

Rutherford's atomic model.

In 1911 A.D., Rutherford proposed an atomic model based on α -particle scattering experiment. It is called α -particle scattering experiment or simply Rutherford's atomic model. This experiment provides very useful information regarding the structure of an atom. This experiment led to the discovery of nucleus. So, it is also called nuclear model of an atom.

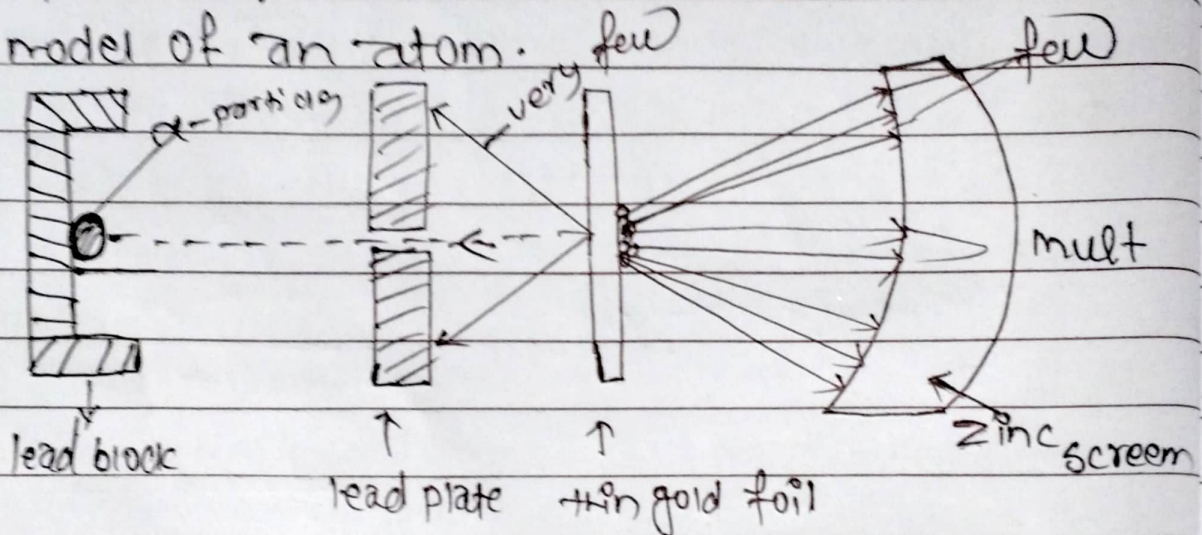


Fig. Rutherford's α -scattering experiment.

Observations

- i). Most of the α -particles pass through the gold foil undeflected.
- ii). Some of α -particles were deflected through small angle.
- iii). Very few are more deflected by making large angles.
- iv). Rarely α -particles return back by gold foil at 180° .



* Limitation of Dalton's atomic theory ?

→ Limitation of Dalton's atomic theory are as follows

i. Dalton's atomic theory doesn't account for subatomic particles.

(ii) It doesn't account for isotopes and isobars.

(iii) Elements need not combine in simple whole number ratio to form compound.

(iv) This theory fails to explain the existence of allotropes.

* Modern Position of Dalton's atomic theory.

→ The modern position of Dalton's atomic theory are as follows :-

(i) Atoms are capable of further subdivision.

(ii) Atoms can be created or destroyed.

(iii) Atoms of a particular element may not be identical in all respects.

(iv) The ratio in which atoms combine to form a compound atom may not be simple.

(v) Atom is the smallest particle that can take part in a chemical reaction.

(vi) Atoms of one element can be changed into atoms of another element.

orbit

3

orbital.

i). It is the well defined circular path where the electron revolves around nucleus.

i). It is the shape around nucleus where electrons found.

ii). orbits are circular in shape

ii). orbitals have different shape.

iii). orbital uses two dimensional concept.

iii). orbital uses three dimensional concept.

iv) orbits are represented by letters K, L, M, N. etc.

iv) orbitals are represented by letters s, p, d, f, g... etc.

v). orbit can accommodate maximum $2n^2$ no. of electron where n is the no. of orbit from nucleus.

v). orbital can accommodate at 2 electrons in one orbital.

The drawback of Rutherford scattering experiment are as follows:

- (i) According to classical electrodynamics, when a charged particle like electron is accelerated, it will lose energy by emitting radiation. In Rutherford's nuclear atom, revolving electron must lose energy continuously and the orbit becomes smaller and finally collapse with nucleus. But electron never collapses in this way.

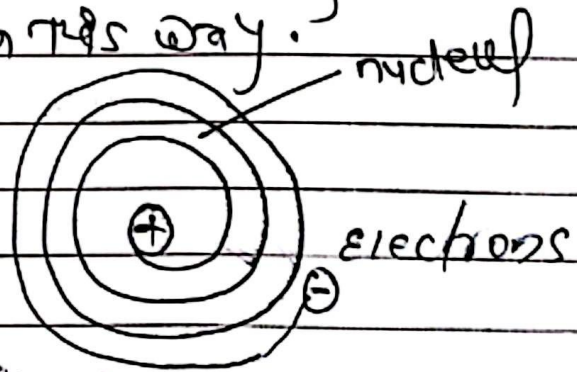


fig:- failure of Rutherford's atom model

- (ii) It could not explain the line spectra of H-atom and discontinuous spectrum nature.

Isobars :- the atoms of the different elements which have the same mass number but different atomic no. are called isobars.
for ex :- $^{40}_{18}\text{Ar}$, $^{40}_{19}\text{K}$ and $^{40}_{20}\text{Ca}$.

Isotones :- the atoms of the different elements which have the same no. of neutrons but different atomic no. are called isotones.
eg :- $^{14}_6\text{C}$, $^{15}_7\text{N}$ and $^{16}_8\text{O}$.

Corrosion:-

The spontaneous destruction of metals due to their interaction with environment is called corrosion. It takes place in the exposed surface.

Types of corrosion:-

① Chemical corrosion

② It is generally taken place when reactive

gases come from contact with metal at high temperature.

eg:- corrosion in chemical industry.

Conclusion :- (Rutherford)

- i). In an atom, the entire mass and positive charge is concentrated in very small region at the centre known as nucleus.
- ii). The magnitude of the positive charge nucleus is ~~surrounded~~ different for different atom.
- iii). The nucleus is surrounded by negatively charged electrons which balance the positive charge on nucleus.
- iv). The electrons are not stationary but are revolving around the nucleus at very high speed.
- v). Most of the space around the nucleus inside an atom is empty.

Limitation / Drawback of Rutherford's atomic model.

- i). When an electron revolves around the nucleus, it will give out energy. This loss of energy will make the electron move slowly, it will be moving in a spiral path and ultimately falls on the nucleus, thus, the atom remains unstable. Fortunately, the atom is stable.

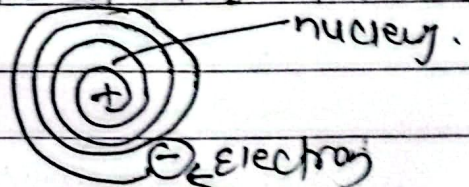


Fig. Failure of Rutherford's atomic model.

- ii). It could not explain the line spectrum of H-atom and discontinuous spectrum nature.



- vii) Mass and energy are interconvertible.
- viii) ~~Interconvertible~~ The ~~turn~~ compound atom have been replaced by the molecules.

* Limitation of chemical equation

→ The Limitation of chemical equation are as follow :

- (i) Physical indicates .
- (ii) Speed of reaction and time taken for its completion is not given.
- (iii) concentration of reactants and products is not indicated .
- (iv) It does not tell whether the reaction is exothermic or endothermic.
- v) It doesn't tell about the mechanism of reaction.
- vi) state

* State dulong petits Law.

According to dulong and Petits law " The ~~height~~ products of atomic weight and specific ~~heat~~ of any solid is approximately equal to 6.4 ".

$$At \text{ of weight} \times \text{specific heat} = 6.4 \text{ (approx)}$$

* Electrochemical series.

12

→ The arrangement of various elements in order of increasing values of standard

Page No.

$$= \frac{\text{weight of 1 molecule of gas}}{\text{weight of 1 molecule of hydrogen.}}$$

9

$$= \frac{\text{weight of 1 molecule of gas}}{\text{weight of 2 atom of hydrogen.}}$$

$$= \frac{\text{weight of 1 molecule of gas}}{2 \times \text{weight of 1 atom of hydrogen}}$$

By divi. definition of molecular weight. we have

$$\text{vapour density} = \frac{1}{2} \times \text{molecular weight}$$

$$\therefore \text{molecular weight} = 2 \times \text{vapour density}$$

* Write avogadro's hypothesis. avogadro's hypothesis.

