UNIT-IV					
8	a)	Differentiate between thermoplasts and thermosets.	L2	CO5	5 M
	b)	Write a note on synthesis of Poly Lactic acid and mention its properties and applications.	L2	CO5	5 M
OR					
9	a)	What are conducting polymers? Discuss the mechanism of conduction in poly aniline.	L3	CO3	5 M
	b)	Outline the synthesis of Bakelite. Mention its properties and applications.	L3	CO5	5 M
UNIT-V					
10	a)	List out the characteristics of electromagnetic spectrum.	L2	CO2	5 M
	b)	Describe the principle and instrumentation of UV-visible spectro scopy with the help of neat diagram.	L3	CO5	5 M
OR					
11	a)	How does the Beer-Lambert law account for the exponential decrease in light intensity with increasing concentration of absorbing species?	L4	CO5	5 M
	b)	Explain how IR spectroscopy is used to identify functional groups in organic molecules.	L3	CO5	5 M

PVP 23

Code: 23BS1202

I B.Tech - II Semester – Regular Examinations - JULY 2024

CHEMISTRY

(Common for IT, AIML, DS)

Duration: 3 hours Max. Marks: 70

Note: 1. This question paper contains two Parts A and B.
2. Part-A contains 10 short answer questions. Each Question carries 2 Marks.
3. Part-B contains 5 essay questions with an internal choice from each unit. Each Question carries 10 marks.
4. All parts of Question paper must be answered in one place.

BL – Blooms Level CO – Course Outcome

PART – A

		BL	CO
1.a)	What is the purpose of de-Broglie's relationship?	L2	CO1
1.b)	State the conditions for linear combination of atomic orbitals.	L2	CO1
1.c)	Mention the reasons for the unique behavior of nano materials.	L2	CO2
1.d)	List out the general applications of carbon nano tubes.	L2	CO2
1.e)	Differentiate between conductance and conductivity.	L3	CO4
1.f)	What is the potential of a half cell consisting of copper electrode in 0.015 M $CuSO_4$ solution at 25 °C , $E°_{Cu^{2+}}/Cu = 0.34$ V.	L3	CO2
1.g)	Define the terms monomer, polymer and polymerization.	L2	CO5

1.h)	Give the monomers used in the synthesis of Nylon-6, 6.	L2	CO5
1.i)	Name two common types of vibrations that are detected in IR spectroscopy.	L2	CO3
1.j)	What is the basic principle involved in chromatography?	L2	CO3

PART – B

			BL	CO	Max. Marks
UNIT-I					
2	a)	Derive the Schrodinger wave equation and give its applications.	L2	CO1	5 M
	b)	Discuss the magnetic property of CO molecule with the help of neat molecular orbital energy level diagram.	L3	CO2	5 M
OR					
3	a)	Show that Heisenberg's uncertainty principle is a natural consequence of wave nature associated with moving material particles.	L3	CO2	5 M
	b)	Describe the stability of butadine using pi molecular orbital energy level diagram.	L3	CO2	5 M
UNIT-II					
4	a)	What are supercapacitors? Discuss the classification and applications of supercapacitors.	L4	CO4	5 M
	b)	Differentiate between intrinsic and extrinsic semiconductors.	L3	CO2	5 M
OR					
5	a)	Compare and contrast the properties of fullerenes with those of graphenes.	L4	CO4	5 M
	b)	Discuss the structure of high temperature super conductors with the help of neat diagram and mention its applications.	L2	CO4	5 M
UNIT-III					
6	a)	How do you differentiate between primary and secondary batteries? Explain the construction and working of Zn – air battery.	L3	CO4	5 M
	b)	Calculate the EMF of the following cell at 25^{O} C. $Cu(s)/Cu^{2+}(0.001M)//Ag^{+}(0.01\ M)/Ag(s)$ $E°(Cu^{2+}/Cu)=-0.34V, E°(Ag^{+}/Ag)=0.80\ V$	L3	CO2	5 M
OR					
7	a)	Derive Nernst equation. Mention its application in determination of pH of unknown acid.	L2	CO4	5 M
	b)	Make the use of neat diagram to explain the construction, working and applications of polymer electrolyte membrane furl cell.	L3	CO2	5 M

PVP23

Code No: 23BS1202

PVP SIDDHARTHA INSTITUTE OF TECHNOLOGY
(Autonomous)
I B.Tech – II Semester Regular Examinations-JULY-2024
CHEMISTRY
(Common to IT,AIML,DS)

