A yearly magazine

CheMystery

4th Edition: ABC's of Chemistry

Department of Chemistry

Barasat Government College

What is chemistry? Dr.C.W.Huey said-"Chemistry is a path of creativity ,it's a subject of logic & it creates a new way of thinking" .It connected both of physical and biological sciences.

Following in each year's footsteps ,we published our magazine "ABC in Chemistry". Doesn't it sound a little bit strange !! what is the connection between 'alphabetical series' and 'chemistry'? Ok , now let me explain ,in this magazine, we represents important events of chemistry in their first syllables, like 'A' represents 'Atomic theory'& so on other alphabet illustrated same way.It is our small effort,to delinate chemistry in a enchanting & interesting way.

DATE OF PUBLICATION
31/03/2024

To the Professors,

On behalf of the student body, we wish to extend our sincerest gratitude for your unwavering dedication and support in bringing our magazine publication to fruition. Your guidance, expertise, and commitment have been invaluable throughout this process, and we are deeply appreciative of the time and effort you have invested in nurturing our creativity and academic growth.

Your encouragement has inspired us to explore new ideas, express ourselves creatively, and engage in meaningful discourse. Your feedback and mentorship have not only enhanced the quality of our work but have also empowered us to develop our skills and pursue excellence in our endeavors.

The publication of this magazine stands as a testament to the collaborative spirit and collective talent within our academic community. It serves as a platform for showcasing our diverse perspectives, intellectual curiosity, and passion for learning. Through articles, artwork, poetry, and more, we have captured the essence of our academic journey and shared it with our peers and beyond.

As we celebrate the publication of this magazine, we are reminded of the profound influence you have had on our lives. Your dedication to our education extends far beyond the classroom, and we are deeply grateful for the positive impact you continue to make on our academic journey.

Thank you once again for your unwavering support, encouragement, and guidance. We are honored to have had the opportunity to work alongside such dedicated and inspiring educators.

From,

the student community of

Dept. of Chemistry

Editor's Corner

I am deeply grateful for the opportunity to serve as the editor of this esteemed magazine for the past 3 years.

Esha Paut

Ex-student

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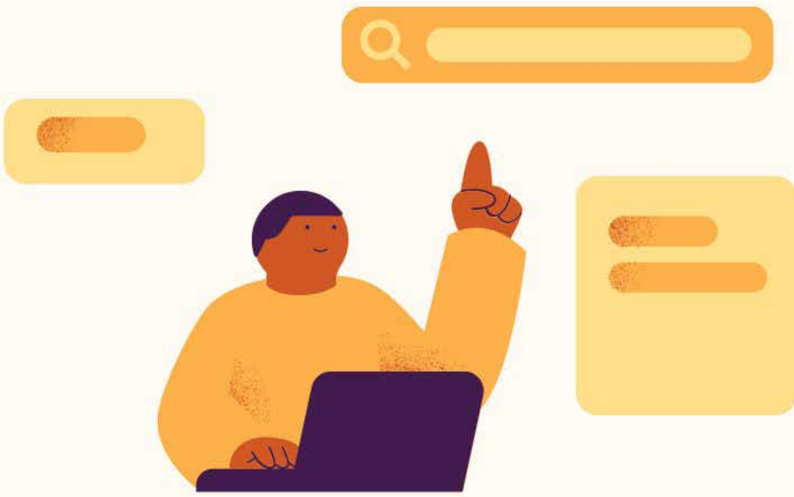


ATOMIC ORBITAL

Atomic orbitals are mathematical functions that provide insight into the wave nature of electrons (or pairs of electrons) that exist around the nuclei of atoms. In the fields of quantum mechanics and atomic theory, these mathematical functions are often employed in order to determine the probability of finding an electron (belonging to an atom) in a specific region around the nucleus of the atom.

Schrodinger equation in cartesian coordinates :

$$\frac{d^2\psi}{dx^2}+\frac{d^2\psi}{dy^2}+\frac{d^2\psi}{dz^2}+\frac{8\pi^2 m}{h^2}(E-V)\psi=0$$

Change into polar coordinates in can be written as :

$$\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial\psi}{\partial r}\right)+\frac{1}{r^2\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\frac{\partial\psi}{\partial\theta}\right)+\frac{1}{r^2\sin^2\theta}\frac{\partial^2\psi}{\partial\phi^2}+\frac{2\mu}{h^2}(E-V)\psi=0$$

Radial Function : From the of the Schrodinger equation, the solution R(r) is governed by the quantum numbers n and l. this is called the radial function .

Radial Distribution Function : The probability of finding electrons from the radial distance from the nucleus is called radial distribution function .

Orbit	Orbital
The concept of nodes is not defined	Idea of nodes is defined
Circular in shape	It has different shapes

ATOMIC ORBITALS

We know that the solution of the Schroodinger's wave equation $\psi_{nlm}(r,\theta,\phi)$ has two parts —

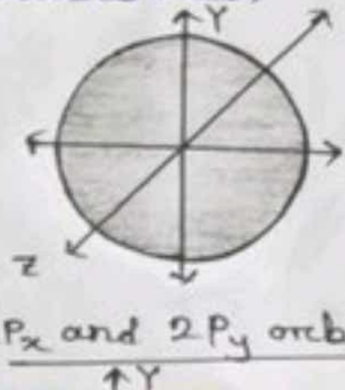
$$\psi_{nlm}(r,\theta,\phi) = \underbrace{R_{nl}(r)}_{\text{Radial}} \times \underbrace{Y_{lm}(\theta,\phi)}_{\text{Angular}}$$

For Hydrogen atom,

n	l	m	orbital	$\Theta(\theta)$	$\Phi(\phi)$	$Y_{lm}(\theta,\phi)$
1	0	0	1s	$\frac{1}{\sqrt{2}}$	$\frac{1}{\sqrt{2\pi}}$	$\frac{1}{\sqrt{4\pi}}$
2	0	0	2s	$\frac{1}{\sqrt{2}}$	$\frac{1}{\sqrt{2\pi}}$	$1/\sqrt{4\pi}$
2	1	0	$2P_z$	$\frac{\sqrt{6}}{2}\cos\theta$	$1/\sqrt{2\pi}$	$\sqrt{3/4\pi}\cos\theta$
2	1	+1	$2P_x$	$\sqrt{3/2}\sin\theta$	$\frac{1}{\sqrt{2\pi}}e^{i\phi}$	$\sqrt{3/4\pi}\sin\theta\cos\phi$
2	1	-1	$2P_y$	$\sqrt{3/2}\sin\theta$	$\frac{1}{\sqrt{2\pi}}e^{-i\phi}$	$\sqrt{3/4\pi}\sin\theta\sin\phi$

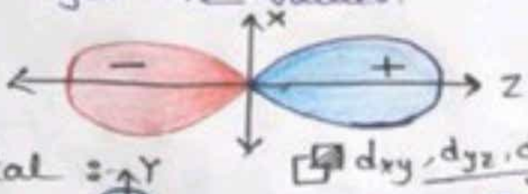
s-orbital :-

no θ or ϕ part is included. So,

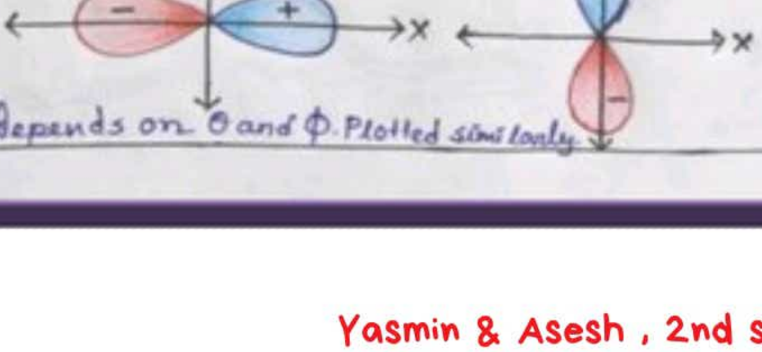


$2P_z$ orbital :-

Depends only on θ, and independent of ϕ. Putting $\theta = 0°-90°$ we get positive values and $\theta = 90°-180°$ we get -ve values.

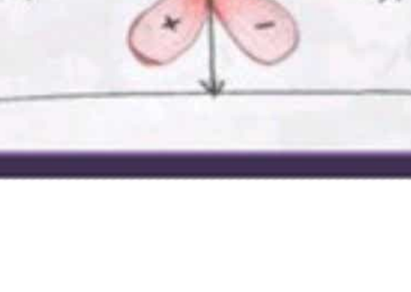


$2P_x$ and $2P_y$ orbital :-

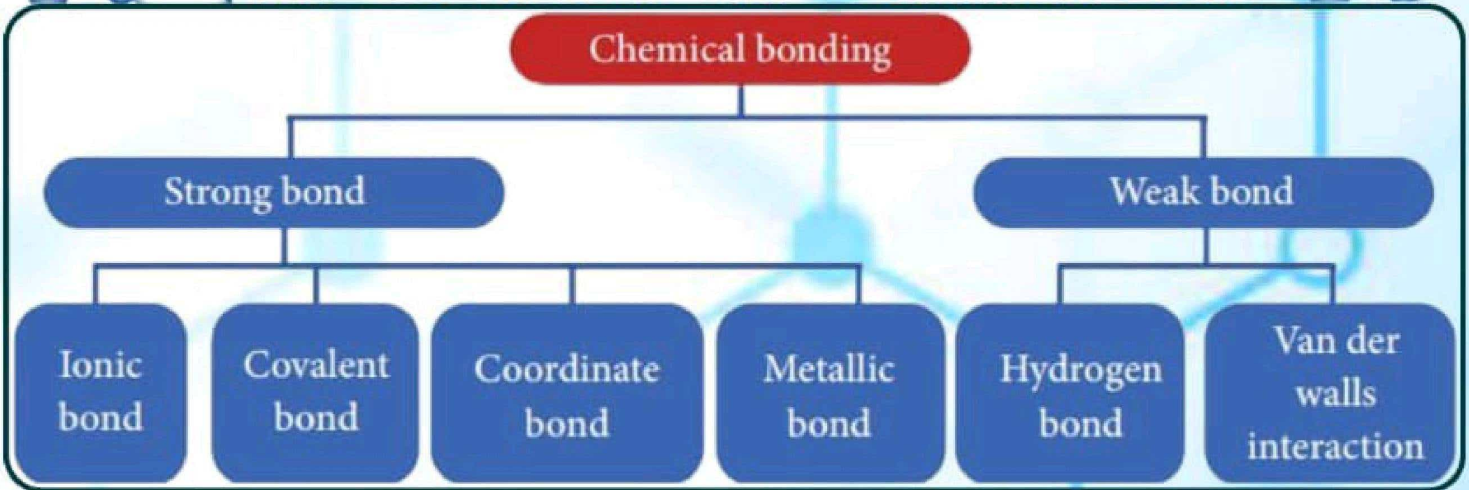


Depends on θ and ϕ. Plotted similarly.

d_{xy}, d_{yz}, d_{zx} (In between the axis)

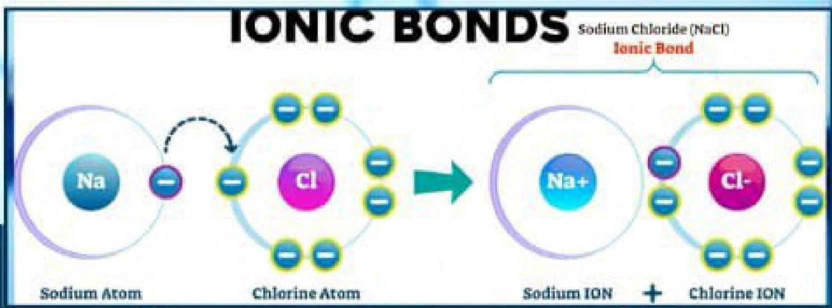


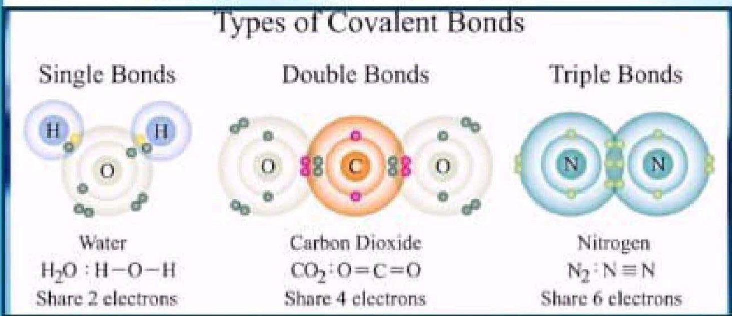
BONDING



HERE ARE SOME PICTURES OF ALL SIX TYPE OF BONDINGS

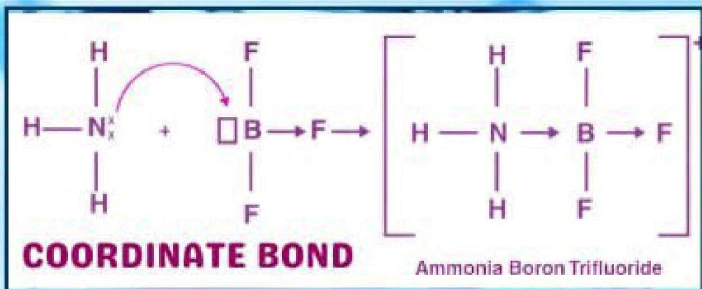
⦿ IONIC BOND ⦿ →

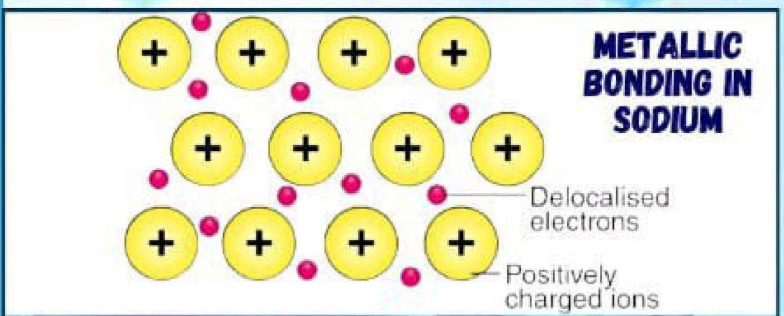




← ⦿ COVALENT BOND ⦿

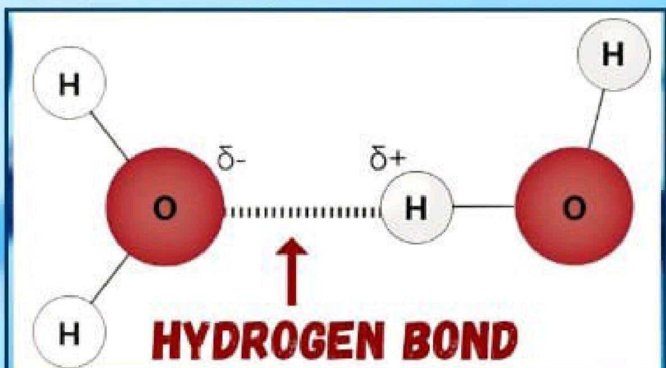
⦿ COORDINATE BOND ⦿ →

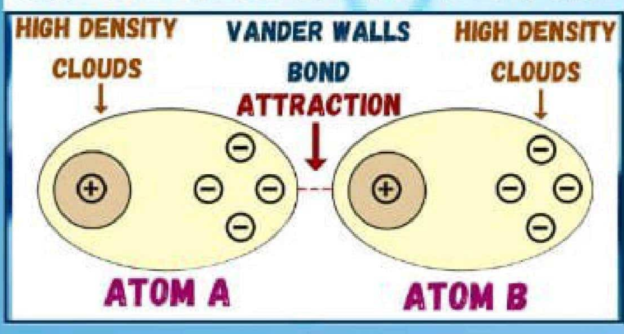




← ⦿ METALLIC BOND ⦿

⦿ HYDROGEN BOND ⦿ →





← ⦿ VANDER WALLS BOND ⦿

Some Points About Bonding

1. Ionic Bond ······>

Ionic bonding is a type of chemical bonding that involves electrostatic attraction between oppositely charged ions, or between two atoms with sharply different electronegatives, and is the primary interaction occurring in ionic Bond

