PUBLIC SCHOOL DARBHANGA

CHEMISTRY

(Class-X)

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1. CHEMICAL REACTIONS AND EQUATIONS

1.1. Chemical Reactions or Changes:

The changes in which chemical composition of the substance is changed, is known as chemical change or chemical reaction. For example;

(a) Freshly cut apples turning brown when kept in open air,
(b) Ripening of fruits,
(c) Rusting of irons,
(d) Digestion of food
(e) Fermentation of grapes,
(f) Burning of a paper,
(g) Burning of candle and
(h) Combustion of fuels.

Chemical Equations:

The symbolic representations of the chemical reactions are known as chemical equation.

For example; rusting of iron is a chemical reaction or change. It may be symbolic represented as:

$$4Fe + 3O_2 + xH_2O \longrightarrow Fe_2O_3.xH_2O$$

This symbolic representation of rusting of iron is termed as chemical equation of it.

Characteristics of Chemical Reactions:

A chemical reaction may be characterized by one of the following criteria:

(a) Change in physical state,
(b) Change in colour,
(c) Formation of precipitate,
(d) Evolution of gas and
(e) Change in temperature,

Change in physical state:

Gaseous substance hydrogen reacts with gaseous substance oxygen to form water, which is a liquid substance, is formed.

$$H_{2(g)} + O_{2(g)} \longrightarrow H_2O_{(l)}$$

Change in Colour:

When colourless silver nitrate is mixed with colourless sodium chloride solution, a white substances silver chloride and sodium nitrate will form.

$$AgNO_3 + NaCl \longrightarrow AgCl_{(White)} + NaCl_{(White)}$$

Formation of Precipitate:

When dilute sulphuric acid is added in barium chloride solution, precipitation of barium sulphate will take place. Precipitation is represented by downward arrow.

$$H_2SO_4 + BaCl_2 \longrightarrow BaSO_4 \downarrow + 2HCl$$

Evolution of gas:

When zinc granules are added in dilute hydrochloric acid, evolution of hydrogen gas takes place. It is represented by upward arrow.

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2 \uparrow$$

Change in temperature:

Some chemical reaction occurs with change in temperature, which is measure by change in heat. There are two types:

Exothermic Reaction:

Such types of chemical reaction in which heat is released, are known as exothermic (exo = to exit, therm = heat) reaction.

For example; when carbon burns in oxygen, carbon dioxide is formed with release of heat.

$$C + O_2 \rightarrow CO_2 + Heat\ (393\ KJmol^{-1})$$

Endothermic Reaction:

Such types of chemical reaction in which heat is absorbed, are known as endothermic (endo = to absorb, therm = heat) reaction.

For example; barium hydroxide reacts with ammonium chloride to form barium chloride, ammonia and water with the absorption of heat.

$$Ba(OH)_2 + NH_4Cl \rightarrow BaCl_2 + NH_3 + H_2O - Heat$$

1.2. Balance Chemical Equation:

Such types of chemical equations in unequal number of same type of atoms are present in reactant side and in product side, are known as unbalanced chemical equation. For example;

$$H_2 + Cl_2 \rightarrow HCl$$

On the other hand, the chemical equations in which both sides i.e. reactant side as well as in product side same number of same atoms are present, are known as balanced chemical equation. For example;

$$H_2 + Cl_2 \rightarrow 2HCl$$

An unbalanced chemical equation may be balanced by following steps of hit and trial method:

First. Write the chemical equation.
Second. Count the total number of different elements in both reactants and products.

Third. Appropriate numbers should be written before the formulae of reactants and products as coefficient so that total number of atoms of same type will be same in both reactants and products side.