Duration: 3 Hours **Max. Marks: 70**

KEY AND SCHEME OF VALUATION

PART-A

1\. a) What is the purpose of de-Broglie's relationship – 2M
1\. b) State the conditions for linear combination of atomic orbitals – 2M
1\. c) Mention the reasons for the unique behavior of nano materials – 2M
1\. d) List out the general applications of carbon nano tubes – 2M
1\. e) Differentiate between conductance and conductivity– 2M
1\. f) What is the potentail of a half cell consisting of copper electrode in 0.015 M CuSO4 solution at 25^0C, $E^0{}_{CU^{2+}}/Cu = 0.34V$—2M
1\. g) Define the term monomer, polymer and polymerization –2M
1\. h) Give the monomers used in the synthesis of Nylon-6,6– 2M
1\. i) Name two common types of vibrations that are detected in IR Spectroscopy—2M
1\. j) What is the basic principle involoved in chromatography—2M

PART – B

UNIT-I

2 a) Schrodinger Wave equation – 3M, applications – 2M
b) Energy level diagram of CO molecule – 5M

OR

3 a) Heisenberg's Uncertainty principle – 5M
b) Diagram of Pi molecular orbital in butadine– 5M

UNIT-II

4 a) Super capacitors - 1M Classification– 2 M Applications -2M
b) Intrinsic Semiconductor –2.5M Extrinsic Semiconductor –2.5M

OR

5\. a)Any five Properties of fullerenes with those of graphene -5M
b) High temperature Super conductors -Structure-3M Applications-2M

UNIT-III

6\. a) Differentiate between primary and secondary batteries- 1M
Construction, Diagram- 2M,Working of Zinc-air battery cell –2M
b) Calculate the EMF of the following cell at 25^0C.
$Cu(s)/Cu^{2+}(0.001M)// Ag^{+}(0.01M)/Ag(s)$ $E^0Cu^{2+/}Cu)$=-0.34V, $E^0(Ag^+ / Ag)$=0.80V

OR

7\. a) Nerst equation-4M , Applications-1M
b) Construction, Diagram- 2M,
Working of polymer electrolyte membrane fuel cell–2M Applications-1M

UNIT-IV

8 a) Differentiate Thermoplastic and thermoset plastic – 5M
b) Poly Lactic acid synthesis -2M, Properties – 2M, applications—1M

OR

9 a) Definition –2M , Mechanism of polyaniline-3M
b) Preparation -2 M, Any three Properties and Application of Bakelite – 3M

UNIT-V

10 a) Any five points regarding Characteristics of electromagnetic spectrum – 5M
b) Principle – 1M, Explanation of Instrumentation with diagram of UV-Visible spectroscopy – 4M

OR

11 a) Beer-Lambert's Law statement – 5 M
b) IR Spectroscopy to identify functional groups – 5M

PART-A

1a) Purpose of de-Broglie's relationship: It describes the wave-like properties of matter, specifically how particles like electrons can exhibit wave characteristics, which is crucial in understanding phenomena like electron diffraction.

1 b) Conditions for linear combination of atomic orbitals: Atomic orbitals must have similar energy and compatible symmetry to combine in a linear fashion to form molecular orbitals.

1 c) Reasons for the unique behavior of nano materials: Nano materials exhibit unique properties due to their high surface area to volume ratio, quantum effects at the nanoscale, and enhanced reactivity, making them useful in various applications.

1d) General applications of carbon nanotubes: Carbon nanotubes find applications in fields such as electronics (as conductive additives), materials science (for reinforcement in composites), and medicine (as drug delivery vehicles), due to their exceptional mechanical, electrical, and thermal properties.

1 e) Difference between conductance and conductivity: Conductance refers to the ability to conduct electric current and is measured in siemens (S), while conductivity is a property describing how well a material conducts electricity and is measured in siemens per meter (S/m).

1 f)

f) Potential of a half cell consisting of a copper electrode in 0.015 M CuSO4 solution at 25°C, with $E^0_{Cu^{2+}/Cu} = 0.34$ V:

To find the potential E of the half-cell Cu^{2+}/Cu at 25°C (298 K), we use the Nernst equation:

$$E = E^0 - \frac{RT}{nF} \ln\left(\frac{[Cu^{2+}]}{[Cu]}\right)$$

Where:

- E^0 is the standard electrode potential, $E^0_{Cu^{2+}/Cu} = 0.34$ V.
- R is the gas constant (8.314 J/(mol·K)).
- T is the temperature in Kelvin (25°C = 298 K).
- n is the number of moles of electrons transferred (for Cu^{2+}/Cu, $n = 2$ electrons).
- F is the Faraday constant (96,485 C/mol).
- $[Cu^{2+}]$ is the concentration of Cu^{2+} ions (0.015 M).
- $[Cu]$ is the activity of solid copper (assumed as 1).