→ avogadro's proposed his hypothesis in 1811 ad. According to this hypothesis "equal volume of all gases under the same condition of temperature and pressure contain an equal number of molecules. This is also called avogadro's law.

This is also called avogadro's law

The important of avogadro's hypothesis are as follow:

(i) It made a clear distinction between atom and molecule.



(i) Position of hydrogen is need fixed.

(ii) metals and nonmetals are not separately placed.

(iii) elements with higher atomic masses are place before the lower atomic mass.

(iv) Lanthanides and actinides not separated.

(v) It cannot deals about isotopes.

* Difference between electrovalent and covalent compound.

electrovalent	covalent
(i) These compounds which are formed by the transfer of one or more electrons from one atom to the other are called electrovalent compound or ionic ionic valent. It have (ii) high density. (iii) It have high melting point and boiling-point. NaCl, CaO	Mutual sharing of electron is called covalent (ii) It have low density. (iii) It have low melting point and boiling point. H₂O, HCl, CH₄



(ii) It helps in determining the atomicity of elementary gases.

(iii) It helps in finding relationship between molecular weight and vapour density of gases.

$$(\text{molecular weight} = 2 \times \text{vapour density})$$

(iv) It helps in ~~also~~ determining the relationship between weight and volume of gases.

$$1 \text{ molecular weight in gram} = \text{weight of } 22.4 \text{ litres of gas at N.T.P.}$$

* State mendeleev periodic law / old.

It states that "The physical and chemical properties of elements are periodic function of their atomic weights." That is the element of lower atomic mass is followed

* New by the elements of higher atomic mass.

State

* New periodic table

It state that "The physical and chemical

* State that new mendeleev periodic table.

* It state Properties of elements are Periodic function of their Atomic number."

* Write the defect of mendeleev periodic table.



$$\text{Approximately atomic weight} = \frac{6.4}{\text{specific heat}}$$

$$\text{Exact atomic wt} = \frac{\text{Equivalent weight} \times \text{valency}}{\text{valency}}$$

$$\text{valency} = \frac{\text{Approximately atomic weight}}{\text{Equivalent weight}}$$

Prove that molecular weight
2X vapour density.

$$\text{Molecular weight} = \frac{\text{Weight of 1 molecule of substance}}{\text{Weight 1 atom of (H}_2\text{) Hydrogen}}$$

$$\text{Weight vapour density (V.D.)} = \frac{\text{Weight of certain volume of gas}}{\text{Weight of same volume of hydrogen gas}}$$

(At same temperature and pressure)

$$V.D. = \frac{\text{Wt of 'v' volume of the vapour substance}}{\text{Wt of 'v' volume of hydrogen}}$$

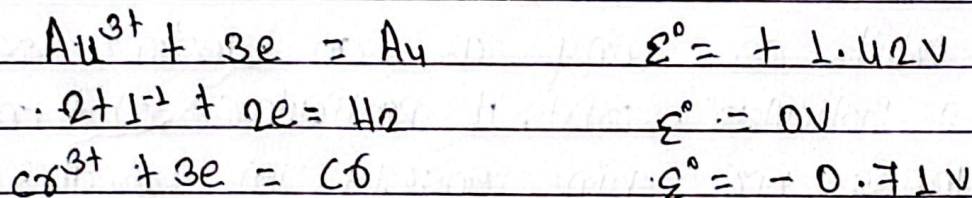
(At same temperature and pressure)

Let 'v' volume of vapour of 'content' n molecules
there for 'v' volume of hydrogen gas and
molecules.

$$\text{Vapour density} = \frac{\text{Weight of } n \text{ molecules of gas}}{\text{Weight of } n \text{ molecules of hydrogen}}$$



reduction potential is called electrochemical series. The standardised oxidation potential is equal to standardised reduction potential with opposite sign. A part of electrochemical series



→ positive sign of in power E° indicates that the substance has greater tendency to reduce than hydrogen

* Uses of electrochemical series.

- (i) To predict whether a metal will liberate hydrogen gas from a hydro acid or not.
- (ii) To predict the occurrence of chemical reaction.
- (iii) To predict cell e.m.f and feasibility of cell reaction.
- (iv) To compare the relative reactivity of metals.

* Write the postulates of neils (bohr) atomic model.

→ neils bohr proposed a model of an atom it deals atomic stability



Example:- Litmus Paper, methyl orange, Phenolphthalein

* Principal of quantum numbers.

→ Principal of quantum numbers are as follows:

- (i) Main shell in which the electron's resides.
- (ii) Approximate distance of electron from the nucleus.
- (iii) Energy of the shell.
- (iv) Maximum number of electrons present in the shell ($2n^2$) when n represent number of shell.

* Principal .

* Quantum numbers.

→ The set of 4 numbers from which we can get complete information of an electron in an atom is called quantum number. The 4 quantum numbers are as follows:-

(i) Principal Quantum number (n)

→ It represent the main shell (K, L, M, ...) and tells about the size and energy.

(ii) Azimuthal quantum number (l)

→ It represent number of sub-shell present in a main shell and tells about the shape of a sub-shell.

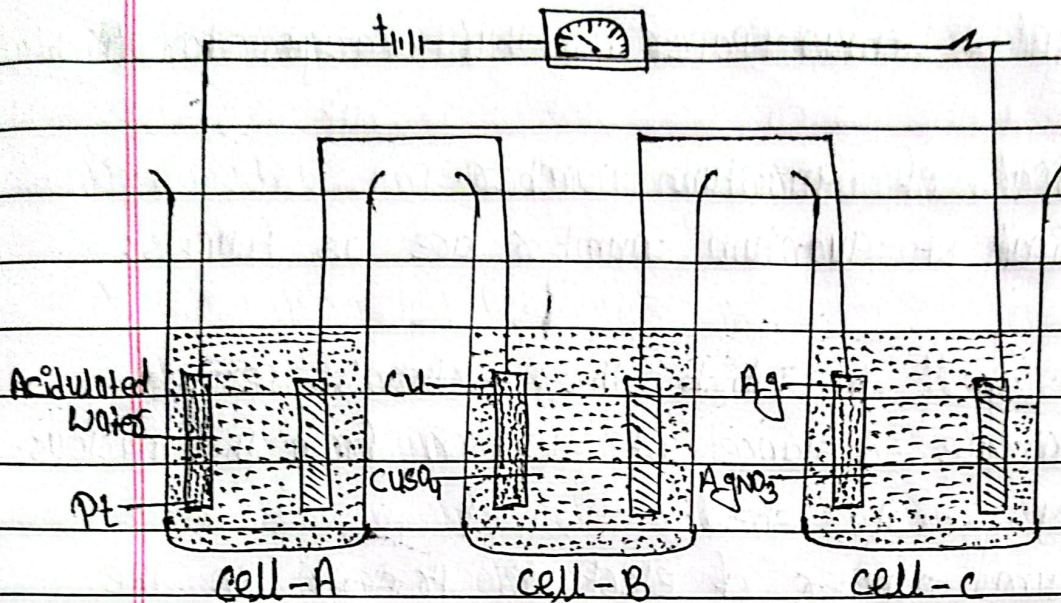


fig:- Verification of Faraday's second law of electrolysis.

* Write the short note of the following.

(i) Titration

→ Titration is the word used to determine strength of a solution by reacting it's known volume with solution of known volume and strength. It is the experimental procedure of volumetric analysis.

Strength of unknown solution can be calculated with the help of the equation.

$$V_1 S_1 = V_2 S_2$$

There are four types of titration.

- (i) Acid - Alkali Titration.
- (ii) Redox titration.
- (iii) Iodometry and Iodimetry titration
- (iv) Precipitation Titration.

In titration, indicators are used to indicate complete reaction between acid and base.



through different electrolytic solutions connected in series, the mass of the substances deposited on or liberated from the surface of respective electrodes are directly proportional to their chemical equivalents or equivalent weights."

$W \propto E$ (Where E is called chemical equivalent)

$W = KE$ (Where K is called proportionality constant)

Example :

Explanation:-

→ consider three cell containing HCl , $AgNO_3$, $CuSO_4$ and solution are connected in series. if some quantity of electricity is passed through these cells then amount of hydrogen, silver and copper deposited at the respective cathodes are in the ratio of their equivalent mass.

Hence,

$$\frac{\text{Mass of hydrogen}}{\text{Equivalent mass of hydrogen}} = \frac{\text{Mass of silver}}{\text{Eq. mass of silver}} = \frac{\text{Mass of copper}}{\text{Eq. mass of copper}}$$

$$\text{or } \frac{\text{Mass of hydrogen}}{1.008} = \frac{\text{Mass of silver}}{108} = \frac{\text{Mass of copper}}{31.75}$$



* Faraday's Laws of electrolysis.

(i) Faraday's first Law of electrolysis.

