \rightarrow H_3O^+$$

In hydronium ion, hydrogen ion is linked to water molecule via coordinate bond which is formed by the participation of lone pair of electrons present on oxygen atom. The structure of hydronium ion is as:



PAGE NO : 63

Solution 9:

1. CaO
2. NaOH
3. CuO
4. Cu[(OH)2]
5. H2CO3
6. Ferric hydroxide [Fe (OH)3].
7. CuO
8. NH3

Solution 10:

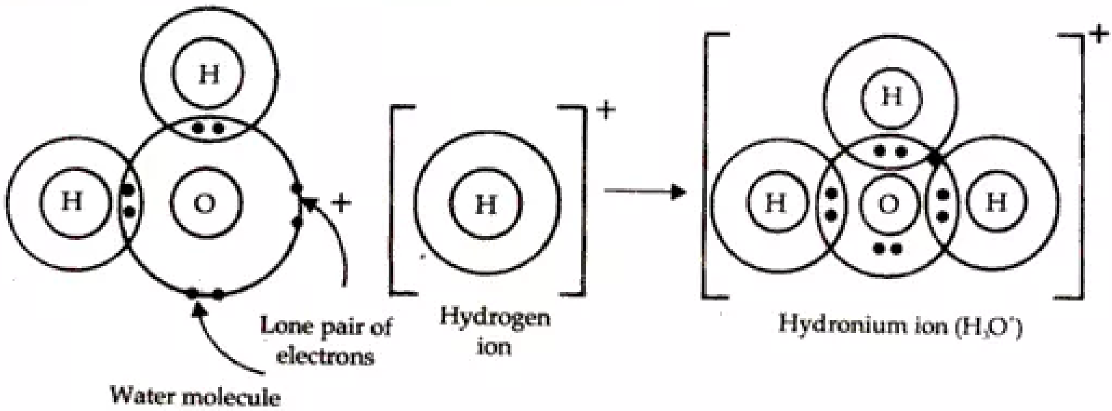
Anhydrous hydrogen chloride is not an acid but its aqueous solution is a strong acid because anhydrous means without water and we know that the property of acidity is shown by a substance only when it is dissolved in water or its aqueous solution is prepared.

Solution 11:

Hydronium ion: Hydronium ion is H_3O^+. It is formed when a hydrogen ion H^+ released from an acid combines with a water molecule as:

$$H^+ + H_2O \rightarrow H_3O^+$$

In hydronium ion, hydrogen ion is linked to water molecule via coordinate bond which is formed by the participation of lone pair of electrons present on oxygen atom. The structure of hydronium ion is as:



Solution 12:

Strength of an acid measures the ease with which the acid can ionize to produce hydrogen or hydronium ions when dissolved in water. Those acids which can easily ionize to form hydrogen ions are called strong acids while those which can partially ionize to form hydrogen ions are called weak acids.

Strength of an acid depends upon many factors such as:

1. Molecular structure of the acid
2. The temperature
3. Properties of the solvent

Solution 13:

(i) Acid from a non metal:

Certain non metals like sulphur (S), phosphorous (P), can be oxidized by concentrated nitric acid to yield corresponding acid.

Non metal + Acid → Acid + Water + Oxide

$S + 6HNO_3 \rightarrow H_2SO_4 + 2H_2O + 6NO_2$

(ii) Base from a metal:

Active metals like K, Na, Ca react with water to produce water soluble bases. These bases are called alkalis.

Active metal + water → Base / Alkali + Hydrogen

$2Na + 2H_2O \rightarrow 2NaOH + H_2$

Solution 14:
Solution B with pH value 9 will give pink colour with phenolphthalein.
Concept Insight: Bases give pink colour with phenolphthalein because a base will abstract two protons from phenolphthalein and the resulting phenolphthalein ion provides pink colour to the solution.

Solution 15:
Two indicators for identification of acid are methyl red and Thymol blue.