2. Covalent Bond ·······>

A covalent bond is a chemical bond that involves the sharing of electrons to form electron pairs between atoms. These electron pairs are known as shared pairs or bonding pairs. The stable balance of attractive and repulsive forces between atoms, when they share electrons, is known as covalent bonding.[

3. Coordinate Bond ·······>

A coordinate Bond also known as a dative bond , or dipolar bond . It's a kind of two centre, two electron covalent bond in which the two electrons derive from the same atom

4. Metallic Bond ·······>

Metallic bonding is a type of chemical bonding that arises from the electrostatic attractive force between conduction electrons (in the form of an electron cloud of delocalized electrons) and positively charged metal ions

5. Hydrogen Bond ·······>

a hydrogen bond (or H-bond) is primarily an electrostatic force of attraction between a hydrogen (H) atom which is covalently bonded to a more electronegative "donor" atom or group (Dn), and another electronegative atom bearing a lone pair of electrons—the hydrogen bond acceptor (Ac). Such an interacting system is generally denoted Dn–H···Ac, where the solid line denotes a polar covalent bond, and the dotted or dashed line indicates the hydrogen bond

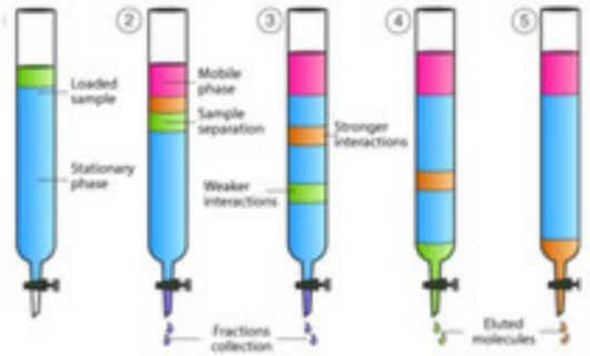
DESHUBA , DEBJIT & PALASH; 4TH SEM

CHROMATOGRAPHY

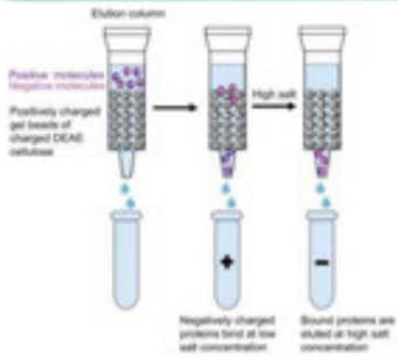
Chromatography is a process for separating components of a mixture. To get the process started, the mixture is dissolved in a substance called the mobile phase, which carries it through a second substance called the stationary phase.

Types of chromatography

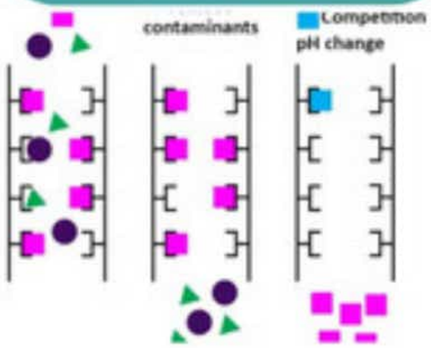
Column chromatography



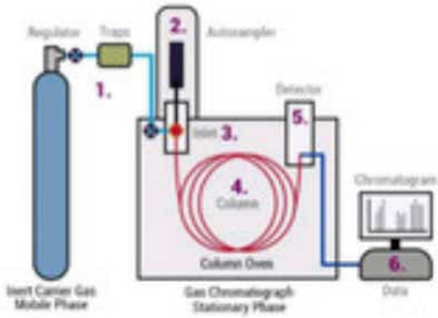
Ion exchange chromatography



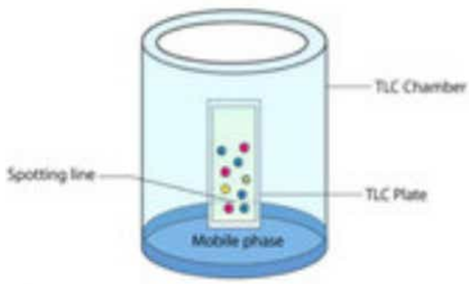
Affinity chromatography



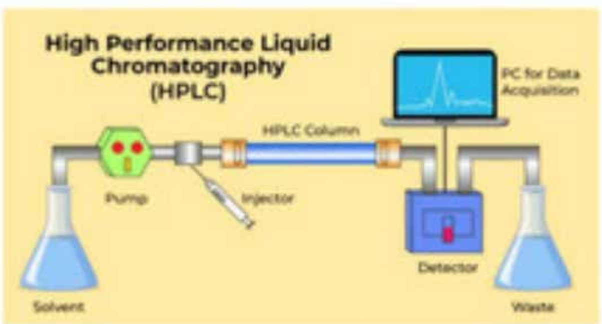
Gas chromatography



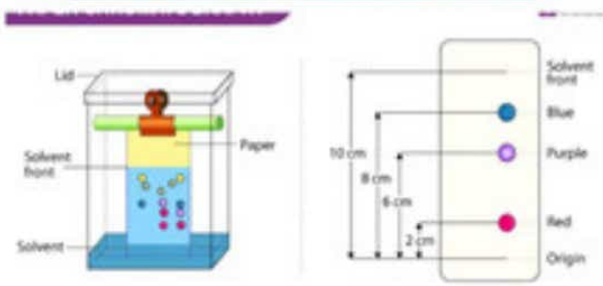
Thin layer chromatography



High-performance liquid chromatography



Paper chromatography



Column chromatography

Chromatography is based on the principle where molecules in mixture applied onto the surface or into the solid, and fluid stationary phase (stable phase) is separating from each other while moving with the aid of a mobile phase.

Ion exchange chromatography

The molecules separated on the basis of their charge are eluted using a solution of varying ionic strength. By passing such a solution through the column, highly selective separation of molecules according to their different charges takes place.

Affinity chromatography

Affinity chromatography is a separation method based on a specific binding interaction between an immobilized ligand and its binding partner.

Gas chromatography

Gas chromatography (GC) is an analytical technique used to separate and detect the chemical components of a sample mixture to determine their presence or absence and/or quantities. These chemical components are usually organic molecules or gases.

High performance liquid chromatography(HPLC)

High Performance Liquid Chromatography (HPLC) is a process of separating components in a liquid mixture. A liquid sample is injected into a stream of solvent (mobile phase) flowing through a column packed with a separation medium (stationary phase).

Thin layer chromatography

Thin-layer chromatography (TLC) is a technique used to separate mixtures of compounds based on differences in polarity. In TLC, a glass plate coated with a stationary phase (typically silica gel) is spotted with the mixture to be separated.

Paper chromatography

Paper chromatography is mostly known as the type of partition chromatography technique. In the paper chromatography method, the stationary phase used is chromatography paper, which is suspended in a mixture of solvents and acts as a mobile phase.

APPLICATION

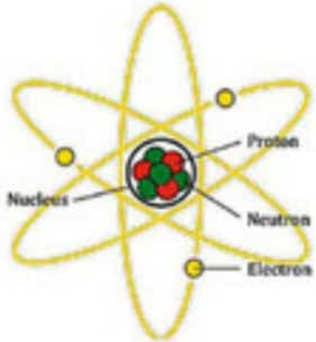
Pharmaceuticals, clinical trials, environmental and chemical safety, food and beverage, drug testing, forensics, petroleum creation, and molecular biology are some of the most common uses of chromatography.

Conclusion

In conclusion, paper chromatography is a useful analytical technique to separate mixtures of soluble substances. Understanding the principles of chromatography and relative affinity helps to interpret the results and identify the components in the mixture.

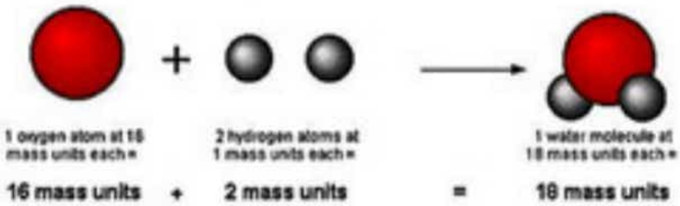
Ishita Haque, 6th Sem

DALTON'S ATOMIC THEORY



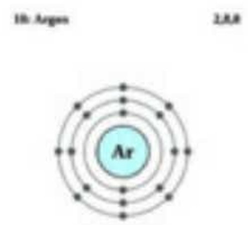
- Elements are made of extremely small particles called atoms.
- Atoms cannot be divided, created,or destroyed.
- Atoms of different elements combine in simple whole number ratio to form chemical compound.
- In chemical reactions, atoms are combined, separated or rearranged.

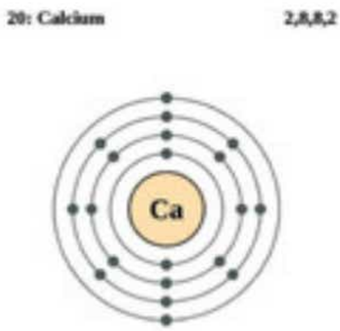
Limitations are-
It could not explain
1.law of chemical combination.
2. Law of gaseous volume.

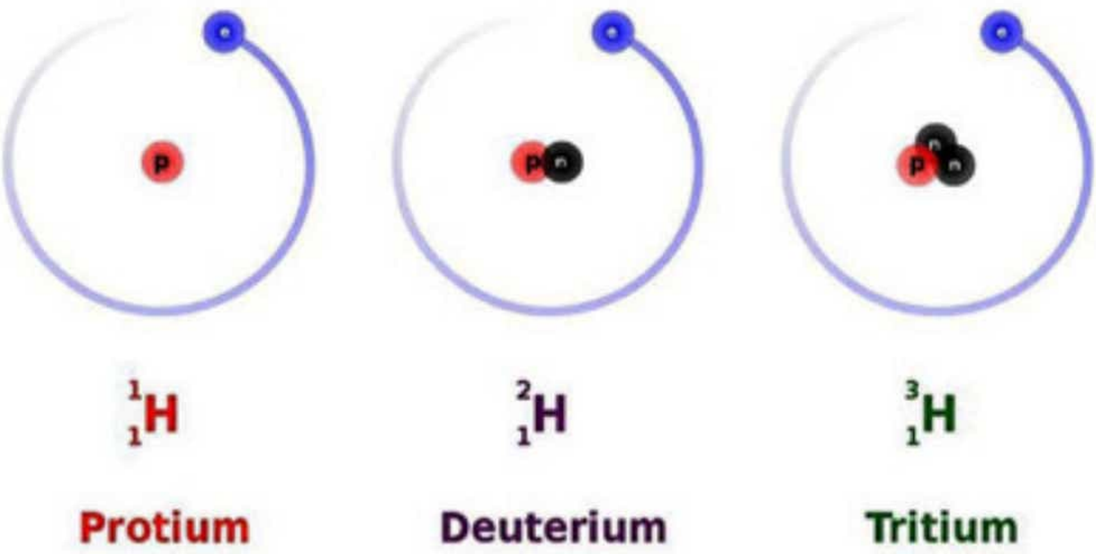


Dalton's compound

compounds in which the atoms of the elements are in simple whole number ratio, are called DALTON'S compound.







Hydrogen isotope

DALTON'S ATOMIC THEORY

Postulates

- All matters are made up of tiny, invisible particles called atoms.
- All atoms of a specific element are identical in mass, size, and other properties. However, atoms of different element exhibit different properties and vary in mass and size.
- Atoms can neither be created nor destroyed. Furthermore, atoms cannot be divided into smaller particles.
- Atoms of different elements can combine with each other in fixed whole-number ratios in order to form compounds.
- Atoms can be rearranged, combined, or separated in chemical reactions.

Limitations

- It does not account of subatomic particles.
- It does not account for isobars.
- Elements need not combine in simple, whole-number ratios to form compounds.

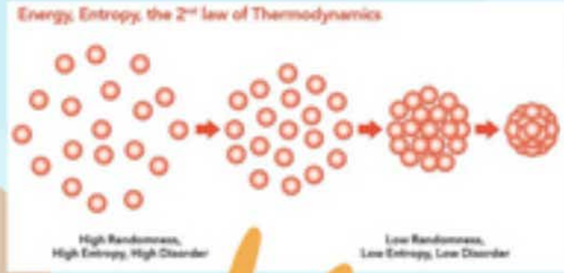
Yasmin & Asesh , 2nd sem

ENTROPY

Entropy is a measure of disorder or randomness in a system. It quantifies the distribution of energy within a system and the number of possible arrangements of its constituent particles.

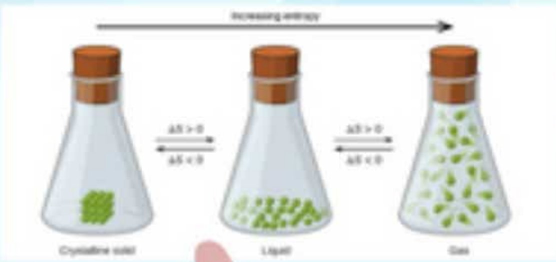
THERMODYNAMIC ENTROPY:

Originated in mid-19th century by Rudolf Clausius.
From Second Law of Thermodynamics: Entropy of an isolated system tends to increase over time.Represents the tendency of systems to move towards states of higher disorder



STATISTICAL MECHANICS:

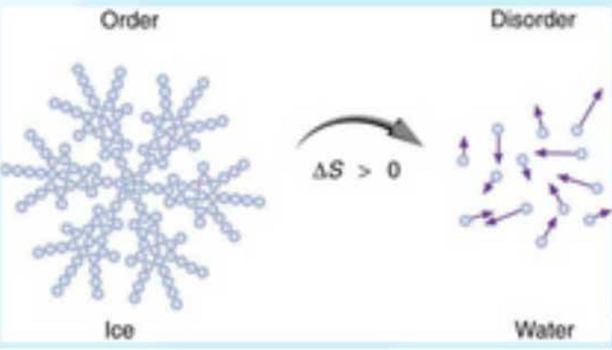
It Provides a microscopic understanding of entropy.It Relates entropy to the number of possible microscopic configurations of a system.It Connects microscopic behavior to macroscopic thermodynamic properties



APPLICATION:

Entropy is utilized to predict the spontaneity and direction of a chemical reaction. It helps in understanding the relationship between temperature, energy and Entropy changes in chemical systems.