Calculate E:

$$E = 0.34 - \frac{8.314 \times 298}{2 \times 96485} \ln\left(\frac{0.015}{1}\right)$$
$$E = 0.34 - \frac{2471.972}{193970} \ln(0.015)$$
$$E \approx 0.34 - 0.031$$
$$E \approx 0.309 \text{ V}$$

Therefore, the potential E of the half-cell Cu^{2-}/Cu in the given conditions is approximately 0.309 V at 25°C.

1.g)Monomer: A small molecule that can react chemically with other molecules to form a larger polymer molecule.

Polymer: A large molecule composed of repeating structural units (monomers) typically linked together by covalent bonds.

Polymerization: The process of chemically bonding monomers together to form a polymer.

1.h) Monomers used in the synthesis of Nylon-6,6: The monomers are adipic acid and hexamethylenediamine.

1. i) Common types of vibrations detected in IR Spectroscopy: Two common types are stretching vibrations (where bonds are stretched) and bending vibrations (where bonds are bent).

1. j) Basic principle involved in chromatography: Chromatography separates components of a mixture based on differences in their distribution between two phases: a stationary phase (solid or liquid) and a mobile phase (gas or liquid). The principle relies on the differential partitioning of components between these phases.

PART – B
UNIT-I

2 a)Derive the Schrodinger wave equation and give its significance -5M

Schrodinger wave equation: The fundamental equation describing the behaviour of a small particle in terms of wave motion is

$$\frac{d^2\psi}{dx^2}+\frac{4\pi^2\psi}{\lambda^2}=0$$

$$\Rightarrow \frac{1}{\lambda^2}=-\frac{d^2\psi}{dx^2}\times\frac{1}{4\pi^2\psi} \qquad \text{-----(1)}$$

where ψ=amplitude of the wave, x=displacement in a given direction and λ=wavelength.

According to de Broglie equation,

$$\lambda=\frac{h}{mc}$$

$$\Rightarrow \frac{1}{\lambda^2} = \frac{m^2c^2}{h^2} \qquad \text{-----(2)}$$

where m=mass of the particle, c=velocity of the particle and h=Planck's constant.
From eqs.(1) and (2),

$$\frac{m^2c^2}{h^2} = -\frac{d^2\psi}{dx^2} \times \frac{1}{4\pi^2\psi}$$

$$\Rightarrow m^2c^2 = -\frac{h^2}{4\pi^2\psi} \times \frac{d^2\psi}{dx^2} \qquad \text{-----(3)}$$

For a particle of mass m moving with velocity c, the kinetic energy is given by,

$$K = \frac{1}{2}mc^2 \quad \text{or,} \quad K = \frac{m^2c^2}{2m}$$

$$\Rightarrow m^2c^2 = K \times 2m \qquad \text{-----(4)}$$

From eqs.(3) and (4),

$$K \times 2m = -\frac{h^2}{4\pi^2\psi} \times \frac{d^2\psi}{dx^2}$$

$$\Rightarrow K = -\frac{h^2}{8\pi^2 m\psi} \times \frac{d^2\psi}{dx^2}$$

As the total energy E is the sum of kinetic energy K and potential energy V,

$$E = K + V$$

$$\therefore \; E = -\frac{h^2}{8\pi^2 m\psi} \times \frac{d^2\psi}{dx^2} + V$$

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

This is the Schrodinger wave equation in one dimension, X. If the motion of the particle is in three coordinates, X, Y and Z, then the equation becomes

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

Significance of ψ and ψ^2: In Schrodinger wave equation, ψ is the amplitude of wave, called wave function. $\frac{d^2\psi}{dx^2}$ represents the second derivative of ψ w.r.t. x and so on. Being a second order differential equation, Schrodinger wave equation has several possible solutions. However, only a few values of ψ have physical significance. Each permitted solution of ψ is called Eigen function and it corresponds to a definite energy state of electron. The Eigen function for an electron is called an atomic orbital. The wave function (ψ) has no physical significance except that it represents the amplitude of the wave. It may be positive, negative or imaginary. However, ψ^2 has a physical meaning and it is related to the probability of finding of electron (particle) with definite energy within a certain domain in space. ψ^2 provides the measure of electronic charge density at a point.