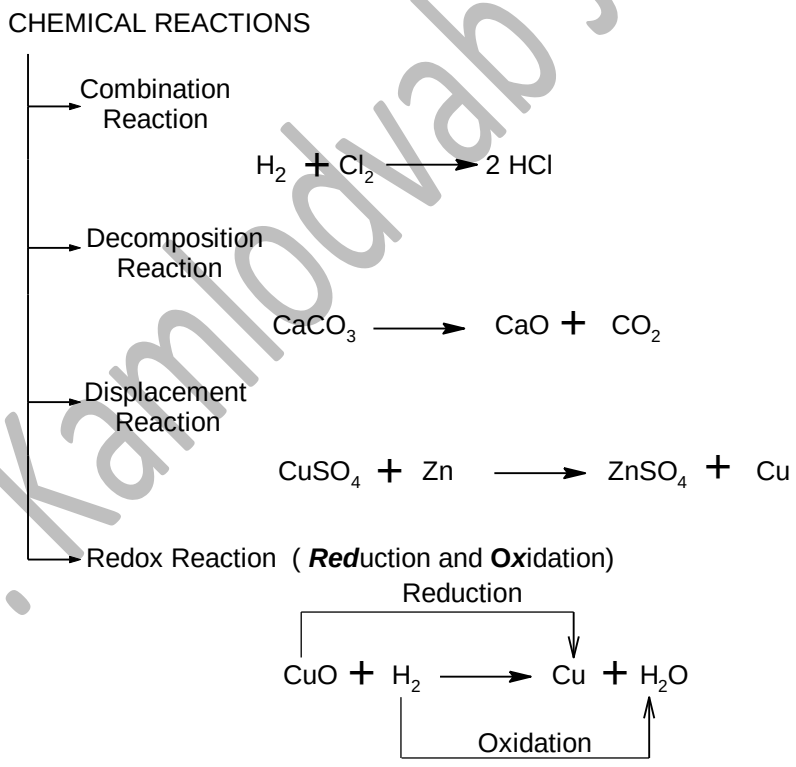
Making Chemical Equations More Informative:

A chemical equation can be made more informative by using some symbols and signs at appropriate positions to indicate a specific meaning.

(a) By indicating the physical states of the reactants and products,
(b) By indicating the formation of precipitate,
(c) By indicating the evolution of gas,
(d) By indicating the heat change and
(e) By indicating the conditions in which the reaction occurs.

1.3. Types of Chemical Reactions:

Chemical reactions are classified as:



1.4. Corrosion:

The deterioration of a metal by the action of air, moisture or a chemical species on their surface is known as corrosion.

Rusting of iron, tarnishing of silver, formation of green precipitate on the surface of copper are common examples of corrosion.

Corrosion may be prevented by:

a) By painting the iron objects,
b) By greasing and oiling the iron objects and
c) By galvanization

1.5. Rancidity:

The deterioration of food stuffs giving bad smell and band taste is called rancidity.

Rancidity is prevented by:

a) By adding antacid,
b) By vacuum packing,
c) By packing the food stuffs in inert medium,
d) By refrigeration and
e) By storing the food stuffs away from light.

2. ACIDS, BASES AND SALTS

On the basis of physical and chemical properties, substances are classified into following three categories:

(a) Acids,
(b) Bases and
(c) Salts

2.1. Acids:

Acids are characterized by their following properties:

(a) All acids have sour taste.
(b) Acids turn blue litmus to red.
(c) Some acids turn solution of methyl orange indicator to red.
(d) Almost all acids have corrosive in nature.
(e) Most metals evolve hydrogen gas with dilute mineral acids.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2 \uparrow$$
$$Mg + 2HCl \rightarrow MgCl_2 + H_2 \uparrow$$
$$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2 \uparrow$$

(f) Acids react with bases to form salt along with water. As in this reaction corrosive nature of both acids and bases are cancelled so, it is specially known as neutralization reaction.

$$HCl + NaOH \rightarrow NaCl + H_2O$$
$$HNO_3 + KOH \rightarrow KNO_3 + H_2O$$

Some examples of acids are:

a) Hydrochloric acid (HCl),
b) Sulphuric acid (H_2SO_4),
c) Sulphurous acid (H_2SO_3),
d) Nitric acid (HNO_3),
e) Phosphoric acid (H_3PO_4),
f) Phosphorous acid (H_3PO_3)
g) Carbonic acid (H_2CO_3),
h) Formic acid (HCOOH),
i) Acetic acid (CH_3COOH) and
j) Benzoic acid (PhCOOH)

2.2. Bases:

Bases are characterized by their following properties:

(a) Bases have bitter taste.
(b) They are soapy in touch.
(c) Bases turn red litmus to blue.
(d) Most bases turn phenolphthalein solution to pink.
(e) Almost all bases have corrosive in nature.
(f) Bases react with acids to form salt along with water. As in this reaction corrosive nature of both acids and bases are cancelled so, it is specially known as neutralization reaction.

$$HCl + NaOH \rightarrow NaCl + H_2O$$
$$HNO_3 + KOH \rightarrow KNO_3 + H_2O$$

Some examples of bases are:

a) Sodium hydroxide (NaOH),
b) Potassium hydroxide (KOH),
c) Magnesium hydroxide; $Mg(OH)_2$
d) Calcium hydroxide; $Ca(OH)_2$,
e) Ammonium hydroxide (NH_4OH),
f) Sodium oxide (Na_2O),
g) Potassium oxide (K_2O),
h) Magnesium oxide (MgO) and
i) Calcium oxide (CaO).