It Provides insights into the behavior of complex systems in various fields like biology, ecology, and economics



CONCLUSION:

Entropy is a fundamental concept with wide-ranging applications across science and technology, providing insights into the behavior of physical systems and the transmission of information

Entropy

Entropy is a measure of disorder or randomness in a system.According to the second law of thermodynamics,it tends to increase in spontaneous processes.

Thermodynamic Entropy:From second law of thermodynamics,entropy of an isolated system tends to increase over time. It represents the tendency of systems to move towards states of higher disorder.

Statistical Mechanics:It provides a microscopic understanding of entropy and connects microscopic behaviour to macroscopic thermodynamic properties.

Application:Entropy has numerous applications across various fields.It helps in understanding processes such as heat transfer,energy conversion and spontaneous reactions,the relationships between temperature,energy.

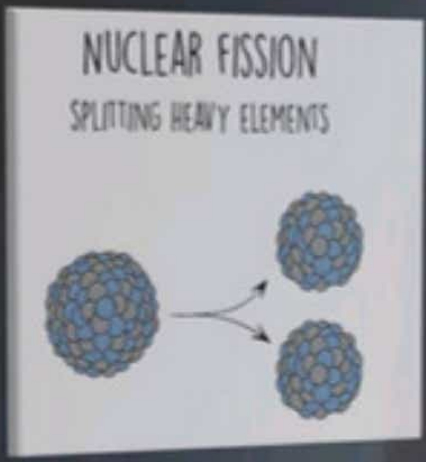
Conclusion: Entropy is a fundamental concept with wide-ranging applications across science and technology, providing insights into the behavior of physical systems and the transmission of information.

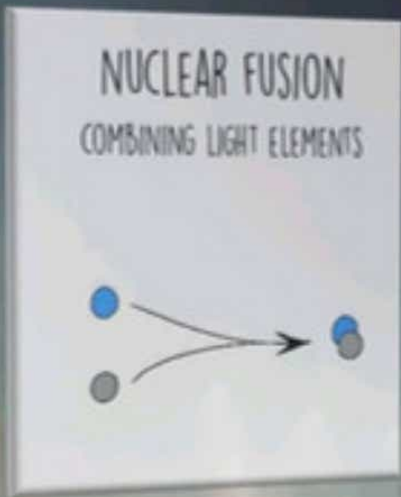
Adrita & Pallabita
4th sem

F Fission & Fusion

Fission involves the splitting of a large atomic nucleus into smaller particles.

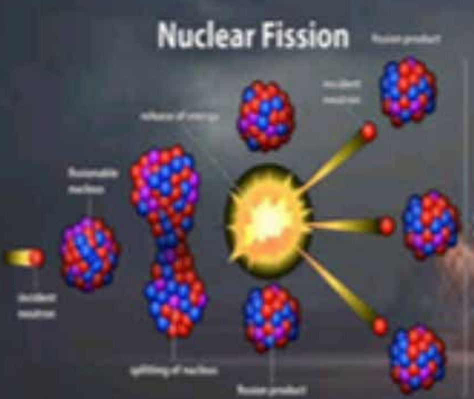
Fusion is the process where two light atomic nuclei combine to form a heavier nucleus.

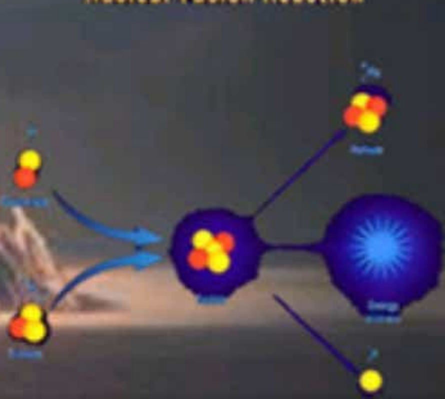




•**Applications** : Nuclear fission is primarily used in nuclear power plants to generate electricity. However, it also produces radioactive waste, which poses storage and contamination challenges.

Applications : Nuclear fusion is primarily used to generate electricity, and it has several advantages over fission reactors. Nuclear fusion is the process of combining two or more atomic nuclei, and it produces energy when some of the mass of the nuclei is transformed into energy





Fusion

$$^{1}_{0}n + ^{235}_{92}U \longrightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + 3^{1}_{0}n + Energy$$

Fusion

$$^{3}_{1}H + ^{2}_{1}H \longrightarrow ^{4}_{2}He + ^{1}_{0}n + Energy$$

Department Of Chemistry
BARASAT GOVERNMENT COLLEGE

FISSION & FUSION

NUCLEAR FISSION	TOPICS	NUCLEAR FUSION
Fission involves the splitting of a large atomic nucleus into smaller particles.	Definition	Fusion is the process where two light atomic nuclei combine to form a heavier nucleus.
A neutron collides with the nucleus of an atom, causing it to break apart into two or more smaller nuclei. This process releases a significant amount of energy.	Process	Fusion requires extremely high temperatures and pressures to overcome the electrostatic repulsion between the positively charged nuclei.
Fission reactions release vast amounts of energy due to the rearrangement of nucleons within the nucleus.	Energy Release	Fusion reactions also release tremendous energy, as predicted by Einstein's equation $E = mc^2$.
The primary by-products of fission are radioactive isotopes and energy.	By products	Fusion primarily produces heliumand energy. While fusion by-products are typically harmless, the release of neutrons can make other materials radioactive.

COMMONALITIES BETWEEN NUCLEAR FISSION AND FUSION:

Both processes release energy due to high-powered bonds between particles in the atomic nucleus. • Both involve changes in binding energy between nuclear particles. • Both can initiate chain reactions (amplifyingenergy release).

DIFFERENCES BETWEEN FISSION AND FUSION:

Nature of Reactions : Fission splits a large nucleus, while fusion combines lighter nuclei. • **Energy Requirements** : Fission can occur with little energy input, while fusion requires extreme conditions. • **By-products :** Fission produces radioactive waste, while fusion's by-products are typically less problematic. In summary, nuclear fission powers our current energy infrastructure, but fusion holds the promise of cleaner, more abundant energy

Shubhadip Paul & Sobhan Datta ,6th sem

What is Galvanic Cell?

A Galvanic cell or voltaic Cell named after lungi Galvani or Alessandro volta respectively ,is an electrochemical cell that derives electrical energy from chemical reactions taking place within the cell.

Parts of Galvanic Cell
Anode - Oxidation occurs at this electrode.
Cathode - Reduction occurs at this electrode.
Salt bridge - Contains electrolytes which are required to complete the circuit in a galvanic cell.
Half-cells - reduction and oxidation reactions are separated into compartments.
External circuit - Conducts the flow of electrons between electrodes

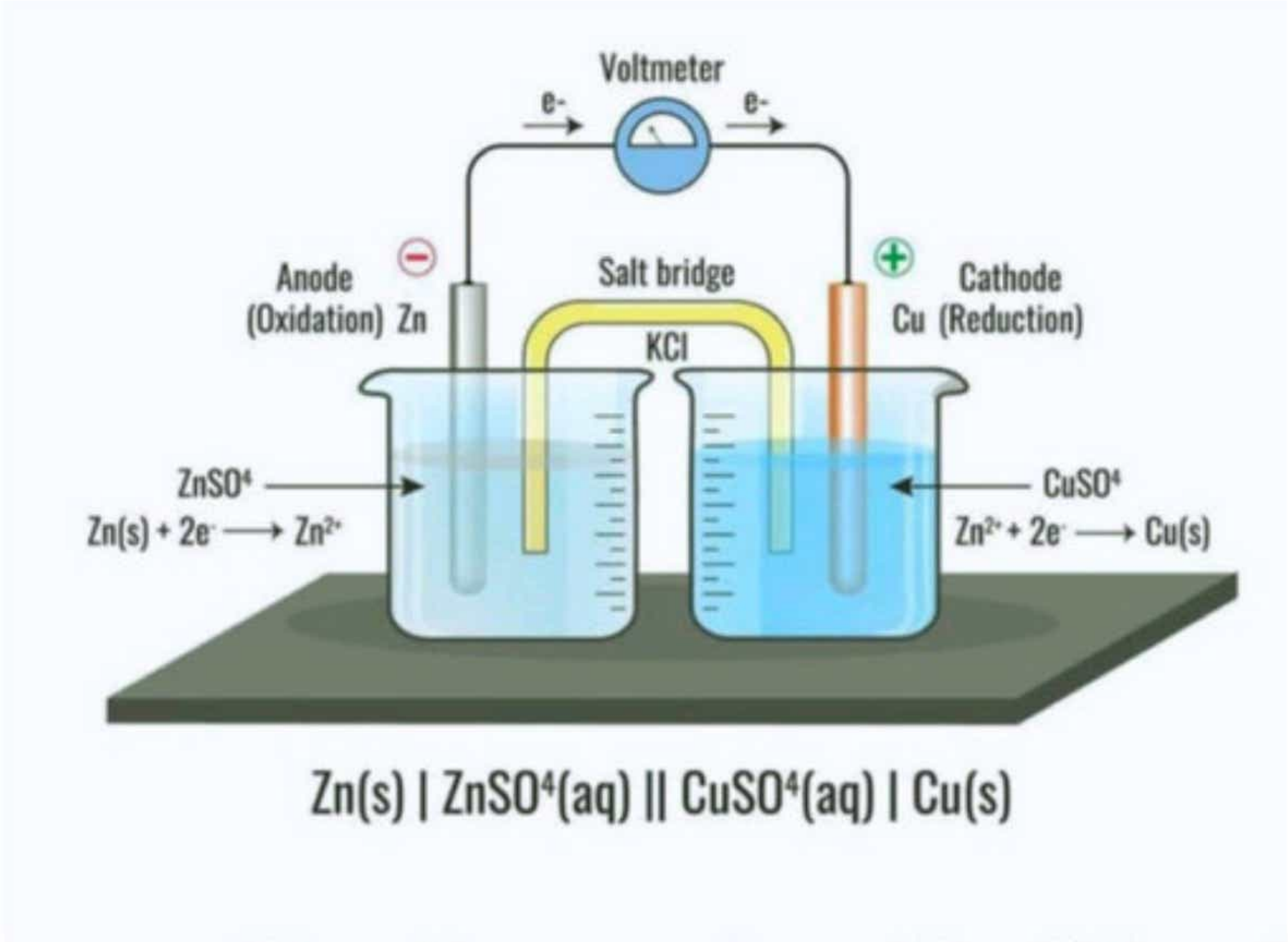
Luigi Galvani

Use of Galvanic Cell

1. They are commonly used as a source of electrical energy, such as in batteries.

2.They can also be used in electroplating, where one metal is coated with another metal using an electric current.

Example- Daniel Cell



Galvanic Cell

(The chemical Energy is converted to electrical energy)

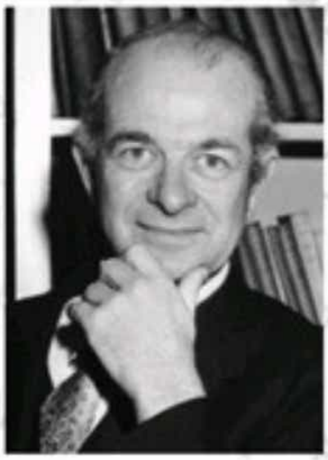
- ***Anode Is negative***
- ***Cathode is positive***
- ***At anode oxidation takes place and at cathode reduction takes place***
- ***Spontaneous reaction takes place***
- ***Flow of electrons from anode to cathode***
- ***Electrons leave the cell anode and enter the cell cathode and***
- ***generates electricity***

Trishanu , Sukanta , Ayush
2nd Sem

HYBRIDIZATION

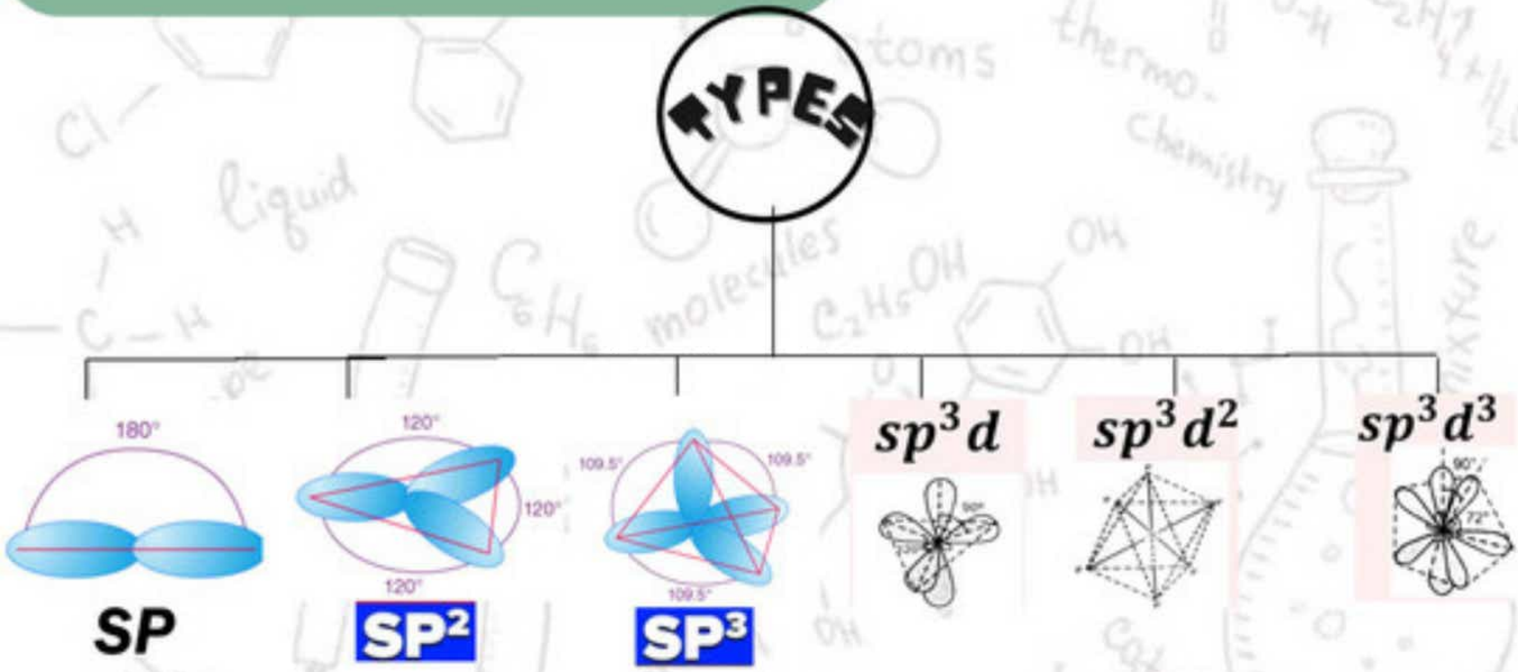
WHAT IS HYBRIDIZATION?