→ This law states that "the mass of any substance deposited or liberated at the surface of electrode as a result of electrolysis is directly proportional to the quantity of electricity passed through the electrolytic solution."

or,

It also defined as "The amount of substance involved in a reaction at any electrode is directly proportional to the quantity of electricity passed through the solution."

$$W \propto Q$$

(where 'W' be the amount of the substance deposited.)

$$W \propto It \text{ (where } Q = It \text{)}$$

$W = ZIt$ (where Z is called proportionality constant or electrochemical equivalent of a substance.)

where, $I = \text{current}$

$T = \text{time}$

* Faraday's second law of electrolysis.

→ Faraday second law of electrolysis state that, "When the same quantity of electricity is passed



Quantum theory of radiation.

The postulates of Bohr's model are as follows:-

(i) The electrons revolve around the nucleus in a fixed circular path, called an orbit as long as an electron remains in a particular orbit, it neither loses nor gains energy. This creates atomic stability.

(ii) Electrons revolve only in those orbits in which the angular momentum of an electron is an integral multiple of $\frac{h}{2\pi}$.

i.e. $mvr = \frac{n h}{2\pi}$ (where h is Planck's constant).

(iii) When an electron absorbs energy, its transition takes place from lower to higher orbits. An absorption spectrum is formed.

When an electron jumps from higher orbits to lower, it radiates energy in the form of emission spectrum. $E_2 - E_1 = hf$ (where ' f ' is frequency of radiation).

(iv) When an electronic transition from one stationary state to another takes place so as to release energy.

Date. ___/___/___

19



(iii) Magnetic quantum numbers (m)

→ It represents number of orbitals in a sub-shell and tells about the orientation of the orbitals.

(iv) Spin quantum numbers (s)

→ It tells the direction of spin of electron.

i.e. clockwise $+\frac{1}{2}$ or $\uparrow$ or anticlockwise

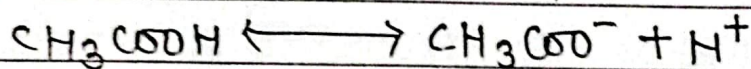
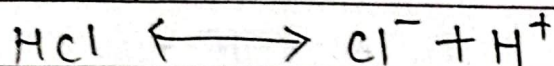
clockwise $-\frac{1}{2}$ or $\downarrow$ or anticlockwise.

Arrhenius Concept of Acids and Base.

* Acid

→ H^+ ions liberated in aq. solution.

→ It is a chemical substance which dissociates in aqueous solution to give hydrogen ion (H^+) or hydronium (H_3O^+). Examples are HCl , H_2SO_4 , CH_3COOH etc.

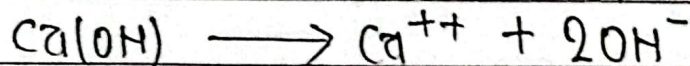
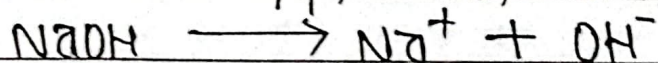


* Base:

→ OH^- ions liberated in aq. solutions.

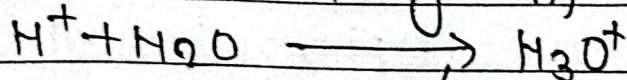
→ It is a chemical substance which dissociates in aqueous solution to give hydroxyl ion.

Examples are $LiOH$, KOH , $NaOH$, $Mg(OH)_2$ etc.



Limitations of Arrhenius Concepts of Acid and Base.

1. It doesn't explain the nature of hydrogen ion in aqueous soln. H^+ ion does not exist independently in solution. It combines with water molecules to give hydronium ion.



2. This theory does not explain the acidic or basic properties of those compounds which do not consist of H^+ or OH^- ions.

for example



* State and explain Pauli exclusion Principle.

→ Pauli exclusion principle states that "It is impossible of any two electrons in the same atom to have all the four quantum numbers identical." This principle exhibits that an orbital can have maximum two electron and they must have opposite spin.

Explanation

Let us consider helium atom which has 2 electron in 1s orbital of K-shell. The four quantum numbers for the two electrons are as follows.

	n	l	m	s
1 st electron	1	0	0	$+\frac{1}{2}$
2 nd electron	1	0	0	$-\frac{1}{2}$

These two sets of quantum numbers are not identical as they differ in their spin. The magnetic field produced by one electron cancelled by that produced by other electrons so two electrons in the same orbital have opposite or anti-parallel spin.

* Give the Lewis concept of Acid and base. ~~Lewis Acid~~

Lewis Acid :-

Lewis acid are those substance which can accept lone pairs of electrons to form coordinate covalent bond for example Ca^{2+} , Na^+ , AlCl_3 , CO_2 etc. Lewis acid is also called as electrophile.



Lewis base

→ Lewis base are those substance which can donate electron pair to form coordinate covalent bond for example:- Cl^- , SO_4^{2-} , H_2O etc.

Lewis base is also called as nucleophile.

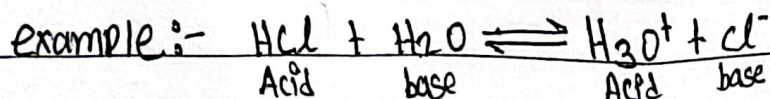
* Postulates of Dalton's atomic theory

→ Postulates of Dalton's atomic theory are as follows:-

- (i) All matter is made up of extremely small indivisible particles called atom.
- (ii) Atoms of the same elements are identical in all respects. ~~have different chemical properties.~~
- (iii) Atom of different elements are totally different and have different chemical properties.
- (iv) Atoms can neither be created nor be destroyed during any chemical or physical change.
- (v) Atom is the smallest unit of matter that can take part in chemical reaction.
- (vi) The relative number and kinds of atoms are constant in a given compound.

* Lowry and Bronsted concept of acid and base.

→ According to this concept a substance which donates proton is called acid and a substance which accepts proton is called base.



Acid and Base

Characteristics of Acid

- * They have sour taste.
- * They have high solvent power and dissolve many substance.
- * Acids change the colour of litmus from blue to red.
- * They convert the colour of methyl orange from ~~orange~~ / Yellow to pink.
- * Acids turn the pink colour of phenolphthalein to colourless.
- * Certain metals react with acid to evolve hydrogen gas.
- * Acid have pH less than 7.
- * Strong acid cause burn on skin.
- * Acids are electrolytes.

Characteristics of Base.

- * They are bitter in taste.
- * Bases feel slippery or soapy.
- * Bases change the colour of litmus from red to blue.
- * Bases turn pink colour of methyl orange to light yellow.
- * Bases turn colourless phenolphthalein to pink colour.
- * Bases react with acid to form salt and water.
- * The pH value of bases ranges from 8-14.
- * Hydrogen gas is evolved when metals react with a base.

2020/8) Derive $PV = nRT$. 20

The ideal gas law combines Boyle's law, Charles's Law, and Avogadro's Law.

$$V \propto \frac{1}{P} \text{ (Boyle's Law)}$$

Page No.

Date. / /



$$V \propto T \text{ (Charles's Law)}$$

$$V \propto n \text{ (Avogadro's Law)}$$

Combining these proportionalities gives:

$$V \propto \frac{nT}{P}$$

This can be written as an equation by introducing the universal gas constant, R :

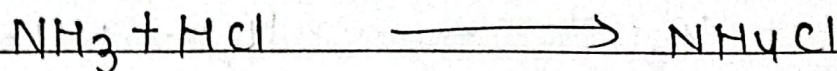
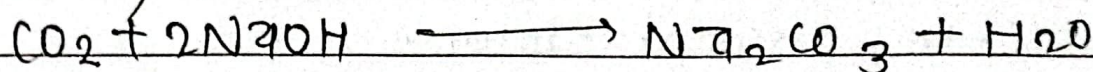
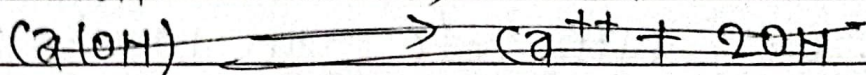
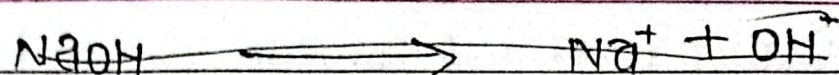
$$V = R \frac{nT}{P}$$

Rearranging the terms yields the ideal gas law:

$$PV = nRT$$

Answer:

The ideal gas law is $PV = nRT$.



3. It doesn't provide any explanation of acid base behavior in the absence of water. i.e. only applicable in aqueous medium.