Common theories regarding to acids and bases:

a. Arrhenius concept,
b. Bonsted-Lowry concept,
c. Lewis concept and
d. Solvent system.

Only Arrhenius theory is being discussed here

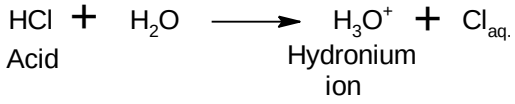
Arrhenius Concept:

It is the first satisfactory explained theory in molecular terms given by S. Arrhenius. According to this concept;

The chemical species, which can form proton (H^+) ion in aqueous solution, are called acids.

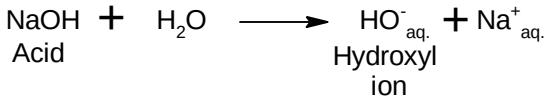
Since in aqueous medium proton is scrambled by water to form hydronium ion so, acid may be defined as;

The chemical species, which can form hydronium (H_3O^+) ion in aqueous solution, are called acids.

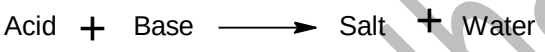


The base is defined as:

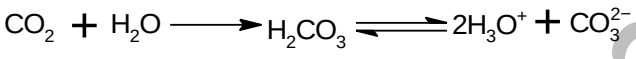
The chemical species that can form hydroxyl (HO^-) ion in aqueous solution are called bases.

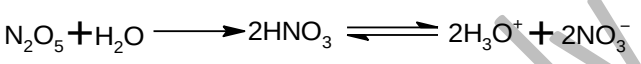


The ions accompanying the proton and hydroxyl ions form a salt so, the overall Arrhenius acid-base reaction may be written as:



This is called neutralization process. Oxides of non-metals are usually acids as they form hydronium ion in aqueous medium.





Oxides of metals are usually basic as they form hydroxyl ion in water.

Limitations:

1. In order to explain acidic and basis properties of a substance aqueous medium is required. Therefore this theory does not explain the acidic and basic properties in gaseous state or in non-aqueous medium.
2. This theory does not explain the acidic character of certain substances such as $AlCl_3$, BF_3, BI_3 etc.

2.3. Strength of Acids and Bases: pH

The pH is defined as:

"*The negative logarithm of hydrogen ion concentration in a solution is called pH of that solution*".

It is formulated as:

$$pH = -\log[H^+]$$

$$or\ \ pH = \frac{1}{\log[H^+]}$$

In other words, reciprocal of logarithmic [H^+] is called pH.

Since nature of the solution has direct relationship with the [H^+] so, Sorenson proposed a scale to explain nature of the solution in terms of pH scale.

From ionic product of water, it may be written as:

$$[H^+][HO^-] = 1 \times 10^{-14} \ldots\ldots\ldots\ldots (1)$$

Taking logarithm on both sides,

$$log[H^+] + log[HO^-] = log1 + log10^{-14}$$

$$or\ \ log[H^+] + log[HO^-] = -14log10^{-14}$$

$$or\ \ log[H^+] + log[HO^-] = -14$$

Upon sign inversion;

$$-log[H^+] - log[HO^-] = 14$$

$$pH + pOH = 14 \ldots\ldots\ldots\ldots (2)$$

The Eq.2 indicates that sum of the pH and pOH is equal to fourteen. While pH is the negative logarithm of [H^+], pOH is negative logarithm of [HO^-]. Again from ionic product of water;

$$[H^+][HO^-] = K_W$$

Taking logarithm on both sides,

$$log[H^+] + log[HO^-] = logK_W$$

Upon sign inversion;

$$-log[H^+] - log[HO^-] = -logK_W$$

$$or\ \ pH + pOH = pK_W \ldots\ldots\ldots\ldots (3)$$

From Eq.2 and Eq.3, it is clear that;

$$pK_W = 14$$

$$or\ \ pH + pOH = 14 \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

As sum of the pH and pOH is equal to 14, the nature of a solution may be represented either in terms of pH or pOH. Sorrenson prepared a scale segmented into fourteen parts, each indicating a particular pH.