HYBRIDIZATION IS THE PROCESS OF COMBINING TWO OR MORE NON-EQUIVALENT ATOMIC ORBITALS WITH SIMILAR ENERGIES BUT DIFFERENT FORMS. THE PROCESS OF COMBINING TWO ATOMIC ORBITALS TO FORM A NEW TYPE OF HYBRIDIZED ORBITALS IS TERMED HYBRIDIZATION.



LINUS PAULING

FATHER OF HYBRIDIZATION (1931)



APPLICATION

HYBRIDISATION HELPS TO PREDICT THE SHAPE OF MOLECULES, PARTICULARLY IN ORGANIC CHEMISTRY. LINUS PAULING OBSERVED THAT ALL THE BOND ANGLES WERE ALL THE SAME IN A COMPOUND LIKE CARBON TETRACHLORIDE (CCl_4), EVEN THOUGH THE ELECTRONS CAME FROM BOTH 2S AND 2P ORBITALS.

HYBRIDIZATION(Z) = 0.5 * (NO. OF VALENCE ELECTRON OF CENTRAL ATOM) + (NO. OF MONOVALENT ATOMS SURROUNDING) - CHARGE ON CATION + CHARGE ON ANION

VALUE OF Z	HYBRIDIZATION	VALUE OF Z	HYBRIDIZATION
2	sp	5	sp^3d
3	sp^2	6	sp^3d^2
4	sp^3	7	sp^3d^3

A Brief Introduction On Hybridization

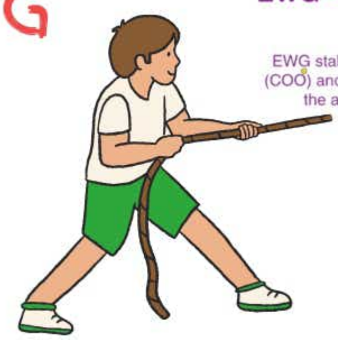
Hybridization is a fundamental concept in chemistry that helps describe the shapes, bonding, and reactivity of molecules. It arises from the need to explain certain molecular geometries that cannot be accounted for by simple atomic orbitals. By mixing atomic orbitals, hybrid orbitals are formed, each possessing characteristics of the original orbitals.Common types include sp, sp2, and sp3 hybridization, where s and p orbitals combine to form hybrid orbitals with distinct shapes and energies. These hybrid orbitals then participate in bonding with other atoms, leading to the formation of molecules with specific geometries and properties. Hybridization is crucial for understanding molecular structures and predicting how molecules interact in chemical reactions.

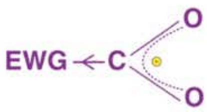
Rohini ,2nd sem

Inductive Effect

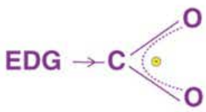
Transmission of charge through a chain of atoms by electrostatic induction

EWG





EWG stabilises the (COO) and increases the acidity



EDG stabilises the (COO) and decreases the acidity

EDG

Pulling: - I effect

Pushing: + I effect

Order of -I

$NR_3^+ > SR_2^+ > NH_3^+ > NO_2 > SO_2R > CN > SO_2Ar > COOH >$ $F > Cl > Br > I > OAr > COOR > OR > COR > SH > SR >$ $OH > C\equiv CR > AR > C=CR_2 >$

Order of +I

$-CH_2^- > -NH^- > -O^- > -C(=O)-O^- > -CMe_3 > -CHMe_2 >$ $-CH_2Me > -CH_3 > T > D > H >$

Inductive Effect

•The phenomena is described by partial shifting of sigma electrons towards more electronegative atom .

•This is a permanent effect, found in both saturated and unsaturated system.

•This effect is distance dependent.

•It depends on electro negetivity of atom.

•The C-H bond is considered as reference of the Inductive effect.

• Inductive effects are of two types~

+I effect

-I effect

•The group which donates electron cloud i.e Electron Donating Group exhibits +I effect.

•The group which withdraws electron cloud i.e Electron Withdrawing Group exhibits -I effect..

•Presence of –I group increases the acidic character.

•Presence of +I group increases the basic character.

•Carbocations are stabilized by +I effect.

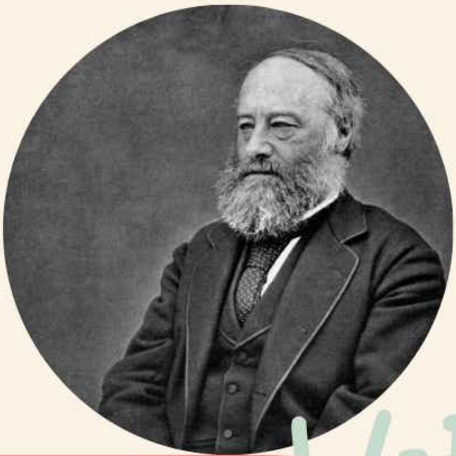
•+I groups increases the electron density at carbonyl carbon,their reactivity towards nucleophile decreases .

The relative reaction rates followed the order formaldehyde > acetaldehyde ≫ acetone.

Prerana Chowdhury

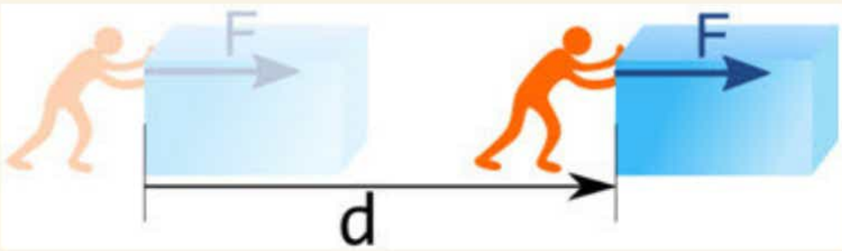
Ex -student

JOULES



"James Prescott Joule FRS FRSE (24 December 1818 – 11 October 1889) was an English physicist, mathematician and brewer, born in Salford, Lancashire. Joule studied the nature of heat, and discovered its relationship to mechanical work. This led to the law of conservation of energy, which in turn led to the development of the first law of thermodynamics. The SI derived unit of energy, the joule, is named after him."- Wikipedia

Defination~



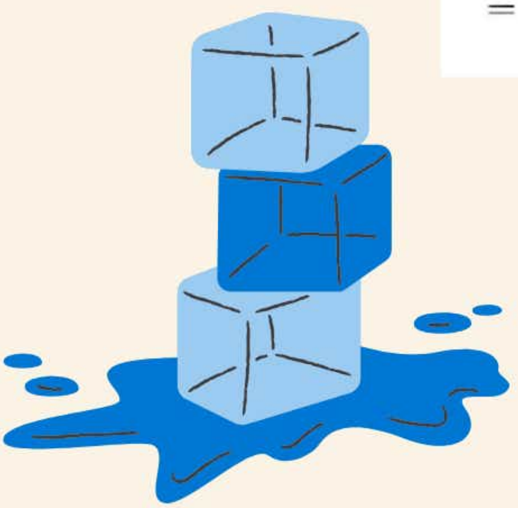
The amount of work done when a force of one newton displaces a mass through a distance of one metre in the direction of that force.

Relations~

$$J = \frac{kg \cdot m^2}{s^2} = N \cdot m = Pa \cdot m^3 = W \cdot s = C \cdot V$$

Symbol	Meaning
J	joule
kg	kilogram
m	metre
s	second
N	newton

Symbol	Meaning
Pa	pascal
W	watt
C	coulomb
V	volt



JOULE

INTRODUCTION: Joule, or j for short, are a unit of measurement used to measure energy, in the international system of units (SI). This unit is named after James Prescott Joule, a renowned British physicist who made significant contributions to the field of thermodynamics.

DEFINATION: The joule, a unit of measurement that holds great significance in the world of science, is defined as the amount of work achieved by a force of one newton over a distance of one meter in the same direction as the force. In simpler terms, one joule is equivalent to the amount of work done when a force of one newton is exerted over a distance of one meter in the same direction as the force.

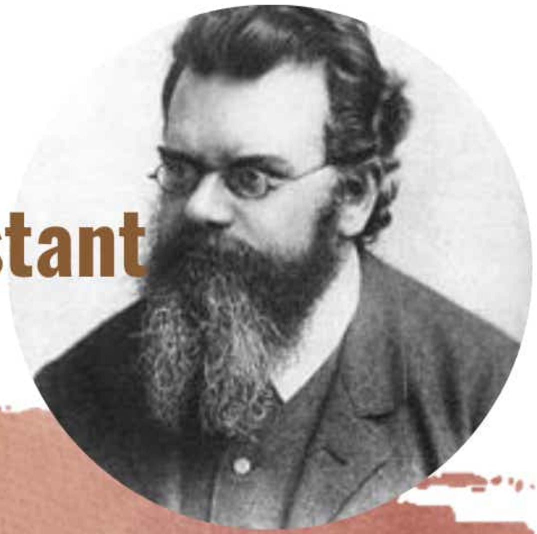
MEASUREMENT: Joule is versatile and can be used to measure different forms of energy, including mechanical, thermal, electrical, and chemical energy. In terms of other units, one joule is equivalent to 1 kilogram meter squared per second squared (1 kg m^2/s^2) or 0.239 calories. This relationship to other units further solidifies the importance of joules in the scientific community.

APPLICATION: The applications of joule are vast and varied, being utilized in fields such as physics, chemistry, engineering, and even in our daily lives. They play a crucial role in measuring energy consumption, production, and transfer. Whether it's in the study of mechanics, thermodynamics, electricity, or nutrition, joules are an integral part of understanding and measuring energy in different contexts. In everyday usage, joules are commonly used to measure energy consumption, production, and transfer in various systems, ranging from electrical circuits to human metabolism. This unit is widely used in fields such as physics and engineering, as well as in our daily lives.

CONCLUSION: In conclusion, joule is a crucial unit of measurement that helps us comprehend and measure energy in its various forms. Without this unit, our understanding of energy and its impact on our world would be incomplete.

Aritra Saha
Ex -student

K Boltzmann Constant



The Boltzmann constant is named after its 19th century Austrian discoverer, Ludwig Boltzmann. Although Boltzmann first linked entropy and probability in 1877, the relation was never expressed with a specific constant until Max Planck first introduced k, and gave a more precise value for it (1.346×10−23 J/K, about 2.5% lower than today's figure), in his derivation of the law of black-body radiation in 1900–1901.

Value:

1.3806452 × 10^-23 J/K

Equations using k:

•Kinetic theory combining with ideal gas law ~

$$k_B = \frac{PV}{TN}$$

k = Boltzmann Constant
T= Kelvin Temperature
P = Pressure , V = Volume
N = Number of gas molecules

• Statistical Thermodynamics ~

$$S = k \ln W$$

k = Boltzmann Constant
S = Entropy
W = Thermodynamic Probability

•Average translation kinetic energy~

$$\frac{1}{2} m\overline{v^2} = \frac{3}{2} kT.$$

k = Boltzmann Constant
T= Kelvin Temperature
m = mass
v = rms velocity

Boltzmann Constant

DEFINATION AND VALUE: The Boltzmann constant, also known as k, is a crucial constant in the world of physics. It links the average energy of particles in a gas to the temperature of the gas. This significant constant was named after the brilliant Austrian physicist, Ludwig Boltzmann and is commonly denoted by the symbol k. In the International System of Units (SI), the Boltzmann constant has a value of approximately 1.380649 × 10^-23 joules per kelvin (J/K).

APPLICATIONS:: The Boltzmann constant has a wide range of applications in various fields of science and engineering, making it a fundamental constant in the scientific world. Here are some notable examples:

Thermodynamics: When it comes to understanding the relationship between heat, work, temperature, and energy, the Boltzmann constant is an essential factor in thermodynamics. It appears in equations such as the ideal gas law, entropy calculations, and the Maxwell-Boltzmann distribution, which explains the statistical distribution of particle speeds in a gas.

Statistical Mechanics: In the realm of statistical mechanics, the Boltzmann constant serves as a bridge between the macroscopic properties of a system, like pressure and temperature, and the microscopic behaviour of its individual particles. It plays a crucial role in formulations such as the Boltzmann distribution, which describes the probability distribution of particles among different energy states in a system.

Material Science: The Boltzmann constant is also heavily utilized in material science, particularly in calculations related to the thermal properties of materials. It helps in understanding how thermal energy impacts the behaviour and characteristics of materials, such as specific heat capacity, thermal conductivity, and diffusion coefficients.