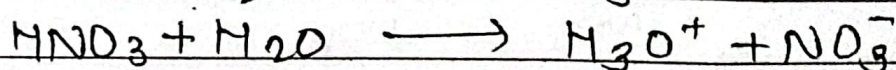
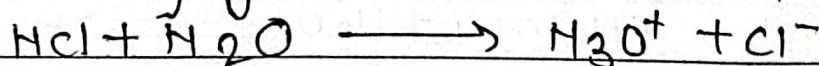
4. It is unable to explain the acidic nature of certain oxide like NO_2 , SO_2 , and acid like AlCl_3 and base like NH_3 , PH_3 .

Bronsted - Lowry's concept of Acid and Base.
Bronsted acid:

→ Those substance that can give a proton to other substance is called Acid.

→ This proton is always solvated i.e., combined with water one or more molecules of the solvent.

→ Ex. HCl , H_2SO_4 , CH_3COOH etc. are acids because they give a proton in aqueous soln



Bronsted base:

→ Those substance that can accept a proton from other substance is called Base.

(b). Acidic salt:

The salt formed by the partial displacement of hydrogen atoms of an acid is called acidic salt. eg:- NaHSO_4 , $\text{Ca}(\text{HCO}_3)_2$

(c). Basic salts:- the salt formed by the partial displacement of hydroxyl group of a base by an acid radical is called basic salt.

eg:- lead hypochloride $[\text{Pb}(\text{OH})\text{Cl}]$
 Zinc " $[\text{Zn}(\text{OH})\text{Cl}]$.

pH:- It is defined as the negative logarithm of the molar concentration of hydrogen ion (H^+). It is a quantitative measure of the acidity or alkalinity. It is equal to the negative log of hydrogen ion (H^+) concentration.

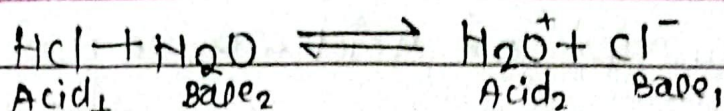
$$\text{pH} = -\log[\text{H}^+]$$

pOH:- It is defined as the negative logarithm of the molar concentration of hydroxide ion (OH^-) concentration in a solution. It is a quantitative measure of the acidity or alkalinity. It is equal to the negative logarithm of hydroxide (OH^-) ion concentration.

$$\text{pOH} = -\log[\text{OH}^-]$$

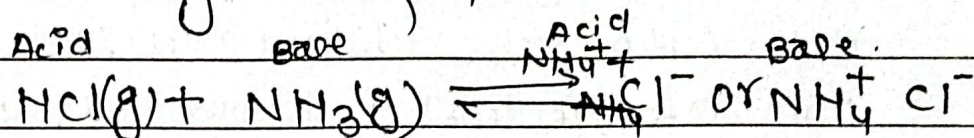
pH scale: the scale on which pH values are computed is called pH scale. (1-14).

$$|\text{pH} + \text{pOH} = 14|$$



Merits of Bronsted - Lowry concept:

1. This concept can explain the acidic/basic nature of a substance in aqueous (H_2O) as well as in other protonic solvents like liq. NH_3 , liq. HF .
2. This concept also explains acid base reaction taking place in gaseous phase.



Limitations of Bronsted - Lowry's concept of Acid and base.

1. This concept is not applicable for non-protonic chemical species. For eg:- SO_2 , CO_2 , NO_2 are acidic and MgO , BaO , CaO are basic in nature but do not have donor proton donor and acceptor.
2. There are some acid-base reactions where there is no transfer of proton. Example are,

$$\text{MgO} + \text{CO}_2 \longrightarrow \text{MgCO}_3$$

$$\text{CaO} + \text{SO}_3 \longrightarrow \text{CaSO}_4$$
3. Unable to explain the acidic nature of some salts such as BF_3 , AlCl_3 , FeCl_3 .

Lewis Concept of Acid - Base.

* Acid:

→ The chemical substance which can accept a lone pair of electrons is known as Lewis acid.

→ Lewis acid is electron deficient compound. therefore, lone pair of electron acceptor is known as Lewis acid.

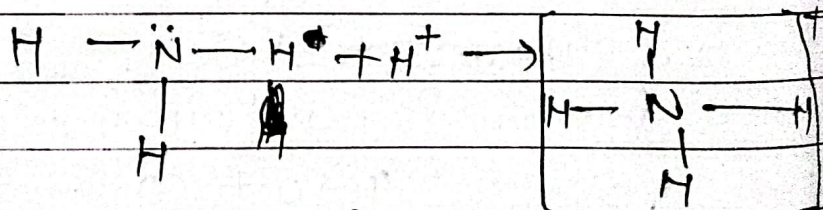
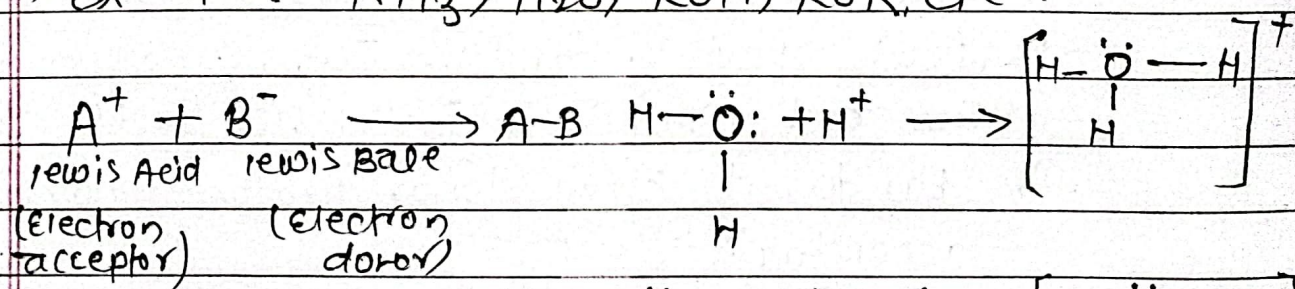
→ Examples are:- AlCl_3 , BF_3 , FeCl_3 , BCl_3 etc.

* Base:

→ The chemical substance which can donate a lone pair of electron is known as Lewis Base.

→ Lewis base is electron efficient compound. therefore, lone pair of electron donor is known as Lewis base.

→ Ex. are:- NH_3 , H_2O , ROH , ROR , etc.



Limitations of Lewis concept of Acid and Base.

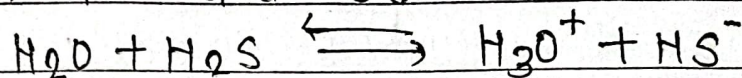
1. It does not explain the behaviour of protonic acid such as HCl , H_2SO_4 , HNO_3 etc.
2. It doesn't predict the magnitude of relative strength of acid and base.

Amphoteric nature of Water.

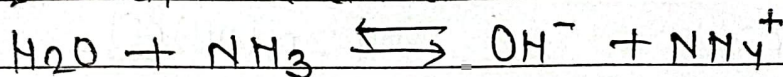
→ Water has ability to act as an acid as well as a base. Such behavior is known as amphoteric nature of water.

The amphoteric nature of water is represented by the following chemical reactions.

a) Water as a base:



b) ~~H₂O~~ water as an acid:

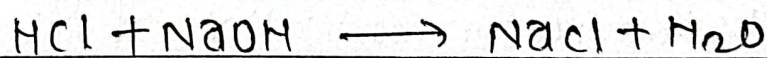


H₂O acts as an acid towards NH₃ and a base towards H₂S. Therefore H₂O is amphoteric.

Salts

* Salts: A salt is a compound formed by the partial or complete neutralization of an acid by base.

→ The substance which are neither acid nor base which means it is Neutral.



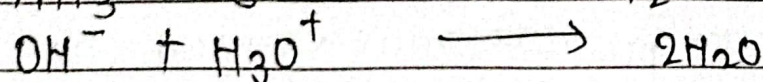
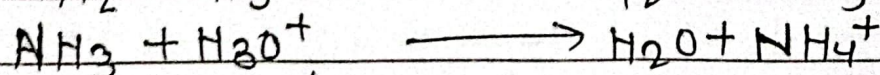
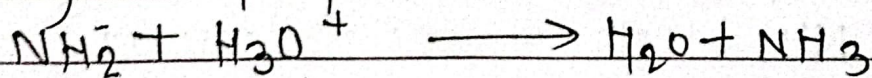
(a) Normal salts:

The salt formed by the complete displacement of hydrogen atoms by a metal or electropositive radical is called normal salt. Normal salt is neutral in nature.

eg :- NaCl, KNO₃.

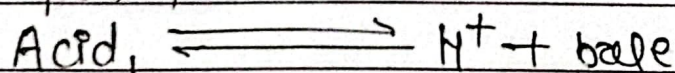
→ It is also called a proton acceptor.

→ Ex. NH_3 , OH^- , NH_2^- , etc are bases because they accept proton.