Solution 16:

(i) Preparation from copper nitrate:

$$2Cu(NO_3)_2 \xrightarrow{\Delta} 2CuO + 4NO_2 + O_2$$

(ii) Preparation from copper carbonate:

$$CuCO_3 \rightarrow CuO + CO_2\uparrow.$$

(iii) Preparation from copper sulphate:

$$CuSO_4 + H_2O \rightarrow CuO + H_2SO_4$$

Solution 17:

Preparation of acids by synthesis follows general reaction:

Hydrogen + Non metal → Acid

(i) $H_2 + I_2 \rightarrow 2HI$
(ii) $H_2 + Br_2 \rightarrow 2HBr$
(iii) $H_2 + Cl_2 \rightarrow 2HCl$
(iv) $H_2 + S \rightarrow H_2S$

Solution 18:

(a) Acid salt: The salt formed by the partial replacement of the replacable hydrogen atoms of an acid molecule by a metallic or ammonium ion is called acid salts.
For example $NaHSO_4$, Na_2HPO_4

Normal salt: The salt formed by replacement of all the replaceable hydrogen atoms of an acid by metallic or ammonium ions is called a normal salt.
For example NaCl, Na_2SO_4

(b)Ortho phosphoric acid is H_3PO_4 i.e. a tribasic acid has three replaceable hydrogen atoms so it forms three series of salts, namely two acid salts and a normal salt, with NaOH as:

$NaOH + H_3PO_4 \rightarrow NaH_2PO_4 + H_2O$
Acid salt
(Monosodium hydrogen salt)

$2NaOH + H_3PO_4 \rightarrow Na_2HPO_4 + 2H_2O$
Acid salt
(Disodium hydrogen phosphate)

$3NaOH + H_3PO_4 \rightarrow Na_3PO_4 + 3H_2O$

Normal salt

(Sodium phosphate)

Solution 19:

(a) $MgCl_2 + Ca(OH)_2 \rightarrow Mg(OH)_2 + CaCl_2$
$Mg(OH)_2 + 2\ CO_2 \rightarrow Mg(HCO_3)_2$
$Mg(HCO_3)_2 \rightarrow MgCO_3 + CO_2 + H_2O$
(b) $Pb(NO_3)_2 + Na_2CO_3 \rightarrow PbCO_3 + 2NaNO_3$
(c) $Na_2CO_3 + CO_2 + H_2O \rightarrow 2NaHCO_3$

Solution 20:

1. **Efflorescence:** It is the phenomenon by which hydrated salts on exposure to dry air, lose their water of crystallization and crumble to powder.
2. **Hygroscopy:** It is the phenomenon by which substances absorb moisture from air, but only sufficiently so as to become wet.
3. **Water of crystallization:** It is the fixed amount of water that is present in a crystal as an integral part of its constitution. Hydrated salts are salts having water of crystallisation.

Solution 21:
Deliquescence is the phenomenon by which certain salts absorb moisture from air, lose their water of crystallization and dissolve in it to form a saturated solution.
The substances which exhibit deliquescence are called deliquescent.
For example Caustic soda NaOH, Caustic potash KOH.

Solution 22:

Salt hydrolysis: The reaction between a salt and water to produce an acid or a base is called salt hydrolysis or hydrolysis. By hydrolysis the salt, we can find out its parent acid and parent base.

For example: $NaCl + H_2O \rightarrow Na^+ + Cl^-$

Salts which are acidic: i. Ammonium sulphate

ii. Ammonium chloride.

Salts which are basic: i. Potassium carbonate

ii. Sodium acetate.

Salts which are neutral: i. Ammonium acetate

ii. Ammonium carbonate.

Solution 23:

Salt	Method of preparation
Zinc sulphate	Displacement
Ferrous sulphide	Synthesis
Barium sulphate	Precipitation
Sodium sulphate	Neutralization

i. Preparation of Zinc sulphate by displacement method:
$Zn + H_2SO_4 \rightarrow 2ZnSO_4 + H_2$

ii. Preparation of Ferrous sulphide by synthesis method:
$Fe + S \rightarrow FeS$

iii. Preparation of Barium sulphate by precipitation method:
$BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$

iv. Preparation of Sodium sulphate by neutralization method:
$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

Solution 24:

1. Common salt gets wet during rainy season because the commercially available salt contains impurities, like magnesium chloride, which are deliquescent substances. These absorb moisture from atmosphere and make the table salt wet.
2. (i) Na2CO3.10H2O = Washing soda
(ii) MgSO4.7H2O = Epsom salt
(iii) CuSO4.5H2O = Blue vitriol
(iv) ZnSO4.7H2O = White vitriol

PAGE NO : 64

Solution 1996-1:

1. pH of a solution having pH 7 can be increased by adding a base to it such as NaOH.
2. pH can be decreased by adding an acid such as HCl to it.
   If a solution changes colour of litmus from red to blue, it shows that its pH is above 7.