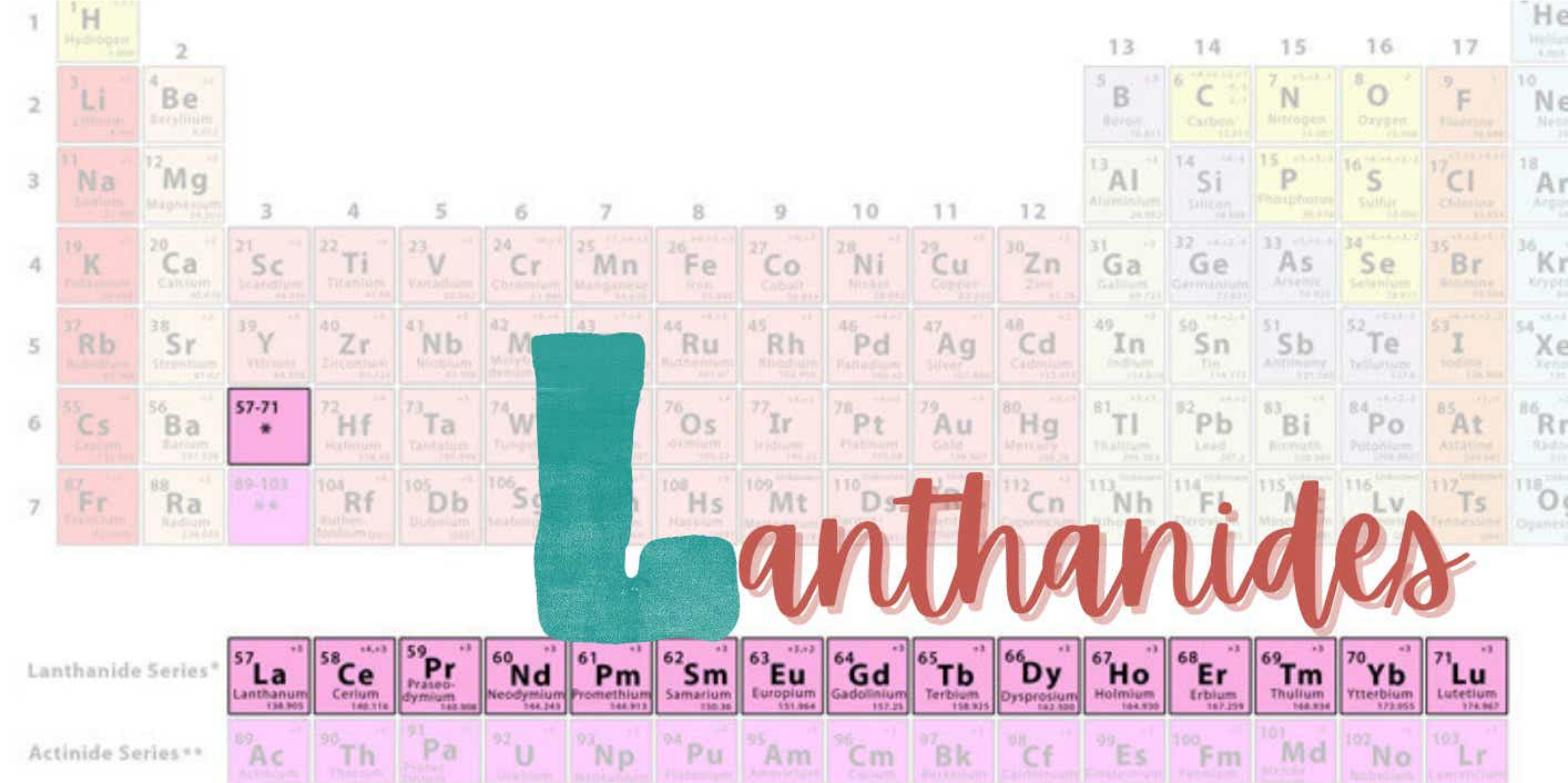
Semiconductor Physics: In the field of semiconductor physics, the Boltzmann constant is a crucial factor in comprehending the behaviour of charge carriers, such as electrons and holes, in materials. It appears in equations that describe carrier concentration, mobility, and conductivity in semiconductors.

Metrology and Standards: In the field of temperature measurement and definition of temperature scales, the Boltzmann constant serves as a crucial reference point. Its precise determination is essential in establishing standards for thermometry and ensuring consistency in scientific measurements worldwide.

Overall, the Boltzmann constant holds significant importance as a fundamental parameter across various scientific disciplines, including physics, chemistry, and engineering. Its applications are far‐reaching and diverse.

Aritra Saha
Ex -student

Lanthanides



The lanthanide or lanthanoid series of chemical elements comprises the 14 metallic chemical elements with atomic numbers 57–70, from lanthanum through ytterbium.

General Electronic Configuration:

$$[Xe]\ 4f^{(1-14)}\ 5d^{(0-1)}\ 6s^{2}$$

LANTHANOIDS

In periodic table, f-block consists of lanthanoid series of chemical elements comprises at least the 14 metallic chemical elements with atomic numbers 57–71, from lanthanum(La) to lutetium(Lu) (because lanthanum closely resembles the lanthanoids).

ELECTRONIC CONFIGURATION:
lanthanoids having an electronic configuration [Xe] 4f(1-14) 5d(0-1) $6S^2$.

ATOMIC AND IONIC SIZES: The overall decrease in atomic and ionic radii from La to Lu is unique feature in the chemistry of lanthanoids. With the increase in atomic number, electron goes into 4f orbital. The shielding of one 4f electron by another is less than d electron by another resulting into the increase in nuclear charge, as a consequence of that size decreases in regular manner, this is known as Lanthanoid Contraction.

OXIDATION STATE: In the lanthanoids, La(II) and Ln(III) compounds are predominant species. However occassionally +2 and +4 ions in solution or in solid compounds are also obtained. This irregularity arises mainly from the stability of emty,half filled or filled f subshell.

GENERAL CHARACTERISTICS: All the lanthanoids are silvery white soft metals and tarnish rapidly in air.The hardness increases with increasing atomic number. Their melting points range between 1000 to 1200 K. They have typical metallic structure and are good conductors of heat and electricity.

SUMITA DUTTA
Ex -student

MOLE IN CHEMISTRY

What is a mole?

One mole is the amount of a substance that contains exactly 6.022×10^{23} atoms, molecules, ions. This number is known as AVOGADRO NUMBER

Mole Day!

23rd October

6.022×10^{23}

6.02am-6.02pm

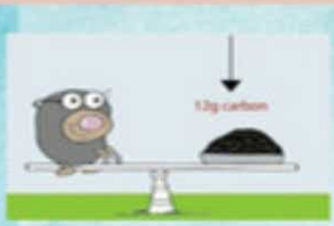
$= 6.022 \times 10^{23}$

LORENZO R.A.C AVOGADRO (1776–1856) ITALIAN SCIENTIST

1 MOLE CARBON = 6.022×10^{23} CARBON ATOMS

Why we use moles?

We use gm, kg etc. to measure things in our daily life. But chemistry deals with "microscopic particles" like atoms and molecules , and to measure them we use 'mole' as a unit.



How we calculate mole?

$$\text{Mole no.} = \frac{\text{Mass of the given sample}}{\text{Molar mass of the sample}}$$

WHAT IS MOLAR MASS?

Mass of one mole substance in grams

1 mole = Molar mass

1 mole= 22.4 litres of ideal gas at NTP

LET'S DISCUSS SOME IMPORTANT FACTORS!

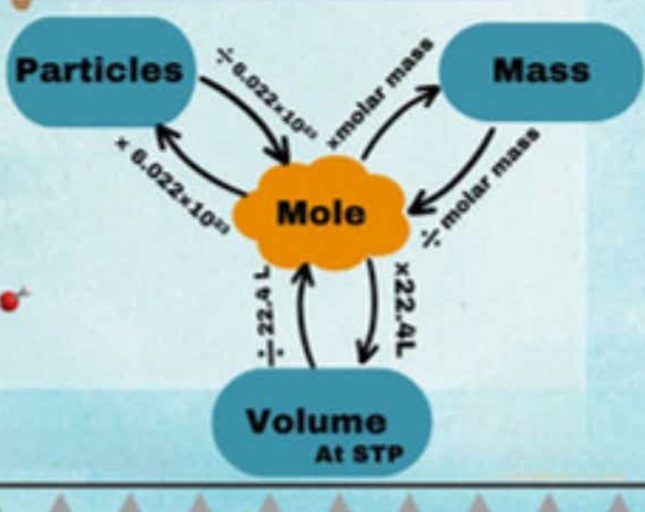
$$\text{Molarity} = \frac{\text{No.of moles of solute}}{\text{Vol of solution (in L)}}$$

$$\text{Molality} = \frac{\text{No.of moles of solute}}{\text{Mass of solvent (in kg)}}$$

$$\text{Normality} = \frac{\text{No. of gram equivalent of solute}}{\text{Vol of solution (in L)}}$$

Mole symbol ⟶ mol

LET'S SEE IT WITH A DIAGRAM!



MOLE CONCEPT

Atoms and molecules are extremely small in size. Number of atoms and molecules in even a small amount of any substance is really very large. To handle such large numbers, a unit of similar magnitude is required.

In SI system, mole(symbol, mol) was introduced as seventh base quantity for the amount of substance.

Definition of mole :

One mole is the amount of substance that contains as many as particles or entities as there are atoms in exactly 12g of the 12C isotope.

Determination of number of particles in 1 mole:

The mass of C12 atom was determined by mass spectrometer and found to be equal to 1.992648 × 10^(-23) g. Mass of 1 mole carbon weighs 12 g.
Therefore,the number of atoms = 12 g/mol ÷ 1.992648 × 10^(-23) g/atom
= 6.0221367 × 10^23 atoms/mol

The number of entities in 1 mol is known as 'AVOGADRO CONSTANT'.

NOTE: The mole of substance always contain the same number of entities, no matter what the substance may be.

Sumita Dutta
Ex -student

Nernst Equation

"One should avoid carrying out an experiment requiring more than 10 per cent accuracy."

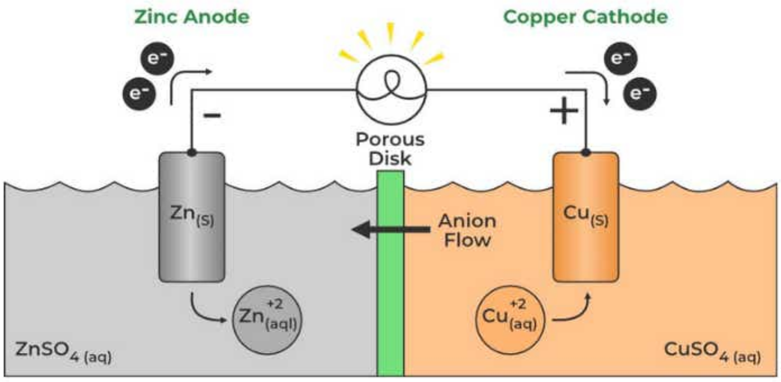
– Walther Hermann Nernst

[Quoted in W. Jost, '45 Years of Physical Chemistry in Germany', Annual Review of Physical Chemistry (1966), 17, 9]

$$E_{\text{cell}} = E^{\circ}_{\text{cell}} - \frac{RT}{nF} \ln Q$$

E: Reduction Potential
E^0: Standard Potential
R: Universal Gas Constant
n : moles of ē

T : Temperature
F :Faraday's Constant
Q : Reaction Quotient



Equilibrium constant from Nernst Eq:

$$E_{(\text{cell})} = 0 = E^{\circ}_{(\text{cell})} + \frac{0.059}{n} \log \frac{[Cu^{2+}]}{[Zn^{2+}]}$$

$$E^{\circ}_{(\text{cell})} = -\frac{0.059}{n} \log \frac{[Cu^{2+}]}{[Zn^{2+}]}$$

or

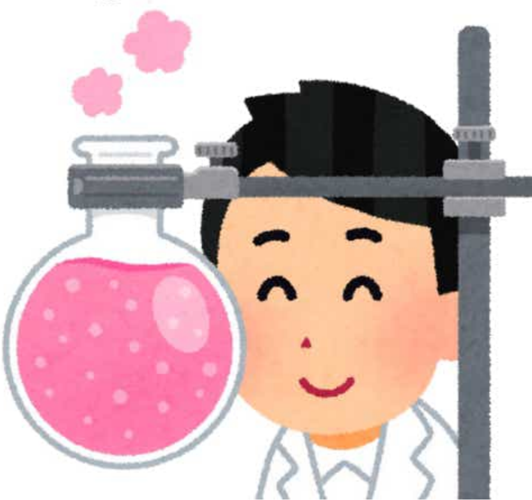
$$E^{\circ}_{(\text{cell})} = \frac{0.059}{n} \log \frac{[Zn^{2+}]}{[Cu^{2+}]}$$

But, at equilibrium

$$\frac{[Zn^{2+}]}{[Cu^{2+}]} = K_c$$

or

$$E^{\circ}_{(\text{cell})} = \frac{2.303\,RT}{nF} \log K_c$$



Nernst Equation

INTRODUCTION: The Nernst equation, which was coined by the renowned German chemist Walther Nernst, is an essential equation in the field of electrochemistry. It delves into the connection between the levels of substances participating in a redox reaction and the voltage of an electrochemical cell, particularly under non-standard circumstances. This equation is pivotal in comprehending and foretelling the performance of electrochemical cells in real-world scenarios.

APPLICATION: The Nernst equation is widely used in many fields, especially in electrochemistry. It has a variety of important applications:~

Electrochemical Cells: The Nernst equation is essential in predicting the cell potential of electrochemical cells when conditions are not standard. This is crucial for understanding how batteries, fuel cells, electrolysis cells, and other electrochemical systems behave in real-life situations where the concentration of reactants may vary.

Biosensors: Biosensors rely on electrochemical reactions to detect and measure biological substances. The Nernst equation is used to relate the concentration of the target substance to the electrical signal produced by the biosensor. This allows for accurate measurement of biomolecules like glucose, cholesterol, and enzymes for medical diagnoses, environmental monitoring, and food safety.

Corrosion Studies: In the field of corrosion science and engineering, the Nernst equation is a valuable tool for analysing and predicting the corrosion potential of metals and alloys in corrosive environments. By taking into account factors like pH, temperature, and concentration gradients, researchers can assess the likelihood and rate of corrosion and develop strategies to prevent and control it.

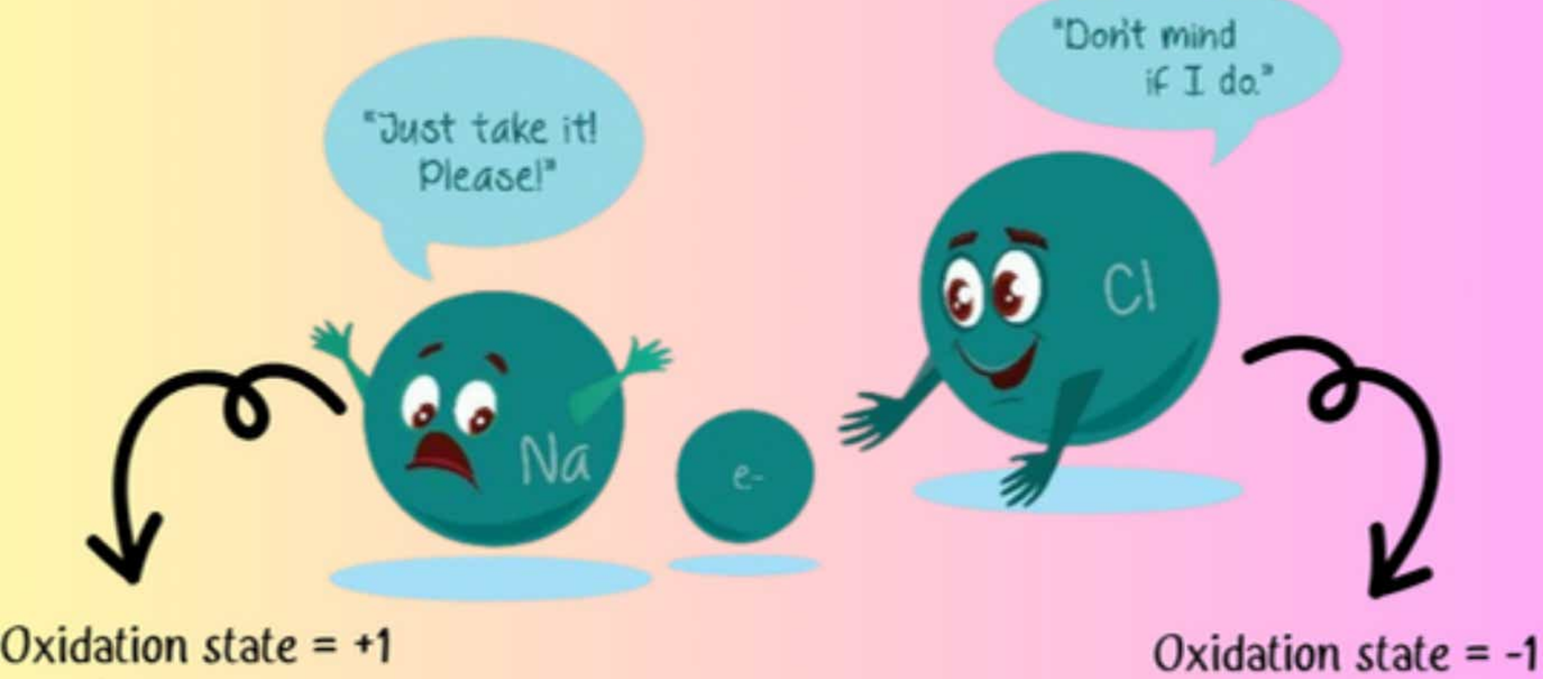
pH Measurements: pH meters use electrochemical cells to measure the acidity or alkalinity of solutions. The Nernst equation is applied to determine the pH of the solution based on the measured potential difference. This enables precise and accurate pH readings in areas such as chemistry, biology, environmental science, and industry.