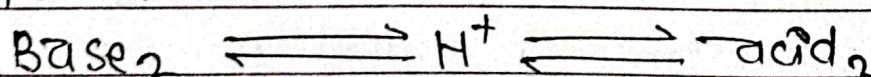
Conjugate Acid and Bases:

Bronsted-Lowry also gave the concept of conjugate acid base pair. Conjugate base is a species that remains when one proton has been removed from the acid.



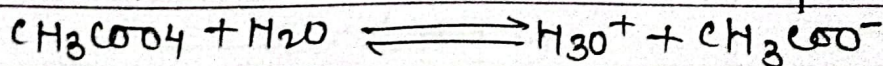
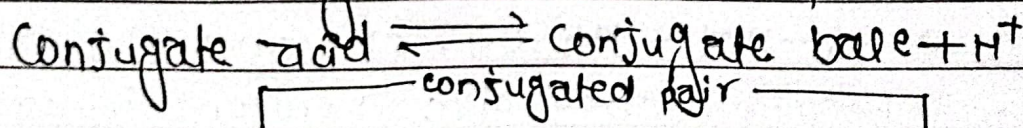
Conjugate base

Conjugate acid results from the addition of proton to a base



Conjugate acid.

An acid base pair which is different by a proton is called conjugate acid base pair.



Acid₁

Base₂

Acid₂

Base₁

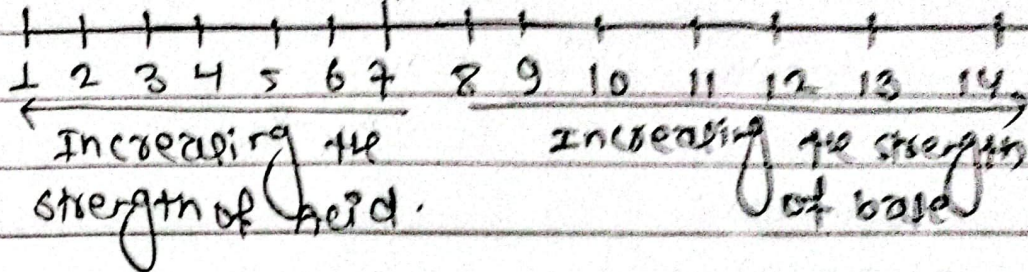
Conjugate pair

Therefore, any acid-base reaction involves two acids and two bases. These acids and bases are called conjugate pairs.

$\text{pH} < 7 \rightarrow \text{Acid}$

$\text{pH} > 7 \rightarrow \text{Base}$

$\text{pH} = 7 \rightarrow \text{Salt}$
 pH of salt



== Relation betⁿ pH and pOH.

As we know,

→ The ionic product of water (K_w) is given by

$$K_w = [\text{H}_3\text{O}^+] \times [\text{OH}^-]$$

$$\text{At } 298\text{K}, K_w = 1 \times 10^{-14}$$

$$\therefore \text{p}K_w = -\log_{10} K_w = -\log_{10} 1 \times 10^{-14} = 14$$

$$\therefore [\text{H}_3\text{O}^+] \times [\text{OH}^-] = 1 \times 10^{-14}$$

taking logarithm to base 10 of both sides.

$$\log_{10} [\text{H}_3\text{O}^+] + \log [\text{OH}] = \log (1 \times 10^{-14})$$

multiplying by -1 on the both sides.

$$-\log_{10} [\text{H}_3\text{O}^+] - \log [\text{OH}] = -\log (1 \times 10^{-14})$$

$$[\text{pH} + \text{pOH} = 14] \text{ proved}$$

characteristics of covalent compound

- i) They may exist in solid, liquid or gaseous state.
- ii) Generally, they don't conduct electricity.
- iii) They are generally insoluble in water.
- iv) They have low m.p and b.p than ionic compounds.
- v) They are directional in nature.

* Co-ordinate Bond *

→ The bond formed by the sharing of electron in which the shared pair of electron is contributed by one of the bonded atoms is called a co-ordinate bond. It is also called dative bond.

→ The atom that donates the shared pair of electron is called the donor atom and which accepts the shared pair of electrons are called the acceptor atom.

It is represented by an arrow ($\rightarrow$) pointing from donor atom to acceptor atom.

2073 (Q) Define molarity and Normality. 18 mL $N_{1/2}$ HCl, 10.3 mL of 2N HCl and 16.4 mL of N_{10} HCl mixed together. Calculate the strength of the mixture in terms of normality and gms per liter.

Solve molarity

→ the number of mole of solute dissolved in one liter of soln is called molarity of a solution.

Normality

→ the no. of gram equivalent of solute dissolved per liter of the given soln is called Normality.

Volume of HCl (V_1) = 18 mL

Normality (N_1) = $N_{1/2} = 0.5N$

Volume of 2N HCl (V_2) = 10.3 mL

Normality (N_2) = 2N

Volume of HCl (V_3) = ~~16.4~~ = 16.4

Normality (N_3) = $N_{10} = 0.1N$

From principle of titration, we know that,

$$\begin{aligned}
 N_R &= \frac{N_1 V_1 + N_2 V_2 + N_3 V_3}{V_1 + V_2 + V_3} \\
 &= \frac{18 \times 0.5 + 2 \times 10.3 + 0.1 \times 16.4}{18 + 10.3 + 16.4} \\
 &= \frac{30.24}{44.7} = 0.67N
 \end{aligned}$$

$$\begin{aligned}
 \therefore \text{g/L} &= \text{Normality} \times \text{eq. wt.} \\
 &= 0.67 \times 36.5 \\
 &= 24.45 \text{ g/L}
 \end{aligned}$$

Basic Assumption of electronic theory of valence.

1. Only valence electrons take part in the formation of chemical bond.
2. Atom with 8 electrons in their valence shell are most stable. However, hydrogen and helium satisfy the duplet rule.
3. Atoms combine with each other by loss or gain of electrons or by mutual sharing of electrons to nearest inert gas by loss or gain or mutual sharing of electrons.
4. Each combining atom attains the electronic configuration to nearest inert gas by loss or gain or mutual sharing of electrons.
5. The chemical bond is formed if there is an overall decrease in energy lower the energy, stable the molecule.

Type of bond

1. Electrovalent bond :- the bond formed between two atoms due to complete transfer of electrons is called electrovalent bond. The bond is formed between metal and non-metal.

(a)

NaCl

Na - 2, 8, 1 (metal)

E.C of Na :- $1s^2 2s^2 2p^6 (3s^1)$

Cl - 2, 8, 7 (non-metal)

E.C of Cl :- $1s^2 2s^2 2p^6 3s^2 3p^5$

covalent bond

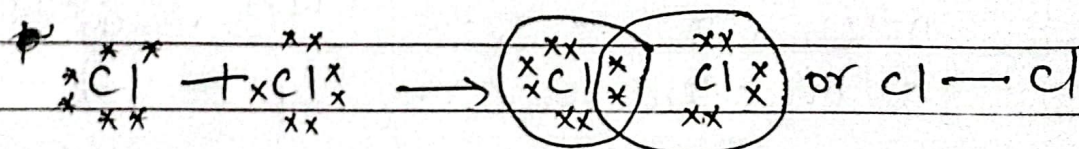
The bond formed between by the mutual sharing of electrons between combining atoms of the same or different elements is called a covalent bond. It takes place between non-metals. It is represented by a dash (—).

The compounds formed by the covalent bond are called covalent compounds.

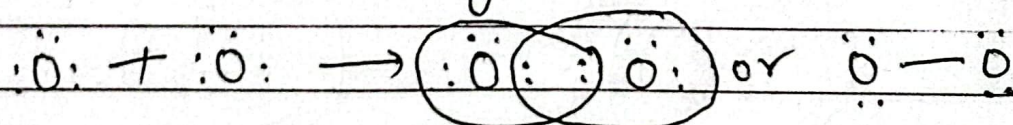
(a) formation of hydrogen molecule.



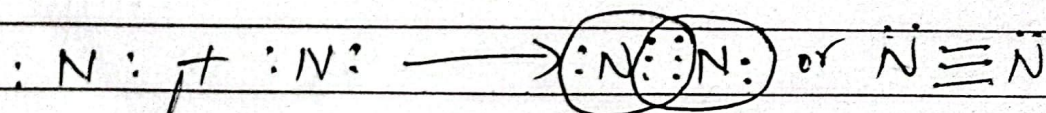
(b) formation of chlorine molecule.



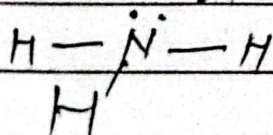
(c) formation of oxygen molecule.



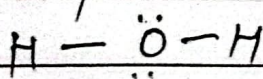
(d) formation of nitrogen molecule.