Solution 1996-2:

The solution that liberates carbon dioxide from sodium carbonate has pH below 7 and hence acidic in nature. Since acids react with carbonates to liberate carbon dioxide gas as:

Carbonate + dil. Acid → Salt + Water + Carbon dioxide

For example: $NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$

Solution 1996-3:

1. Zinc sulphate = Zinc and dilute sulphuric acid
2. Copper sulphate = Copper oxide and dilute sulphuric acid
3. Sodium sulphate = Sodium carbonate solution and dilute sulphuric acid
4. Lead sulphate = Lead carbonate and dilute sulphuric acid

Solution 1997-1:
The term acid salt means the salt formed by partial replacement of the hydrogens present in the acid by metallic or ammonium ions.
For example: NaHCO3

Solution 1997-2

1. pH scale is used to express the acidic or basic nature of solution.
2. pH of pure water is 7 since it does not have any impurities.
3. (a) A soluble oxide of A will have pH less than the pH of pure water i.e. below 7.
   (b) A solution of 'B' will have more pH than pure water i.e. above 7.

Solution 1997-3:

1. Water of crystallization: It is the fixed amount of water that is present in a crystal as an integral pat of its constitution. Compounds having water of crystallization are called hydrous salts.
   For example: Sodium carbonate Na2CO3 has 10 molecules of water present as water of crystallization Na2CO3.10H2O
2. Anhydrous: Hydrous salt on heating lose their water of crystallization, such salts are then called anhydrous.
   For example: Na2CO3.10H2O on losing 10 molecules of water forms Na2CO3.

Solution 1997-4:

$MnO_2 + 4HCl\ (conc) \rightarrow MnCl_2 + Cl_2 + 2H_2O$.
Chlorine thus obtained is dried by passing through concentrated Sulphuric acid. This dried chlorine is passed over heated Iron to get anhydrous Iron (III) chloride.
$2Fe\ (heated) + 3Cl_2\ (dry) \rightarrow 2FeCl_3$.

Solution 1998-1:

1. Water of cystallization.
2. White.
3. Efflorescence.
4. Sodium chloride.

Solution 1998-2:
Those acids which ionize partially in aqueous solution and thus they contain ions as well as molecules of the acid. Organic acid such as CH3COOH, is a weak acid.

Solution 1998-3:

(a) Solution P with pH 13 will liberate ammonia from ammonium sulphate on heating:

Ammonium salt + alkali $\rightarrow$ Salt + Water + Ammonia.

(b) Solution R with pH 2 is a strong acid.

(c) Solution Q with pH 6 contains molecules as well as ions.

Solution 1998-4:
The name and formula of the acid salt which gives sodium ions and sulphate ions in solution is Sodium hydrogen sulphate NaHSO4.

Solution 1999-1:

(a) (i) Acid: An acid is a compound which when dissolved in water produces hydronium ion ($H3O^+$), the only positively charged ion and a negative ion.

(ii) pH scale: The scale over which a range of pH values from acidic to basic are arranged is called a pH scale.

(iii) Neutralisation: It is the process by which H^+ ions of an acid react completely with water the [OH^-] ions of a base to give salt and water only.

For example $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

(b) (i) Treatment of lead dioxide with4 molecules of hydrochloric acid gives lead(II) chloride as well as chlorine gas

(ii) Steps required for this reaction are:

$PbO_2 \rightarrow PbO + O$
$PbO + 2HCl \rightarrow PbCl_2 + H_2O$
$2HCl + O \rightarrow H_2O + Cl_2$
$PbO_2 + 4HCl \rightarrow PbCl_2 + 2H_2O + Cl_2$

(iii) Iron reacts with dilute sulphuric acid as:

$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$

(iv) Since the value of pH is less than 7 so the solution will be acidic.

Solution 2000-1:

Salt	Method of preparation
Ammonium sulphate	Titration
Calcium carbonate	Precipitation
Iron (III) chloride	Direct combination
Lead nitrate	Carbonate + acid
Zinc sulphate	Metal + acid

Solution 2001-1:

(a) (i) Preparation of sodium sulphate:

Sodium carbonate + dilute sulphuric acid → Sodium sulphate + water + carbon dioxide.