Overall, the Nernst equation serves as a fundamental tool in electrochemistry and related disciplines, enabling the quantitative analysis of electrochemical processes and their applications in various scientific, industrial, and environmental contexts.

Aritra Saha
Ex -student

OXIDATION STATE

The concept of oxidation state or oxidation number is used to describe the electron gain or loss of an element in a chemical compound. This measurementreflects the level of oxidation of an atom within the compound.



Importance of oxidation state

- Chemical equations
- Balancing equations
- Electron bookkeeping
- Determining chemical properties

Determining the oxidation state of an atom in a compound can sometimes be a bit tricky especially when dealing with more complex molecules or polyatomic ions.

Rima Biswas, 6th sem

Oxidation State

INTRODUCTION: The concept of oxidation state, or oxidation number, is used to describe the electron gain or loss of an element in a chemical compound. This measurement reflects the level of oxidation of an atom within the compound. To represent oxidation state, a signed integer is used, where positive numbers signify electron loss (oxidation) and negative numbers signify electron gain (reduction). In certain situations, the oxidation state may even be a fractional value. For example: • In NaCl (sodium chloride), sodium has an oxidation state of +1, while chlorine has an oxidation state of -1.Determining the oxidation state of an atom in a compound can sometimes be a bit tricky, especially when dealing with more complex molecules or polyatomic ions. It's not always a straightforward process like in simple ionic compounds. In these cases, having a good understanding of chemical bonding and electron distribution is key.

IMPORTANCE: The idea of oxidation state is crucial in various aspects of chemistry and has many important implications: **Chemical Reactions:** Understanding oxidation states helps in predicting and comprehending chemical reactions. Reactions that involve the exchange of electrons, like redox reactions, are fundamental in chemistry. By monitoring changes in oxidation states, chemists can identify which substances are being oxidized and which are being reduced. **Balancing Equations:** When balancing chemical equations, knowledge of oxidation states is crucial. Balancing redox equations requires ensuring that the total increase in oxidation state (oxidation) equals the total decrease in oxidation state (reduction). **Electron Bookkeeping:** Oxidation states provide a convenient way to keep track of electron transfers in complex molecules. They allow chemists to understand how electrons are distributed within a compound and how they contribute to its chemical properties. **Determining Chemical Properties:** Oxidation states greatly influence the chemical behaviour and properties of elements and compounds. For example, transition metals can exhibit multiple oxidation states, resulting in a variety of compounds with different colours, reactivities, and magnetic properties.

Aritra Saha
Ex -student

PERIODIC TABLE

Group ▸ / Period ▾	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18 (*Noble gases*)
Nonmetals 1	1 H																		2 He
Metals 2	3 Li	4 Be												5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg												13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca		21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr		39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	La to Yb	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	Ac to No	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
	s-block (incl. He)		f-block	d-block										p-block (excl. He)					

Transition metals (sometimes excl. group 12)

Some elements near the dashed staircase are sometimes called *metalloids*

Lanthanides	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb
Actinides	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No

John Dalton's atomic theory in the early 19th century pavedthe way for understanding elements as the fundamental building blocks of matter.

In 1864, **John Newlands** an English chemist proposed the Law of Octaves.

In 1869, **Dimitri Mendeleev** an Russian chemist arranged the elements in order of increasing atomic weight and grouped them based on similar properties

In 1913, **Henry Moseley** found that their properties were more closely linked totheir atomic number.

The Periodic table is controlled by the International Union of Pure Applied Chemistry, IUPAC.

Over 99% of the observable universe is made up of hydrogen and helium.

Hydrogen (H) is the first element and oganesson (Og) is the last element.

RIMA BISWAS, 6TH SEM

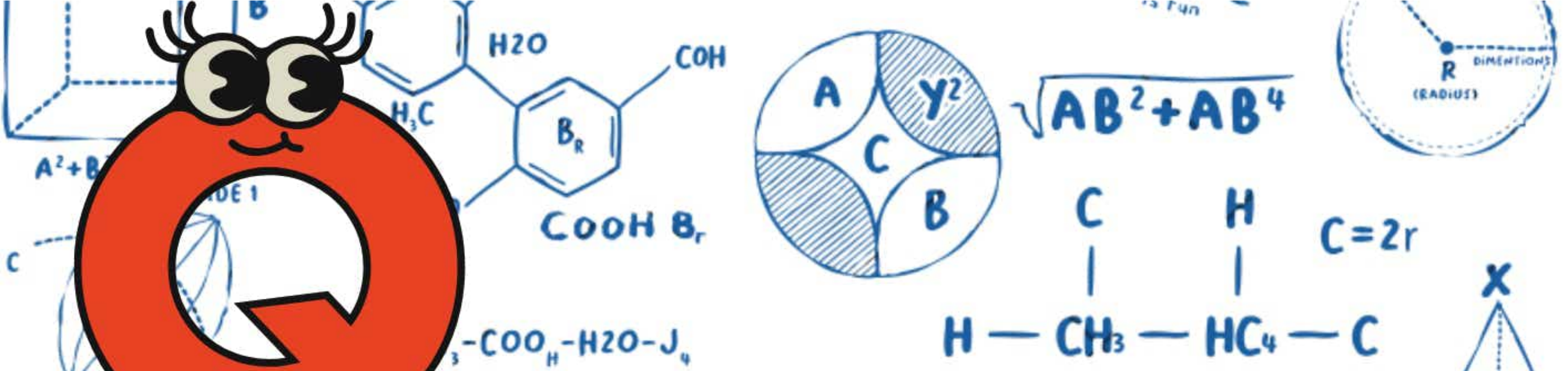
Periodic Table

The periodic table is a tabular arrangement of chemical elements, organized based on their atomic number, electron configuration, and recurring chemical properties.

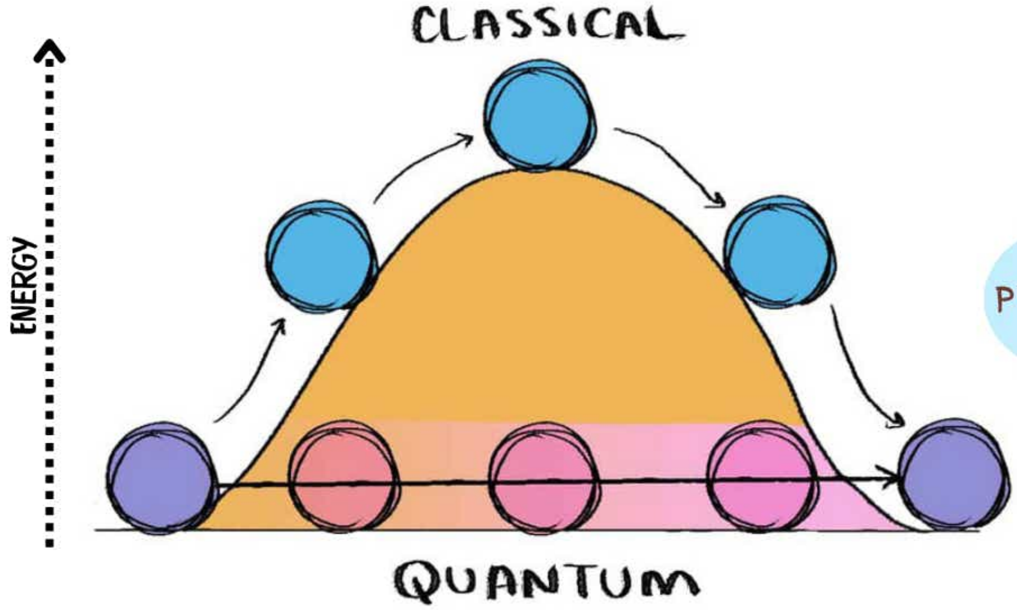
Properties of Periodic table:

CONSTRUCTION: - The table itself is divided into horizontal rows, called periods, and vertical columns, called groups. In total, there are 7 periods and 18 groups in the modern periodic table. It's a neat and organized way to categorize the elements. **PERIODICITY**: - One of the most interesting aspects of the periodic table is its periodicity. This refers to the recurring patterns in properties of elements as you move across a period or down a group. Think of it like a ripple effect caused by differences in electron configuration and atomic structure. **MAIN GROUPS AND TRANSITION METALS:** - Now, let's talk about the main groups and transition metals. The main groups include elements in groups 1, 2, and 13-18, while the transition metals are located in the middle (groups 3-12). It's common to refer to the main groups by the number of valence electrons they have. For example, Group 1 elements have 1 valence electron. It's a simple yet effective way to distinguish between the different groups. The periodic table is a crucial tool for comprehending the characteristics and actions of chemical elements. It is divided into distinct groups, with representative elements (groups 1, 2, and 13-18) and transition elements (groups 3-12) being the main divisions. Transition elements are known for their filling of inner d orbitals. **METALLOIDS**: - Additionally, there are metalloids, which fall along the diagonal line between metals and nonmetals on the periodic table. These elements possess properties that lie between those of metals and nonmetals. **NOBLE GASES**: - In group 18, we find the noble gases. These elements have complete valence electron shells and are chemically inert, hence the historical term "inert gases." **LANTHANIDES AND ACTINIDES**: - At the bottom of the periodic table, we have the lanthanides and actinides. These two series of elements are often depicted separately to save space, appearing as two rows below the main body of the table. **PERIODIC LAW**: - The modern periodic table is based on the groundbreaking work of Dmitri Mendeleev and his periodic law. This law states that the properties of elements are a periodic function of their atomic masses. It was Mendeleev who first created the widely accepted periodic table in 1869.

Aritra Saha
Ex -student



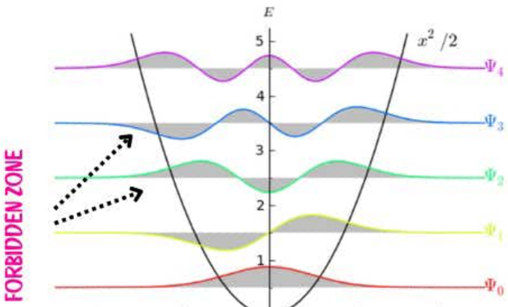
QUANTUM TUNNELING



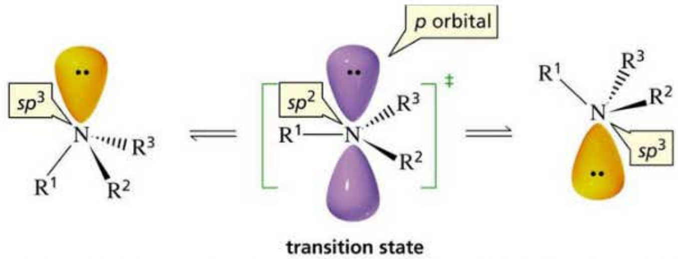
Describes how particles passes through a classically forbidden zone

Tunneling is a consequence of the wave nature of matter, where the quantum wave function describes the state of a particle or other physical system, and wave equations such as the Schrödinger equation describe their behavior.

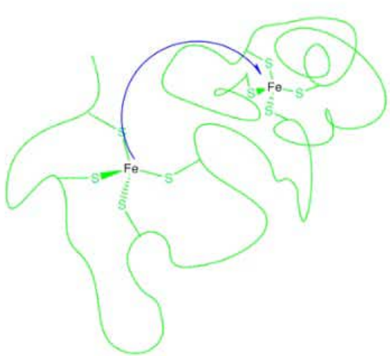
Some phenomenons explained by quantum tunneling ~



quantum mechanical oscillator can be found in the forbidden region 16% of the time



GEOMETRY OF AMMONIA TURNS INSIDE OUT - UMBRELLA EFFECT



OUTER SPHERE ELECTRON TRANSFER ALSO HAPPENS VIA TUNNELING

QUANTUM TUNNELING

•Heisenberg Uncertainty principle (HUP) says that position and momentum of quantum particle(microscopic objects and minuscule particles whose location and velocity change when photons strike them) cannot be measured simultaneously .
•With a thrown baseball , there are only two ways to get to the other side of the wall- one is to go around other is to burst through . But the fastest pitch would just bounce off a brick wall.
•Surprisingly quantum particles are caught passing through the barriers. As they don't have the energy to break the barrier, logically they should just bounce off like the baseball.
•Yet quantum particles are found to sit happily on the other side of the barrier.
•This phenomena is called quantum tunnelling.
Due to uncertainty in position ,the particles can be other side of barrier. This is possible for the wave nature of particle.

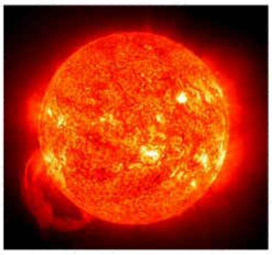
The sun shines due to nuclear fusion

$${}^1_1H + {}^1_1H \rightarrow {}^2_1H + {}^0_1\beta^+ + \nu \text{ (nutrino)}$$

$${}^2_1H + {}^1_1H \rightarrow {}^3_2He + \gamma$$

$${}^3_2He + {}^3_2He \rightarrow {}^4_2He + 2\,{}^1_1H$$

$$4\,{}^1_1H \rightarrow {}^4_2He + 2\,{}^0_1\beta^+ + 2\gamma + 2\nu \quad \text{Overall reaction}$$



•In one step of the fusion reaction two +vely charged protons are pushed togther to form a bond , but the protons repeals each other like same poles of magnets.
•The repulsive force is acting like barrier , due to quantum tunneling the protons overcome the repulsion barrier . The sun shines.