2 b) Discuss the magnetic property of CO molecule with help of neat molecular orbital energy level diagram– 5M

Carbon monoxide (CO): Atomic number of carbon is 6 and that of oxygen is 8.

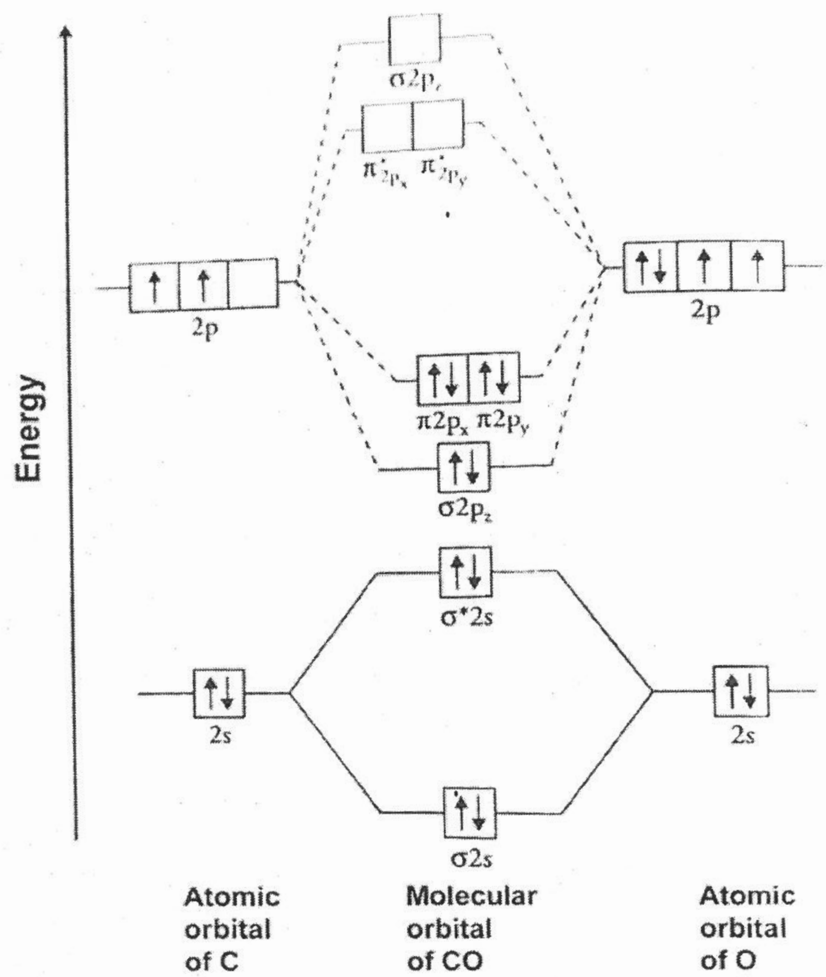
C (Z=6): $1s^2\ 2s^2\ 2p_x^1\ 2p_y^1\ 2p_z^0$ O (Z=8): $1s^2\ 2s^2\ 2p_x^2\ 2p_y^1\ 2p_z^1$

The molecular orbital configuration of CO is:

$$\sigma(1s^2) < \sigma^*(1s^2) < \sigma(2s^2) < \sigma^*(2s^2) < \sigma(2p_z^2) < [\pi(2p_x^2) = \pi(2p_y^2)]$$

$$\text{Bond order} = \frac{N_b - N_a}{2} = \frac{8 - 2}{2} = 3.0$$

Thus, CO molecule is quite stable and has a shorter bond length. The molecular orbital configuration of CO is similar to that of N_2 (isoelectronic). CO has a triple bond (one σ, two π). Since the molecular orbitals of CO has no unpaired electron, it is diamagnetic.



OR

3a) Show that Heisenberg's Uncertainty principle is a natural consequence of wave nature associated with moving material particle – 5M

Heisenberg uncertainty principle: In consequence to the dual nature of matter, it is not possible to measure simultaneously both velocity and position with accuracy. According to Heisenberg, it is not possible to determine accurately the position and velocity (or momentum) of smaller moving particles.