$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2$

(ii) Preparation of Copper sulphate:

Copper carbonate + dilute sulphuric acid → Copper sulphate + water + carbon dioxide.

$CuCO_3 + H_2SO_4 \rightarrow CuSO_4 + H_2O + CO_2$

(iii) Preparation of iron (II) sulphate.

Iron+ dilute sulphuric acid → Iron (II) sulphate + Hydrogen

$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$

(iv) Preparation of Zinc carbonate.

$Zn + H_2SO_4\,(dil) \rightarrow ZnSO_4 + H_2$

$ZnSO_4 + Na_2CO_3 \rightarrow ZnCO_3 + Na_2SO_4$

(b)(i) $NaHSO_4$.

(ii) AgCl.

(iii) $CuSO_4.5H_2O$

(iv) $CuCO_3$

(v) $Pb(NO_3)_2$

Solution 2002-1:

(a) (i) Fe + dilute $HCl \rightarrow FeCl_2 + H_2$

(ii) $2Fe + 3Cl_2 \rightarrow 2FeCl_3$

(iii) Fe + dilute $H_2SO_4 \rightarrow FeSO_4 + H_2$

(iv) $Fe + S \rightarrow FeS$

(b) (i) $2NaOH$ + dilute $H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

(ii) $Pb(OH)_2$+ dilute $H_2SO_4 \rightarrow PbSO_4 + 2H_2O$

Solution 2003-1:

1. Hydronium, positive.
2. Acid, metal.

Solution 2003-2:

(i) Fe + dilute $H_2SO_4 \rightarrow FeSO_4 + H_2$

(ii) Cu + conc. $H_2SO_4 \rightarrow CuSO_4 + 2H_2O + SO_2$

(iii) $Pb(NO_3)_2$+ dilute $H_2SO_4 \rightarrow PbSO_4 + 2HNO_3$

(iv) Na_2CO_3 + dilute $H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O + CO_2$

Solution 2004-1:
methods for preparation:

1. Preparation of copper(II) chloride.
   Action of an acid on an oxide or carbonate
2. Preparation of iron(III) chloride.
   Direct combination
3. Preparation of iron (II) chloride.
   Action of an acid on a metal
4. Preparation of lead (ii) chloride
   Precipitation (double decomposition)
5. Preparation of sodium chloride
   Neutralization of an alkali by an acid.

Solution 2005-1:

(a) Lead carbonate is first treated with dilute HNO_3.
(b) $PbCO_3 + 2HNO_3 \rightarrow Pb(NO_3)_2 + H_2O + CO_2$
(c) Lead carbonate and lead sulphate both are insoluble in water. So when dilute H_2SO_4 is added to lead carbonate, lead sulphate formed deposits on the remaining lead carbonate thereby stopping the further reaction.

PAGE NO : 67

Solution 2005-2:
Positive, hydroxyl, Salt, Neutralization.

Solution 2005-3:
When neutral litmus solution is added to sodium hydrogen carbonate solution, litmus solution turns red

Solution 2006-1:

1. From pink to colourless.
2. From orange to pink.
3. From colourless to red.

Solution 2007-1:

1. Hydronium
2. Hydroxide
3. Salt
4. Water
5. Hydrogen

Solution 2007-2:

Column A	Column B
1. Acid salt	(a)Sodium hydrogen carbonate
2. Mixed salt	(b) Sodium potassium carbonate
3. Complex salt	(c) Sodium zincate
4. Double salt	(d) Alum
5. Normal salt	(e) Sodium carbonate

Solution 2008-1:

1. Complex salt.
2. Alkali.

Solution 2009-1:
Acidified potassium dichromate paper

PAGE NO : 68

Solution 2009-2:

1. Solution B.
2. Solution A.
3. Solution B
4. Solution of ammonium hydroxide NH4OH is a weak alkali.

Solution 2009-3:

(a) (i) Substance B is a dehydrating agent.

(ii) B prevents the entry of moisture inside the apparatus because it absorbs moisture.

(iii) Iron (III) chloride is stored in a closed container because it is a deliquescent compound.

(iv) $2Fe + 3Cl_2 \rightarrow 2FeCl_3$

(b) $PbCO_3 + 2HNO_3 \rightarrow Pb(NO_3)_2 + H_2O + CO_2$

$Pb(NO_3)_2 + H_2SO_4 \rightarrow PbSO_4 + 2HNO_3$