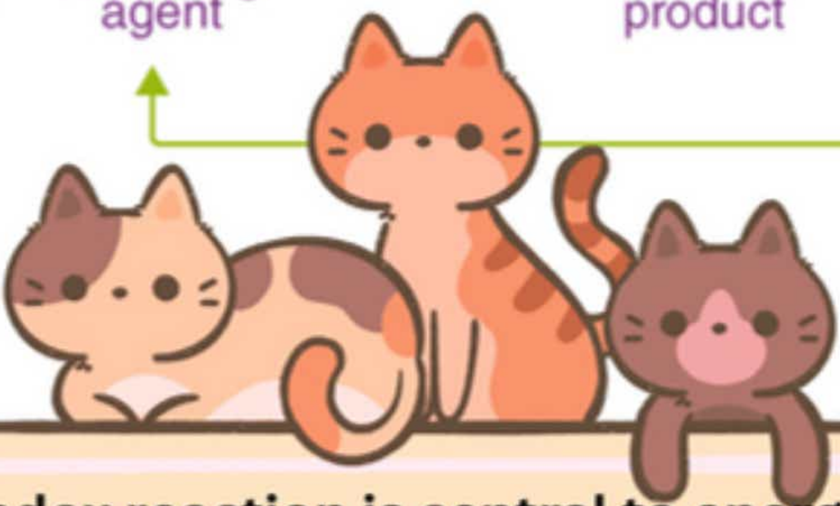
PRERANA CHOWDHURY
EX -STUDENT

REDOX REACTION

In these reactions, one substance undergoes oxidation (loses electrons) while another undergoes reduction (gains electrons).

$$Zn + Cu^{2+} \longrightarrow Zn^{2+} + Cu$$

Zn	Cu²⁺	Zn²⁺	Cu
Reducing agent	Oxidising agent	Oxidized product	Reduced product



Redox reaction is central to energy production, such as in batteries and fuel cells, and are crucial in biological systems, including cellular respiration and photosynthesis.

Rima Biswas, 6th sem

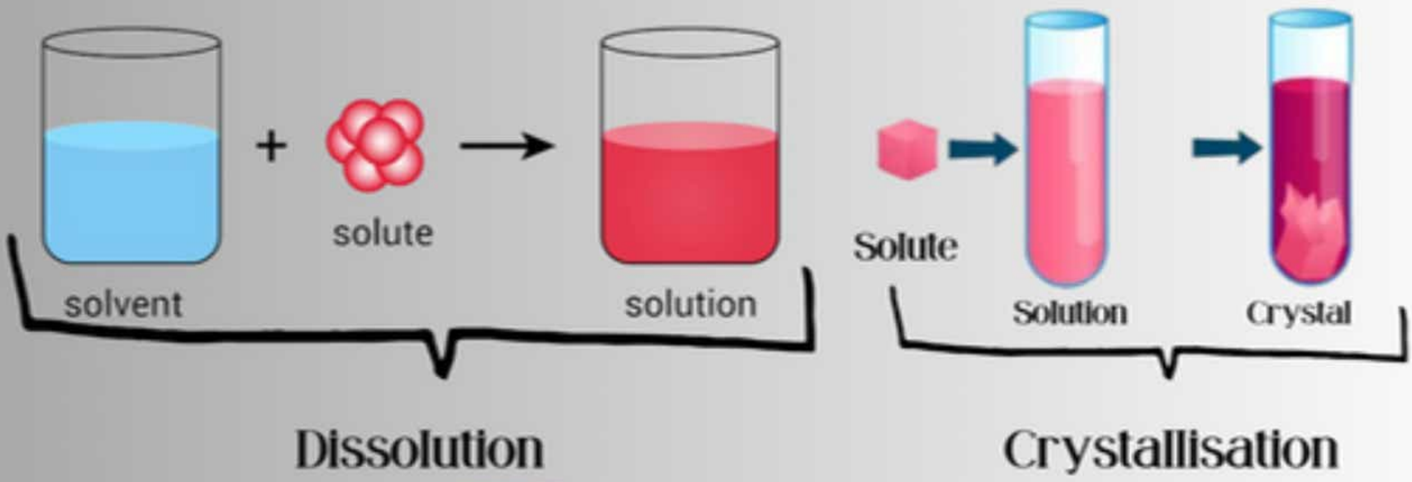
Redox Reaction

Redox reactions, short for reduction-oxidation reactions, involve the transfer of electrons between chemical species. In these reactions, one substance undergoes oxidation (loses electrons) while another undergoes reduction (gains electrons). Redox reactions are ubiquitous in chemistry, playing essential roles in various natural and industrial processes. They are central to energy production, such as in batteries and fuel cells, and are crucial in biological systems, including cellular respiration and photosynthesis. Understanding redox reactions is fundamental in fields ranging from environmental science to materials science, as they govern numerous chemical transformations and have significant implications for technological advancements and everyday life.

Rohini Mondal
2nd sem

SOLUBILITY

Solubility of a substance is its maximum amount that can be dissolved in a specified amount of solvent at a specified temperature.



Interesting fact: If you heat up a solvent, it can dissolve more solute!

When a solute dissolves in the solvent, concentration increases and it is known as dissolution. Some salute particles in solution collide with solid solute particles and get separated out, it is known as crystallization.

Rima Biswas, 6th sem

SOLUBILITY

DEFINATION: Solubility of a substance is its maximum amount that can be dissolved in a specified amount of solvent at a specified temperature.

SOLUBILITY OF SOLUTE (SOLID / GAS) IN A LIQUID:
When a solute is added to the solvent,some solute dissolves and it's concentration increases in solution,known as dissolution. Some solute particle in solution collide with solid solute particles and get separated out of solution, known as crystallization. When these two processes occur at same rate i.e the solution is in dynamic equilibrium with undissolved solute and contains maximum amount of solute dissolved in a given amount of solvent. Thus, the concentration of solute in such condition is its solubility.

$$\text{Solute} + \text{Solvent} \rightleftharpoons \text{Solution}$$

EFFECT OF TEMPERATURE & PRESSURE:
i. If in a nearly saturated solution, the dissolution process is endothermic, the solubility should increase with rise in temperature and if it is exothermic, the solubility should decrease.
ii. Pressure doesn't have any significant effect on solubility of solids in liquids. Whereas, the solubility of gases in a solvent increase with increase of pressure.

Sumita Dutta
Ex -student

TERM SYMBOL

GENERAL FORM:

$^{2S+1}L_J$

2S+1=*Maximum spin multiplicity*

L=*Total angular momentum*

J=*Total orbital and spin angular momentum*

|**L**| = 0 1 2 3 4 5 6 .....and so on

States = S P D F G H I......

Electronic configuration	m_L value	L value	S value	Ground Term symbol
	+1 0 -1			
p^1	↑	1	1/2	$^2P_{1/2}$
p^2	↑ ↑	1	1	$^3P_0$
p^3	↑ ↑ ↑	0	3/2	$^4S_{3/2}$
p^4	↑↓ ↑ ↑	1	1	$^3P_2$
p^5	↑↓ ↑↓ ↑	1	1/2	$^2P_{3/2}$
p^6	↑↓ ↑↓ ↑↓	0	0	$^1S_0$

Electronic configuration	m_L value	L value	S value	Ground Term symbol
	+2 +1 0 -1 -2			
d^1	↑	2	1/2	$^2D_{3/2}$
d^2	↑ ↑	3	1	$^3F_2$
d^3	↑ ↑ ↑	3	3/2	$^4F_{3/2}$
d^4	↑ ↑ ↑ ↑	2	2	$^5D_0$
d^5	↑ ↑ ↑ ↑ ↑	0	5/2	$^6S_{5/2}$
d^6	↑↓ ↑ ↑ ↑ ↑	2	2	$^5D_4$
d^7	↑↓ ↑↓ ↑ ↑ ↑	3	3/2	$^4F_{9/2}$
d^8	↑↓ ↑↓ ↑↓ ↑ ↑	3	1	$^3F_4$
d^9	↑↓ ↑↓ ↑↓ ↑↓ ↑	2	1/2	$^2D_{5/2}$
d^{10}	↑↓ ↑↓ ↑↓ ↑↓ ↑↓	0	0	$^1S_0$

TERM SYMBOL

TERM SYMBOLS *are shorthand method used to describe the energy,angular momentum and spin multiplicity of an atom in any particular state where the general form* $^{2S+1}L_J$

- **2S+1**=*Maximum spin multiplicity*
- **S**=∑s=n/2(*n=No of unpaired electron*)
- **L**=∑x×m_l =*Total angular momentum*
- ***J*** =*Total orbital and spin angular momentum of the system having values* |L+S|.....|L-S|

  = |L+S|→*ground state when configuration>half filled*

  = |L−S|→*ground state when configuration<half filled*

  = S→*ground state when the configuration=half filled*

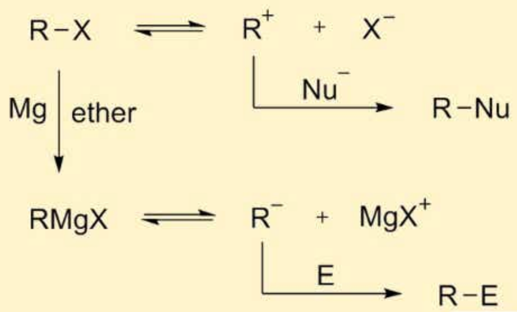
Puja Dutta & Sagnik Chowdhury
2nd sem

Umpolung

REVERSIBLE OF POLARITY

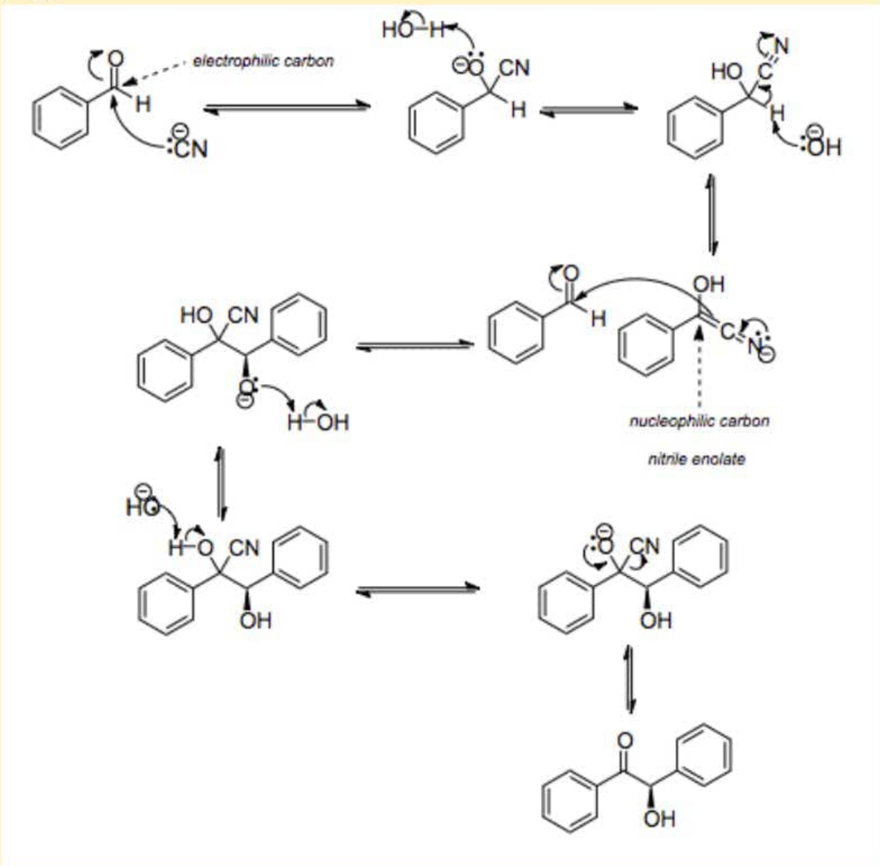
~introduced by D. Seebach and E.J. Corey during retrosynthetic analysis

Most common example is polarity of carbon in a Grignard Reagent



Generally carbon bears partial positive charge in a bond with hydrogen or hetero atom but in case of metal as they are electro-positive so there carbon bears partial negative charge

In restro synthetic analysis umpolung has a huge role. Another classic example : In benzoin condensation , cyanide (catalyst) inverses polarity of carbonyl carbon ~



UMPOLUNG

•UMPOLUNG is reversal of polarity.
This inversion of the atoms inherent polarity allows the carrying out of reactions that are not possible from the original reactivity of its functional group.

•For Grignard reagent, RMgX, the R(alkyl group) has -ve charge ,as Mg carries +2 charge and halides(X) has -1 charge. Thus the compound is neutralized.But normally alkyl groups has +ve charge.

•Normally the carbon of aldehyde or ketone is electrophilic in nature. Due to umpolung the carbon becomes nuclaeophilic from electrophilic character.

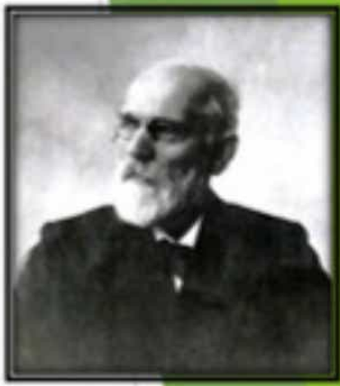
• Umpolung is a synthetic tool which includes the reversion of the normal reactivity of amines (donors) by replacing one or more of their hydrogens with good leaving groups.

•This strategy provides a method of obtaining amines from organometallic compounds such as Grignard reagents (RMgBr), as an alternative to the alkylation of ammonia and primary amines, which takes advantage of the normal reactivity of the amines.

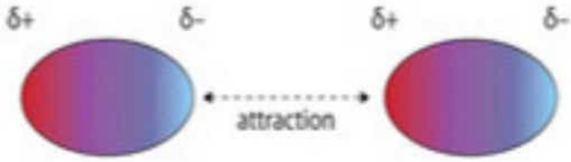
PRERANA CHOWDHURY
EX -STUDENT

VAN DER WAALS FORCES

1. Weaker than normal covalent bonds
2. Short range forces
3. Depend on molecular parameters

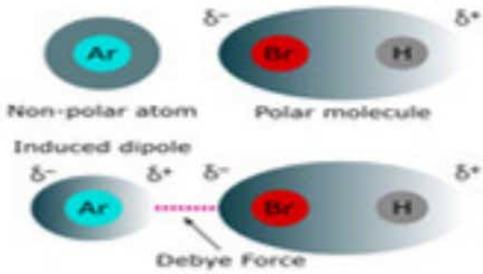


Keesom interaction or dipole-dipole interaction



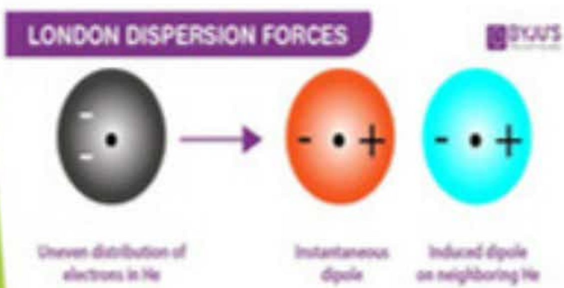
1. Occur among molecules that possess permanent dipole moments.
2. Energy depends on the inverse sixth power inter molecular separation.
3. Temperature dependent.