Mathematically,

$$\Delta x.\Delta p \square \geq \frac{h}{4\square}$$

- $\Delta x.m\Delta v \geq h\,4\square$

where, Δx = Uncertainty in measurement of position;

Δp = Uncertainty in measurement of momentum; Δv = Uncertainty in measurement of velocity;

m = mass of the particle and

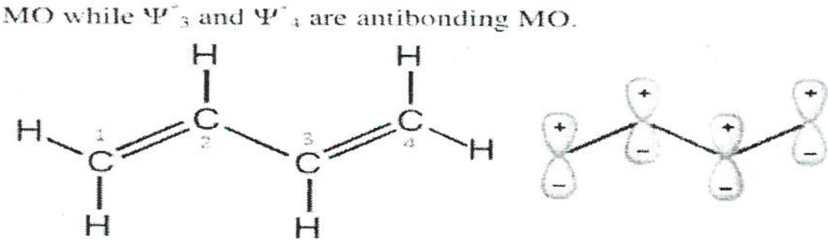
h = Planck's constant.

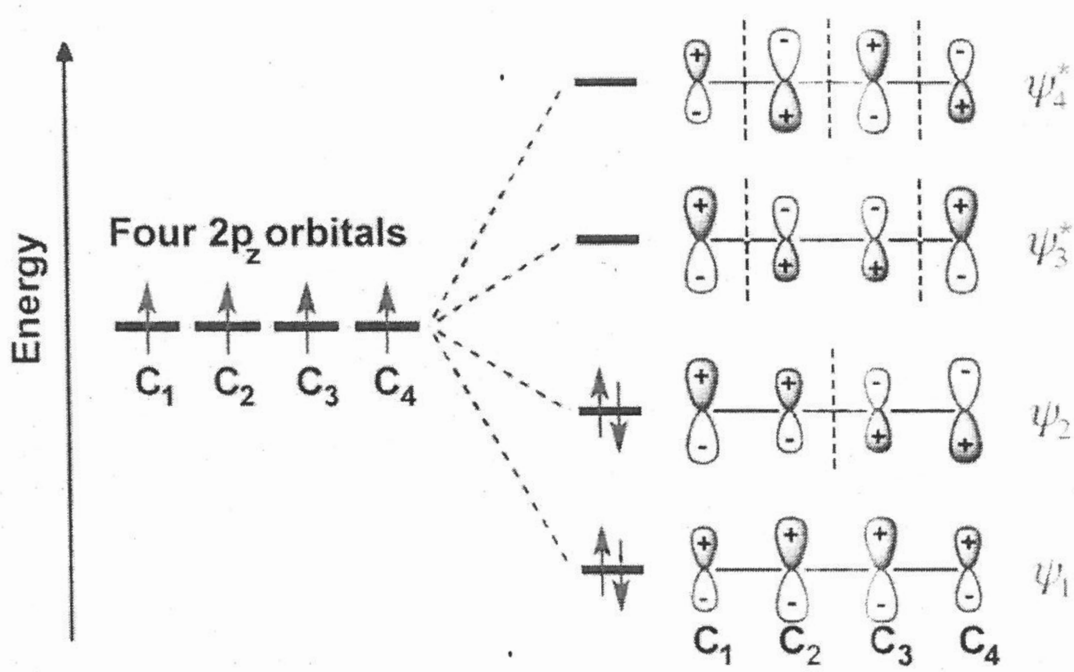
i.e., the product of uncertainty in position and uncertainty in velocity is constant. In other words, if the position of particle is measured accurately, then momentum cannot be determined accurately and vice versa.

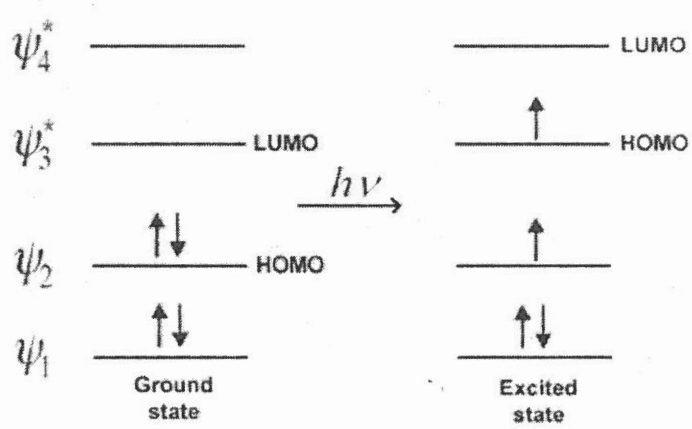
According to the principle of optics, the accuracy in measurement of position of a particle depends on wavelength □ and uncertainty in position is ±□. Hence, in order to determine position of the particle, we need to use light of shorter wavelength. But, such light is associated with higher energy. This energy changes the velocity (momentum) of the particle. Hence, accurate determination of velocity is not possible. On the other hand, in order to minimize the change in momentum, if we use light of higher wavelength, then the uncertainty in position becomes higher.