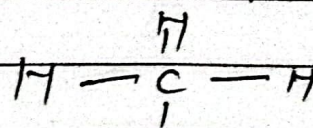
* Lewis dot s/s of some covalent compounds.



Ammonia



water



methane

* Buffer solⁿ.

→ A solution whose pH is not altered to a great extent by the addition of small quantities of either an acid or base is called buffer solution.

→ which resist change in pH with addition of small amount of acid or base.

* characteristics of buffer solutions.

- i). It has a definite pH.
- ii). Its pH does not change on standing for long periods of time.
- iii). Its pH does not change on dilution.

Types of Buffer solⁿ.

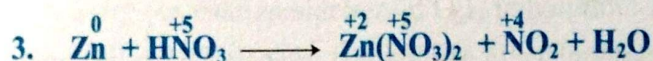
(A) Acidic formed by the mixture acid and its salt with a strong base.
 eg:- (i) $\text{CH}_3\text{COOH} + \text{CH}_3\text{COONa}$
 (ii) $\text{HCN} + \text{NaCN}$.

(B) Basic Buffers.

→ It is formed by the mixture of weak base and its salt with strong acid.

eg:- (i) $\text{NH}_4\text{OH} + \text{NH}_4\text{Cl}$
 (ii) $\text{NH}_4\text{OH} + \text{NH}_4\text{NO}_3$

(C) simple buffer :- It is formed by a mixture of salt and normal salt of poly basic acid. eg:- $\text{Na}_2\text{HPO}_4 + \text{Na}_3\text{PO}_4$.



Solution:

O.N. of uncombined zinc atom = 0

O.N. of nitrogen in $\text{HNO}_3 = +5$

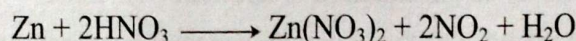
O.N. of zinc in $\text{Zn}(\text{NO}_3)_2 = +2$

O.N. of nitrogen in $\text{NO}_2 = +4$

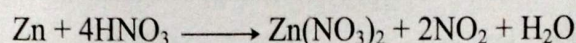
$\therefore$ Increase in oxidation number = 2

$\therefore$ Decrease in O.N. = 1

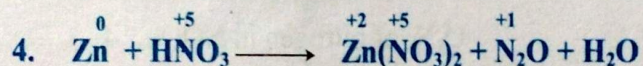
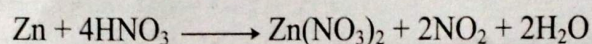
Total increase in oxidation number should be equal to total decrease. Therefore ratio of zinc and HNO_3 must be 1:2 and molecule where O.N. of nitrogen is changed is multiplied by 2.



To balance nitrate radicals where O.N. of nitrogen remains unchanged, i.e., +5, 2HNO_3 are added towards the LHS of the equation.



Water molecule on RHS is multiplied by 2, to balance hydrogen and oxygen atoms.



Solution:

O.N. of uncombined zinc = 0

O.N. of nitrogen in $\text{HNO}_3 = +5$

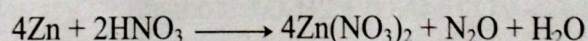
O.N. of zinc in $\text{Zn}(\text{NO}_3)_2 = +2$

O.N. of nitrogen in $\text{N}_2\text{O} = +1$

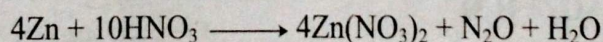
$\therefore$ Increase in O.N. = 2

$\therefore$ Decrease in O.N. = 4

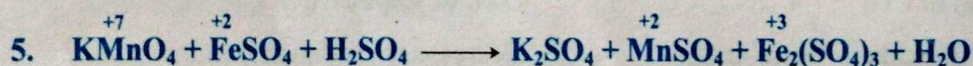
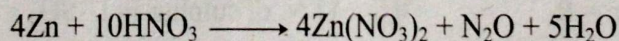
To make change in O.N. equal, ratio of zinc and HNO_3 must be 4:2. As nitrous oxide molecule contains two nitrogen atoms, it is not necessary to multiply it by 2. But molecule containing zinc should be multiplied by 4.



To balance nitrate radicals on either side of the equation where O.N. of nitrogen remains unchanged, 8HNO_3 are added towards the LHS of the equation.



To balance hydrogen and oxygen atoms, H_2O on RHS is multiplied by 5.



Solution:

O.N. of Mn in $\text{KMnO}_4 = +7$

O.N. of Fe in $\text{FeSO}_4 = +2$

O.N. of Mn in $\text{MnSO}_4 = +2$

O.N. of Fe in $\text{Fe}_2(\text{SO}_4)_3 = +3$

$\therefore$ Decrease in O.N. = 5

$\therefore$ Increase in O.N. = 1

To make change in O.N. equal, ratio of KMnO_4 and FeSO_4 must be 1:5. Five molecules of FeSO_4 will yield $2\frac{1}{2}$ molecules of $\text{Fe}_2(\text{SO}_4)_3$. But molecules are not written in fractional numbers. Therefore above ratio of molecules must be doubled.

8. a) State and explain Faraday's 2nd law of electrolysis.

➤ Statement :

If same quantity of electricity is passed through different electrolytes connected in series, then the amount of substances deposited or liberated at their respective electrodes are in the ratio of their equivalent weight.

➤ Explanation :

Consider 3 cells containing H_2SO_4 , CuSO_4 and AgNO_3 , solutions are connected in series. If some quantity of electricity is passed through these cells, then amount of hydrogen, copper and silver deposited at the respective cathodes are in the ratio of their equivalent mass.

Hence,

$$\frac{\text{Mass of hydrogen}}{\text{Eq. mass of hydrogen}} = \frac{\text{Mass of copper}}{\text{Eq. mass of copper}} = \frac{\text{Mass of silver}}{\text{Eq. mass of silver}}$$

$$\text{or, } \frac{\text{Mass of hydrogen}}{1.008} = \frac{\text{Mass of copper}}{31.75} = \frac{\text{Mass of silver}}{108}$$

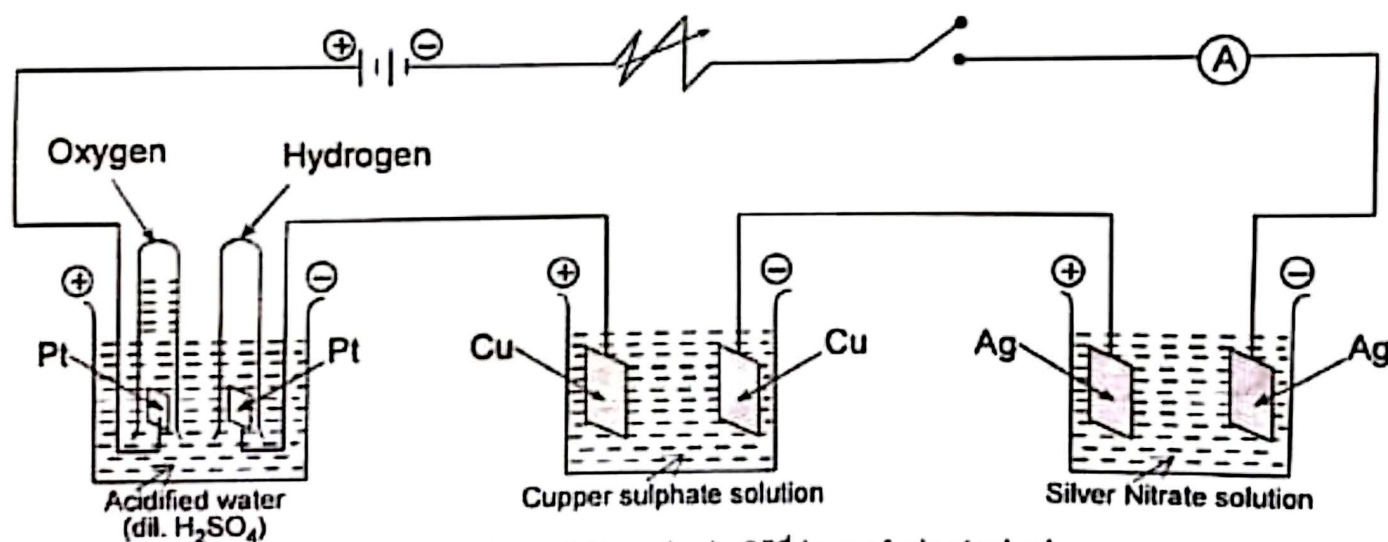


Fig: Illustration of Faraday's 2nd law of electrolysis

➤ We know,

$$\text{Molecular weight} = \frac{\text{Weight of one molecule of the substance}}{\text{Weight of one atom of hydrogen}}$$

$$\text{and, Vapour density} = \frac{\text{Weight of certain volume of a gas}}{\text{Weight of same volume of hydrogen gas}}$$

(At same temperature and pressure)

$$\text{V.D} = \frac{\text{Weight of (V) volume of the vapour of a substance}}{\text{Weight of (V) volume of hydrogen}}$$

(At same temperature and pressure)

Let 'V' volume of vapour of the substance contain 'n' molecules.