For neutral medium;

$$[H^+] = [HO^-] = 1 \times 10^{-7}$$

Taking logarithm;

$$log[H^+] = log[HO^-] = log10^{-7}$$

$$or\ -log[H^+] = -log[HO^-] = 7log10$$

$$or\ \ pH = pOH = 7$$

For acidic medium;

$$[H^+] > [HO^-] = 1 \times 10^{-7}$$

$$[H^+] > 1 \times 10^{-7}$$

Taking logarithm;

$$log[H^+] > log10^{-7}$$

$$or\ -log[H^+] < 7log10$$

$$or\ \ pH < 7$$

For basic medium;

$$[HO^-] > [H^+] = 1 \times 10^{-7}$$

$$[HO^-] > 1 \times 10^{-7}$$

Taking logarithm;

$$log[HO^-] > log10^{-7}$$

$$or\ -log[HO^-] < 7log10$$

$$or\ \ pOH < 7$$

$$or\ \ pH > 7$$

2.4. Salts:

Acids and bases combine with each other to form salt along with water.

Some salts are:

a) Sodium chloride; NaCl
b) Calcium chloride; $CaCl_2$
c) Potassium sulphate; K_2SO_4
d) Calcium sulphate; $CaSO_4$
e) Sodium nitrate; $naNO_3$
f) Sodium carbonate; Na_2CO_3
g) Sodium acetate; CH_3COONa
h) Calcium oxalate; $(COO)_2Ca$

2.5. Some Important Salts:

(a.) Washing soda:

It is chemically decahydrate of sodiumcarbonate; $Na_2CO_3.10H_2O$. It is prepared by Solvay process.

Properties:

a) It is white crystalline solid.
b) It is soluble in water.
c) Its aqueous solution has pH more than 7. So it is basic in nature.
d) When it is heated at 373K, nine molecules of water will evolve. If heating is continued, it forms anhydrous sodium carbonate called soda ash.

$$Na_2CO_3.10H_2O \xrightarrow[373\ K]{\Delta} Na_2CO_3.H_2O + 9H_2O$$

$$Na_2CO_3.H_2O \xrightarrow{\Delta} Na_2CO_3 + H_2O$$

e) It reacts with acids to form salt, carbon dioxide and water.

$$Na_2CO_3 + 2HCl \rightarrow NaCl + CO_2 + H_2O$$

Uses:

a) It is used as cleansing agent.
b) It is used in the manufacturing of soap.
c) It is used in paper and glass industries.

(b.) Baking soda:

It is chemically sodium bicarbonate; $NaHCO_3$. It is prepared as:

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

Properties:

a) It is white crystalline solid.
b) It is sparingly soluble in water.
c) It is stable in air.
d) Its aqueous solution has pH more than 7. So it is basic in nature.
e) On heating it forms sodium carbonate.

$$Na_2HCO_3 \xrightarrow{\Delta} Na_2CO_3 + CO_2 + H_2O$$

f) It reacts with acids to form salt, carbon dioxide and water.

$$NaHCO_3 + HCl \rightarrow NaCl + CO_2 + H_2O$$

Uses:

a. It is used as antacid.
b. It is used as an ingredient of baking powder.
c. It is used to kill cockroaches.
d. It is used to remove paint and corrosion.
e. It is used as an effective fungicide.

(c.) Bleaching Powder:

It is chemically calcium oxychloride ($CaOCl_2$). It is prepared as:

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

Properties:

a) It is yellowish-white powder.
b) It has strong smell of chlorine.
c) It is soluble in water with some milkiness.
d) When it is exposed to air, chlorine gas is liberated due to the presence of carbon dioxide in air.

$$CaOCl_2 + CO_2 \rightarrow CaCO_3 + Cl_2$$

Uses:

a) It is used as bleaching agent.
b) It is used for disinfecting drinking water supply.
c) It is used for manufacturing chloroform.
d) It is used as oxidizing agent in chemical industries.

(d.) Plaster of Paris:

It is chemically hemihydrates of calcium sulphate. It is prepared as:

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

Properties:

a) It is white powder.
b) It is remarkable property of setting into a hard mass when mixed with water and form gypsum.

Uses:

a) It is used for fixing fractured bones and ligaments to ensure correct healing.
b) It is used for making casts in dentistry.
c) It is used for making toys, statues, cosmetics, decorative materials, chalks etc.