Debye interaction or dipole-induced dipole interaction



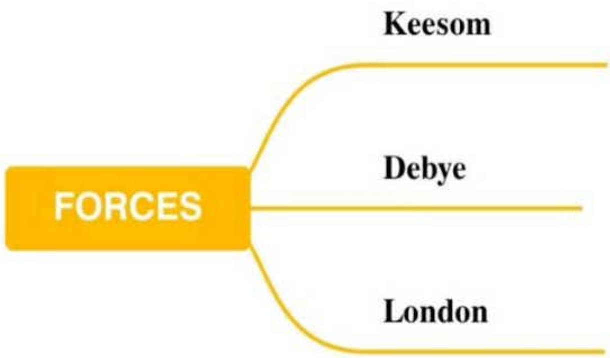
1. One of the molecules must be polar., other one may be polar or non-polar.
2. Temperature independent.

London or dispersion or induced dipole-induced dipole interaction



1. Interaction between any kind of molecules.
2. Interaction increases with increase in polarisability.
3. Temperature independent.
4. Weak interaction but stronger than Keesom and Debye.

VAN DER WAALS FORCES



DIPOLE - DIPOLE INTERACTION

When temperature is very high then the molecules rotates more or less freely and probability of opposite poles and same poles to come in closure proximity becomes equal. Consequently dipole-dipole interaction reduces to zero.

$$V_{(r)} = -\frac{2}{3}\frac{\mu_1^2\mu_2^2}{(4\pi\epsilon)^2 K_B T r^6}$$

DIPOLE – INDUCED DIPOLE INTERACTION

The angle averaged interaction is given by the following equation

$$V_{(r)} = -\frac{1}{(4\pi\epsilon)^2 r^6}\left(\mu_1^2\alpha_2 + \mu_2^2\alpha_1\right)$$

Where μ_1 and μ_2 are the permanent dipole moments of polar molecules , α_1 and α_2 are the polarisibility of the molecules

INDUCED DIPOLE – INDUCED DIPOLE INTERACTION

if α_1 *and* α_2 are dipole polarisibility of the respective atoms , the quantities I_1 and I_2 are the first ionization potentials of the atoms and r is the intermolecular distance then London interaction energy is given by -

$$V_{(r)} = -\frac{3}{2}\frac{I_1 I_2}{I_1 + I_2}\frac{\alpha_1\alpha_2}{(4\pi\epsilon_0)^2}\frac{1}{r^6}$$

The London theory has much similarity to the quantum mechanical theory of light disparsion , which is why London coined the phrase " **Dispersion effect** "

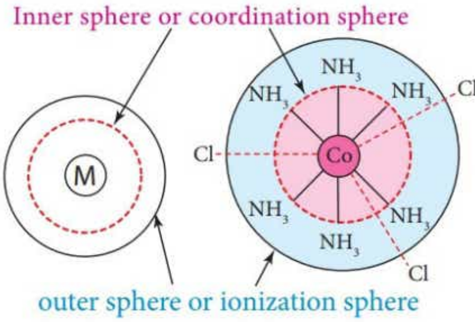
Asesh & Yasmin, 2nd sem

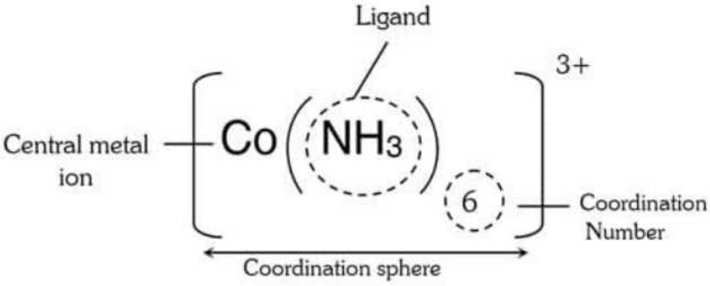
Werner's Theory

Chemistry must become the astronomy of the molecular world.

- Alfred Werner

Compounds		Colour	Old Name	No. of charges on complex ion	No. of Ions		
Old Formulae	New Formulae				Cation	Anion	Total
$CoCl_3 \cdot 6NH_3$	$[Co(NH_3)_6]Cl_3$	Yellow	Luteo complex	+3	1	3	4
$CoCl_3 \cdot 5NH_3$	$[Co(NH_3)_5Cl]Cl_2$	Purple	Purpureo complex	+2	1	2	3
$CoCl_3 \cdot 4NH_3$	Trans- $[Co(NH_3)_4Cl_2]Cl$	Green	Praseo complex	+1	1	1	2
$CoCl_3 \cdot 4NH_3$	Cis- $[Co(NH_3)_4Cl_2]Cl$	Violet	Violeo complex	+1	1	1	2
$CoCl_3 \cdot 3NH_3$	$[Co(NH_3)_3Cl_3]$	Blue green	—	—	—	—	—





Complex	Groups satisfy the secondary valence (non-ionaisable, inner coordination sphere)	No. of ionisable Cl^- ions in the complex (outer coordination sphere)	No. of moles of AgCl formed = no. of moles of ionisable Cl^-
$CoCl_3.6NH_3$	6 NH_3	3 Cl^-	3 AgCl
$CoCl_3.5NH_3$	5 NH_3 & 1 Cl^-	2 Cl^-	2 AgCl
$CoCl_3.4NH_3$	4 NH_3 & 2 Cl^-	1 Cl^-	1 AgCl
$CoCl_3.4NH_3$	4 NH_3 & 2 Cl^-	1 Cl^-	1 AgCl

WERNER'S THEORY

Alfred Werner, a Swiss chemist, was the first to formulate his ideas about the structures of coordination compounds. Werner in 1898, propounded his theory of coordination compounds. The main postulates are-

1. In coordination compounds metals show two types of valences- primary and secondary.
2. The primary valences correspond to oxidation number of metal ion. Primary valences are normally ionisable and are satisfied by negative ions.
3. The secondary valences are non ionisable, these are satisfied by neutral molecules or negative ions. It is equal to coordination number and is fixed for a metal.
4. The ions/groups bound by the secondary linkages to the metal have characteristics spatial arrangements corresponding to different coordination number.

LIMITATIONS:

1. It failed to explain why all elements don't form coordination compounds.
2. It failed to explain the directional properties of bonds in coordination compounds
3. It doesn't explain the colour, magnetic and optical properties of coordination compounds.

Sumita Dutta
Ex -student

X-RAY DIFFRACTION

X-ray is a electromagnetic radiation of extremely short wavelength and high frequency, with wavelengths ranging from about 10^{-8} to 10^{-12} metre.

USES

- Determine the crystallographic structure of a material
- Detect abnormalities in bone structure
- Identification of unknown crystalline materials

Did You Know?

Rontgen referred to the radiation as "X", to indicate that it was an unknown type of radiation. Some early texts refer to them as Chi-rays having interpreted "X" as the uppercase Greek letter Chi, X.

Rima Biswas, 6th Sem

X RAY DIFFRACTION

•Most of materials composed of small crystals ,crystals are composed of regular arrangements of atoms ,this forms distinct planes separated by well defined distances .

•The wavelength of X ray is similar with the distance between atoms in a crystal, a special interference effect called DIFFRACTION can be used to measure the distance between the atoms.

• When atomic planes are exposed to X ray beams the beams are scattered by atoms.

•Strong amplifications of emitted signals occours at specific angles .

•The signals coming are recorded and graphed ,the peaks are related to the sample.

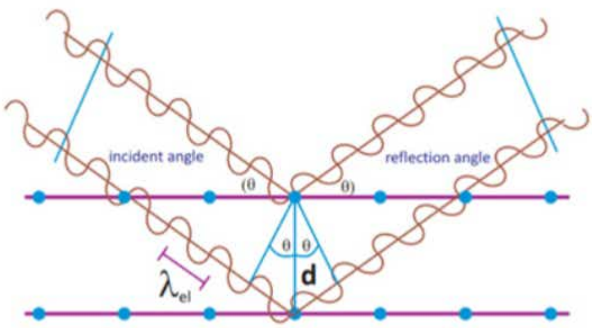
OBTAINABLE INFORMATION FROM A DIFFRACTOGRAMM :

Qualitative and Quantitative Analysis

Unit Cell Lattice Parameters

Crystallite Size and Strain

Diffraction of rays – Braggs equation



Bragg Equation: $n\lambda = 2d\sin\theta$

Where,

λ = Wavelength of rays

θ = The angle between incident rays and the surface

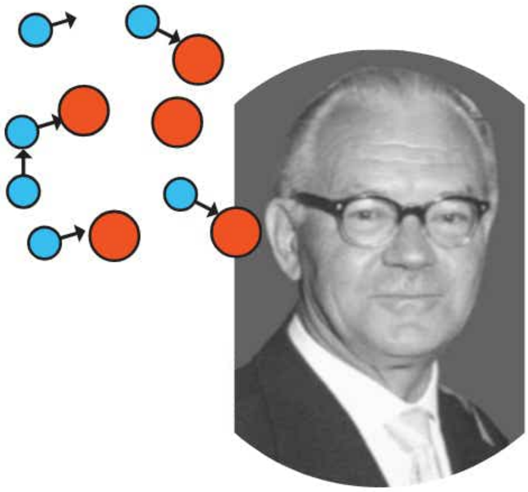
d = Distance between a layer of atom

n = An integer

PRERANA CHOWDHURY

EX -STUDENT

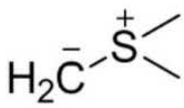
Ylide



Georg Wittig, a German chemist, pioneered a synthesis method for alkenes from aldehydes and ketones. His groundbreaking work introduced phosphonium ylides in what is now known as the Wittig reaction.

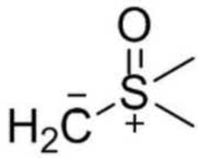
Ylides are neutral dipolar molecule with a negatively charged atom immediately linked to a positively charged hetero-atom.

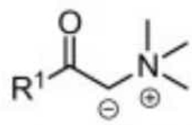
Phosphorus ylide



Sulfonium ylide

Sulfoxonium ylide

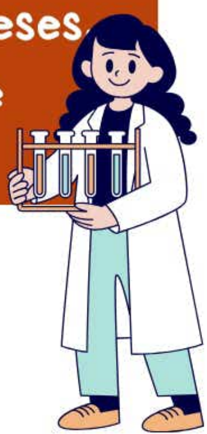




Nitrogen ylide

actual bonding picture of these types of ylides is strictly zwitterionic

Phosphonium ylides are key in the Wittig reaction, converting ketones and aldehydes to alkenes. Sulfonium and sulfoxonium ylides aid in asymmetric reactions, forming C-X bonds and enabling cyclization. Iodonium ylides, notable for their versatility, find application in various organic syntheses, including cyclization, C-H transformation, alkene difunctionalization, and radiofluorination.



ylide

•Ylides contain two oppositely charged atoms of different element adjacent to one another.

•The anionic atom(Y) very often is carbon atom and cationic atom is heteroatom from group 15 or 16 (P,N,O,S)

•They are nucleophilic at anionic atom (they have non bonding electrons) and electrophilic at cationic atom.

•There are three main types of ylides : Nitrogen ylide,Phosphorus ylide,Sulfer ylide.

•Phosphorus and Sulfer ylide the non bonding electron from carbon atom can be transfered to vacant 3d orbital of P and S. So these ylides are stable but not the Nitrogen ylide (absence of d orbital).

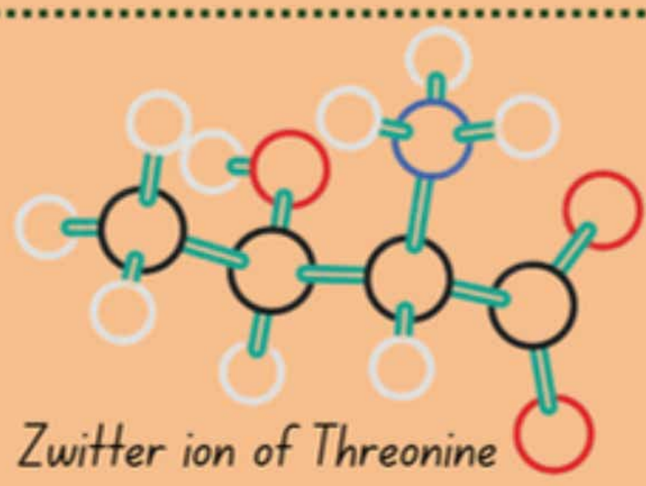
•Nitrogen ylides are prepared from alkyl ammonium salt by treating with strong base.

•Reaction of P ylide with aldehyde / ketone gives alkene,reaction of S ylide with same gives epoxide/ cyclo propane.

Ylides are very useful in organic synthesis. Most comon example of ylide is Phosphorus ylide (Wittig Reaction). But there are many more like Nitrogen Ylides(Sommelet Rearrangement) , Sulfonium Ylides(Corey-Chaykovsky Reaction) etc.

Prerana Chowdhury
Ex -student

Zwitter ion



Zwitter ion of Threonine

Zwitterion is a neutral molecule with both positive and negative electrical charges.

pH and Ionization

$$\overset{+}{H_3N}\text{-}CH_2\text{-}COOH \xleftarrow{H^+} \overset{+}{H_3N}\text{-}CH_2\text{-}COO^- \xrightarrow{OH^-} H_2N\text{-}CH_2\text{-}COO^-$$

Positive ion	Zwitter ion	Negetive ion
Low pH	pH 7	High pH

The amino group is protonated (-NH,*) because the pk, is close to 9 while the carboxyl group is deprotonated/ionized (-COO) because the pk, is below 3.

Zwitterions are sometimes referred to as "inner salts". The name "Zwitterion" originated from the German term "zwitter," which is roughly comparable to "hermaphrodite" or "hybrid"

Rima Biswas, 6th Sem

Zwitter Ion

DEFINITION: A zwitterion is a functional group molecule in which equal number of positive electrical charge group and negative electrical charge group present. The net charge of the entire molecule is zero.

EXAMPLE: Amino acids are well known example of Zwitter ions. They have a group of amine(basic) and carboxylic acid(acidic).

EFFECT OF pH ON AMINO ACID SOLUTION:

i. If the pH of the solution is increased by adding hydroxide ions, the hydrogen ion is removed from $-NH_3^+$ group and the amino acid becomes negatively charged.

ii. If the pH of the solution is decreased by adding acid, the carboxylate group captures a hydrogen (H^+) ion, and the amino acid becomes positively charged.

APPLICATIONS OF ZWIITER ION :

i. Zwitterions are widely applied in the process of separating protein molecules.

ii. In the marine industry, Zwitterionic polymers are used to prevent subaquatic organisms from building up on boats and piers.

iii. Some of the most popular uses of zwitterions include medical implants, drug delivery, blood contact sensor, separation membrane, and antifouling coatings of biomedical implants.

Sumita Dutta
Ex -student

Memories Corner

02 / 06 / 2023

Inauguration of CheMystery_3rd_Edition

MEMORIES

Batch of 2023

Batch of 2024

Batch of 2025