Therefore 'V' volume of hydrogen also contain 'n' molecules.

$$\text{V.D} = \frac{\text{Weight of n molecules of gas}}{\text{Weight of n molecules of hydrogen}}$$

$$= \frac{\text{Weight of 1 molecules of gas}}{\text{Weight of 1 molecules of hydrogen}}$$

$$= \frac{\text{Weight of 1 molecules of gas}}{\text{Weight of 2 atom of hydrogen}} \quad [\because \text{hydrogen is diatomic}]$$

$$= \frac{\text{Weight of 1 molecules of gas}}{2 \times \text{Weight of 1 atom of hydrogen}}$$

By definition of molecular weight; we have,

.. -

$$V.D. = \frac{1}{2} \times \text{molecular weight}$$

$$\therefore \text{Molecular weight} = 2 \times V.D.$$

Hence,

The molecular weight of the compound is twice of its vapour density.

b) What is mole?

➤ *Mole is a unit used to measure the amount of a substance. One mole of a substance contains the same number of particles as there are in 12 grams of carbon-12. This number is approximately 6.02×10^{23} particles and is known as Avogadro's number.*

Calculate the no of mole in

i) 11.2 ltr of CO_2 at NTP.



We have,

22.4 L Contains 1 mole of CO_2 at NTP

1 L Contains $\frac{1}{22.4}$ mole of CO_2 at NTP

By question,

11.2 L contains $\frac{11.2}{22.4}$ mole of CO_2 at NTP

11.2 L Contains 0.5 mole of CO_2 at NTP

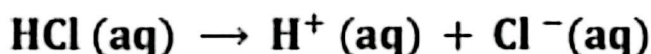
No. of mole = 0.5

4. a) Define acid and base in terms of Arrhenius concept with one examples of each.

➤ **According to the Arrhenius concept**, all substances which contain hydrogen and give H^+ ions when dissolved in water are called **acids** while those which contains hydroxyl groups and which when dissolved in water give OH^- ions are called **bases**.

• **Example of an acid:** Hydrochloric acid (HCl)

When HCl is dissolved in water, it dissociates into H^+ and Cl^- ions, increasing the concentration of H^+ ions in the solution. The reaction can be written as:



• **Example of a base:** Sodium hydroxide ($NaOH$)

When $NaOH$ is dissolved in water, it dissociates into Na^+ and OH^- ions, increasing the concentration of OH^- ions in the solution. The reaction can be written as:



Additional : If ask,

➤ **Limitations of Arrhenius concept :**

- ✓ Hydrogen ion does not exist as free ion but combines with water molecule to form H_3O^+ . This is not covered in this concept.
- ✓ This concept is limited to only one solvent water.
- ✓ It does not cover those compounds that act like acid (CO_2) and base (NH_3) though they do not contain H^+ and OH^- ion respectively.
- ✓ The Arrhenius concept also does not explain the behavior of amphiprotic substances, which can act as both an acid and a base depending on the reaction, such as water(H_2O).

3. a) Define Avogadro's hypothesis. Show that the molecular weight of the compound is twice of its vapour density.

38

- **Avogadro's hypothesis states that, "equal volumes of all gases under the same conditions of temperature and pressure contain an equal number of molecules".**

10. Write short notes on:

a) Assumption of electronic theory of valency

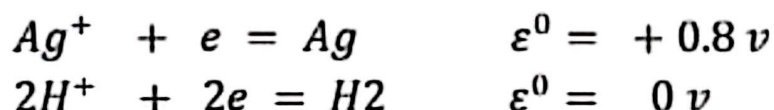
➤ *The assumptions of electronic theory of valency are as follows:-*

- ✓ Only the valence electrons participate in chemical combination.
- ✓ Number of valence electrons determines the capacity of atoms to take part in chemical combination.
- ✓ Every element has tendency to acquire the nearest inert gas configuration which is considered as stable configuration.
- ✓ The combination of atoms takes place by transfer or mutual sharing or donating one or more valence electrons.
- ✓ The attractive forces which hold various constituents (atoms, ions) together in different chemical species are called chemical bond.

b) Electrochemical series

➤ The arrangement of various elements in order of increasing values of standard reduction potentials is called **electrochemical series**. The standard oxidation potential is equal to standard reduction potential with opposite sign.

{ **A part of electrochemical series :**



Positive sign of ϵ^0 indicates that the substance has greater tendency to reduce than hydrogen. }

* State Dulong and petit's Law? State Avogadro's hypothesis? State Faraday's first law of electrolysis?

⇒ Dulong petit's law

According to Dulong and petit's law, the product of atomic weight and specific heat of a solid element is approximately equal to 6.4.

$$\text{Atomic weight} \times \text{Specific heat} = 6.4 \text{ (approx.)}$$

$$\text{or, Approximate atomic weight} = \frac{6.4}{\text{Specific heat}}$$

$$\text{Exact atomic weight} = \text{Equivalent Weight} \times \text{valency}$$

$$\text{or, Valency} = \frac{\text{Approximate atomic weight}}{\text{Equivalent Weight}}$$

Avogadro's hypothesis :- Avogadro's hypothesis states that, "equal volumes of all gases under the same conditions of temperature and pressure contain an equal number of molecules".

Faraday's first law of electrolysis :-

The mass of substances discharged at electrode is directly proportional to the amount of current passed through it.

$$\text{i.e. } m \propto Q \text{ (charge)}$$

$$\text{or, } m = ZQ$$

Where, Z is E.C.E. of the substance

$$\text{or, } m = ZIt$$

b) State Mendeleev's periodic law? Explain Mendeleev's periodic table in brief. Also mention it's anomalies.

45

➤ **Mendeleev's periodic law** states that " *the physical and chemical properties of elements are periodic functions of their atomic weights*". This means that the properties of elements are related to their atomic weights, and elements with similar properties occur at regular intervals. The periodic law is the basis for the arrangement of the elements in the modern periodic table.

➤ **The (*Features*) of Mendeleev's periodic table In brief :-**

- ✓ This table is based on the Mendeleev's periodic law which states, "The physical and chemical properties of all elements are periodic functions of their atomic mass".
- ✓ The elements are arranged in nine vertical columns known as groups. The ninth one is called zero group.
- ✓ There are seven horizontal rows known as periods. Six periods are complete whereas seventh one is incomplete.
- ✓ All the groups except zero and VIII are further divided into subgroups A and B.
- ✓ There are some blank spaces for undiscovered elements.

➤ **The anomalies of Mendeleev's periodic table are :-**

- ✓ Position of hydrogen in the table is controversial.
- ✓ Metals and non-metals are not separately placed.
- ✓ Elements with higher atomic masses are placed before that of lower atomic masses.
- ✓ Lanthanides and Actinides are not separated from the main body of the periodic table.

6. Write short notes on: (Any Five)

46

a) Radical

➤ Refer to the solution 2076 of Q. No 10(e) on page 25

b) Covalent bond

➤ The bond which is formed between two or more atoms of the same or different elements by equal sharing of electron between any two combining atom is known as *covalent bond*. It may be polar or non polar. It is denoted by dash line (—). For Example : Cl_2 molecule

Types of Covalent bond :

- ✓ **Single covalent bond:** It is formed by the sharing of one electron between the two combining atoms. Example: F_2 , H_2 etc.
- ✓ **Double covalent bond:** It is formed by the sharing of two electrons between the two combining atoms. Example: O_2 , CO_2 etc.
- ✓ **Triple covalent bond:** It is formed by the sharing of three electrons between two combining atoms. N_2 , C_2 etc.

c) Hund's rule

➤ Hund proposed a rule of filling of degenerate orbital with electrons which is known as **Hund's rule** for maximum multiplicity. This rule is stated as, "*Electrons in degenerate orbital in the ground state first fill singly, and then pairing-up starts*". When electrons enter a set of orbital of a given sub-shell, electron will pair up only when all the available orbital have had at least one electron each.

d) Titration

47

➤ **Titration** is the word used to determine strength of a solution by reacting its known volume with solution of known volume and strength. It is the experimental procedure of volumetric analysis.

Strength of unknown solution can be calculated with the help of the equation $V_1 S_1 = V_2 S_2$.

Types of Titration :

- ✓ Acid-alkali titration
- ✓ Redox titration
- ✓ Iodometry and iodimetry
- ✓ Precipitation titration

In titration, indicators are used to indicate complete reaction between acid and base. Examples of indicators are litmus paper, phenolphthalein, methyl orange, etc.

e) Normality

➤ It is defined as the number of gram equivalents of solute present in one litre of the solution. *It is represented by N.*

i. e.,

$$\begin{aligned}\text{Normality (N)} &= \frac{\text{Number of gm equivalents of solute}}{\text{Volume of Solution in litre}} \\ &= \frac{\text{weight of solute in gm}}{\text{Equivalent weight of solute}} \times \frac{1}{\text{Volume of Solution in litre}}\end{aligned}$$

or, Normality $\times$ Equivalent weight = Concentration in gm per litre

d) Preventions from corrosion

➤ *The prevention of corrosion are given below :-*

- ✓ **Protective coatings** - Applying a layer of paint or powder coating can create a barrier between the metal and the environment.
- ✓ **Cathodic protection** - Connecting the metal to a sacrificial anode made of a more active metal can prevent corrosion.
- ✓ **Control the environment** - Reducing humidity, maintaining a certain temperature, or using a dehumidifier can reduce the risk of corrosion.
- ✓ **Alloying** - Adding a small amount of a more corrosion-resistant metal to the alloy can improve its corrosion resistance.
- ✓ **Galvanization** - Applying a layer of zinc can protect the metal from corrosion.
- ✓ **Proper maintenance** - Regular cleaning, inspection, and maintenance can prevent corrosion by removing any corrosive substances that may have accumulated on the surface.
- ✓ **Design considerations** - Proper design, including material selection, surface preparation, and proper drainage, can reduce the risk of corrosion.

e) Radicals

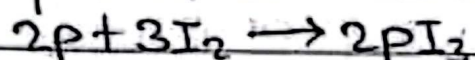
➤ An Atom or group of atoms carrying charge which acts as single unit in the chemical reaction is called **radicals**.

Types of Radicals :

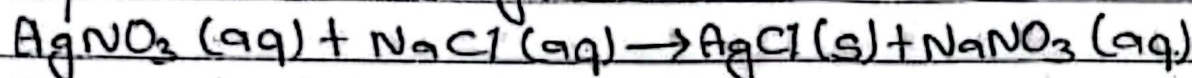
Electronic configuration of nitrogen ($Z=7$) is $1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$ and not $1s^2 2s^2 2p_x^2 2p_y^1$ etc.

The electronic configuration of silicon and copper in terms of s, p, d orbital are:-

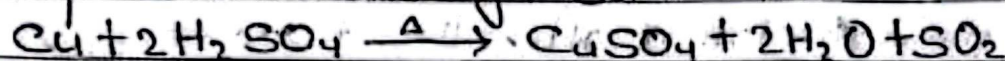
i) By simple contact



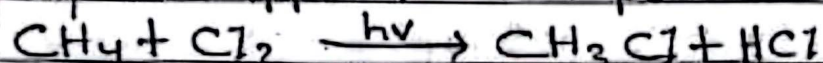
ii) By contact through solution



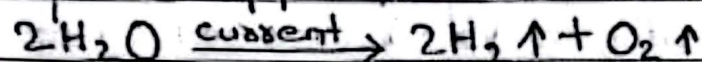
iii) By contact through solution



iv) By the application of pressure and light



v) By the application of electricity



* What is molecular formula? Define modern periodic law.

→ Molecular formula:-

Molecular formula is a brief representation of molecules of any various compounds or elements in terms of symbols showing actual numbers of various elements present in it. For eg:-
Molecular formula of copper sulphate crystal is $CuSO_4 \cdot 5H_2O$.

Electrovalent compounds

- i) Compounds formed due to electrovalent bond (transfer of electrons) are called electrovalent compound.
- ii) They have high density melting point and boiling point.
- iii) They conduct electricity in their aqueous solution.
- iv) For eg - NaCl, MgO, etc.

Covalent compounds

- i) Compounds formed due to covalent bond (sharing of electrons) are called covalent compounds.
- ii) They have low density, melting point and boiling point.
- iii) They do not conduct electricity.
- iv) For eg - PCl_3 , H_2O etc.

Orbit

- i) It is well defined circular path around the nucleus through which the electrons revolve.
- ii) It is denoted by K, L, M, N.
- iii) All orbits are circular.
- iv) Maximum number of electrons in an orbit is given by $2n^2$.

Orbital

- i) It's three dimensional space around the nucleus within which probability of finding electron is at maximum.
- ii) It is denoted by s, p, d and f.
- iii) Orbital have various shapes.
- iv) An orbital cannot hold more than 2 electrons.

* State and explain Faraday's second law of electrolysis.

→ Statement

If same quantity of electricity is passed through different electrolytes connected in series then amount of substances deposited or liberated at their respective electrodes are in the ratio of their equivalent weight.

Explanation

Consider 3 cells containing HCl, AgNO₃ and CuSO₄ solutions are connected in series. If same quantity of electricity is passed through these cells, then amount of hydrogen, silver and copper deposited at the respective cathodes are in the ratio of their equivalent mass. Hence,

$$\frac{\text{Mass of hydrogen}}{\text{Eq. mass of hydrogen}} = \frac{\text{Mass of silver}}{\text{Eq. mass of silver}} = \frac{\text{Mass of copper}}{\text{Eq. mass of copper}}$$

$$\text{or, } \frac{\text{Mass of hydrogen}}{1.008} = \frac{\text{Mass of silver}}{108} = \frac{\text{Mass of copper}}{31.75}$$

* What are the limitations of Arrhenius theory of acids and bases? Explain dual nature of water as an acid and a base.

⇒ The limitations of Arrhenius theory of acids and bases are:-

i) This concept is only limited to the substances

* State Mendeleev's periodic law.

→ It states that, "the physical and chemical properties of elements are periodic functions of their atomic weights." That is, the elements of lower atomic mass is followed by the elements of higher atomic mass. This law leads to the construction of Mendeleev's periodic table.

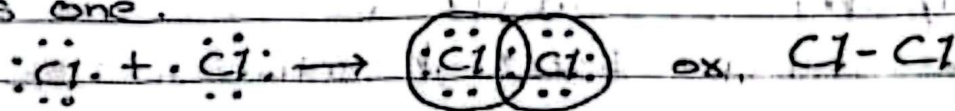
* What is covalent bond? How is it formed?

Explain with an example.

→ The chemical linkage formed by mutual sharing of electrons between the combining atoms of same or different elements is called covalent bond. The number of electrons used for sharing by the both atoms is equal which is known as covalency.

Formation of Cl_2 molecule.

Chlorine molecule is formed by the combination of two chlorine atoms. Each atom contains 7 valence electrons. Each atom contributes one electron to form a covalent bond. Hence, Cl_2 molecule is a covalent compound and its covalency is one.



Covalent bond is represented by a dash line (-).

* Define decinormal solution. A 20 c.c. $\frac{N}{5}$ HCl solution is mixed with 100 c.c. of $\frac{N}{20}$ HCl solution. Calculate the strength of resultant solution in terms of normality, gram per litre and percentage. (Equivalent weight of HCl = 36.5)
 Soln:-

If $\frac{1}{10}$ part of 1 gm equivalent of solute is present in 1 litre solution, then it is called decinormal solution. For eg:- 5.3 gm of Na_2CO_3 in 1 litre solution is decinormal solution.

Given here,

20 c.c. $\frac{N}{5}$ HCl is mixed with 100 c.c. $\frac{N}{20}$ HCl

$$\therefore V_1 = 20 \text{ c.c.} \quad V_2 = 100 \text{ c.c.}$$

$$S_1 = \frac{N}{5} \quad S_2 = \frac{N}{20}$$

Let 's' be the strength of mixture, then,

$$S = \frac{V_1 S_1 + V_2 S_2}{V_1 + V_2} = \frac{4 + 5}{20 + 100} = \frac{9}{120} = \frac{3}{40}$$

$$\therefore S = \frac{3N}{40}$$

we know,

$$\text{gm/litre} = \frac{3}{40} \times 36.5 = 2.74$$

Also,

$$\text{gm/litre} = \text{percentage} \times 10$$

$$\therefore \text{percentage concentration} = 0.274\%$$

$$\left[\because \text{Normality} = \frac{\text{gm/litre}}{\text{Equivalent wt}} \right]$$

Modern periodic law :-

Modern periodic law states, "The physical and chemical properties of the elements are the periodic function of their atomic numbers". This law is developed to overcome the difficulties brought by Mendeleev's periodic law.

* Which postulates of Dalton's atomic theory needed modification after the discovery of isotopes? Explain.

→ In Dalton's atomic theory, it has said that atoms of same elements are identical in all respects, an atom has fixed mass and atoms of different elements are entirely different in their mass and properties. But after the discovery of isotopes, this postulate needed modification. Isotopes of same elements possess different relative weights and properties whereas isobars which are of different elements, have same relative weight.