3b)Describe the stability of butadiene using of Pi molecular orbital energy level diagram– 5M

π-Molecular orbitals of 1,3-butadiene: 1,3-butadiene is an organic molecule that contains four carbon atoms with two double bonds in conjugation. Each carbon is involved in sp^2 hybridisation and contains one p_z orbital unhybridised. Each p_z orbital contains one unpaired electron. These orbitals overlap to form four π-molecular orbitals denoted as Ψ_1, Ψ_2, Ψ^*_3 and Ψ^*_4. Here Ψ_1 and Ψ_2 are bonding MO while Ψ^*_3 and Ψ^*_4 are antibonding MO.







MO	Bonding interactions (B.I.)	No. of B.I.	No. of vertical nodes
Ψ_1	C_1 & C_2, C_2 & C_3, C_3 & C_4	3	0
Ψ_2	C_1 & C_2, C_3 & C_4	2	1
Ψ^*_3	C_2 & C_3	1	2
Ψ^*_4	Nil	0	3

- After formation of molecular orbitals, the four electrons are filled in bonding MO as two pairs and antibonding MO do not contain any electrons.
- Vertical nodes are the planes indicating the space where the possibility of finding of electron is zero.
- The bonding MO Ψ_1 has the least energy and is formed by the interaction of the p_z orbitals of all the four carbon atoms. The resulting MO has no nodal planes.
- The bonding MO Ψ_2 has two bonding interactions with one nodal plane between C_2 and C_3.
- The antibonding MO Ψ^*_3 has one bonding interaction between C_2 & C_3. It has two nodal planes between C_1 & C_2 and C_3 & C_4.
- The antibonding MO Ψ^*_4 exhibits highest energy and has no bonding interactions. It has three nodal planes.

UNIT-II

4a)What are Super-capacitors ? Discuss the classification and application of supercapitors.-5M

A super capacitor, also known as an ultra-capacitor or electric double-layer capacitor (EDLC), is an energy storage device that stores and releases electrical energy much like traditional capacitors. However, it distinguishes itself by having a much higher energy density compared to conventional capacitors. Super-capacitors are designed to bridge the gap between traditional capacitors (which release energy rapidly but have low energy density) and batteries (which have higher energy density but release energy more slowly).

Super-capacitors can be classified into three main types based on their characteristics: Double-layer capacitors, Pseudo-capacitors, and Hybrid capacitors.

Double-layer capacitors:

These capacitors primarily store charge electrostatically in the electric double layer formed at the interface between the electrode and the electrolyte.
The electrodes are typically made of activated carbon, which provides a large surface area for the formation of the electric double layer.
The separation of charge in the electric double-layer capacitors is much smaller than in traditional capacitors, ranging from 0.3–0.8 nm.
Energy storage occurs through the physical separation of charges at the electrode-electrolyte interface.

Pseudo-capacitors:
Pseudo-capacitors store charge electrochemically, involving redox reactions at the electrode-electrolyte interface.
Metal oxide or conducting polymer electrodes are commonly used, providing a high amount of electrochemical pseudocapacitance.
Energy storage happens through reversible oxidation and reduction reactions, resulting in a faradaic charge transfer.
Pseudo-capacitors can offer higher energy densities compared to double-layer capacitors due to the additional electrochemical contributions.

Hybrid capacitors:

Hybrid capacitors combine the characteristics of both double-layer capacitors and pseudo-capacitors, utilizing electrodes with different properties.

One electrode exhibits electrostatic capacitance (double-layer capacitor behavior), while the other electrode displays electrochemical capacitance (pseudo-capacitor behavior).

These capacitors leverage the strengths of both types to achieve a balance between high power density (from double-layer capacitors) and high energy density (from pseudo-capacitors).

An example of a hybrid capacitor is the lithium-ion capacitor, which combines aspects of lithium-ion batteries and super-capacitors.

Each type of super-capacitor has distinct characteristics, making them suitable for different applications. Double-layer capacitors are known for their high power density, pseudo-capacitors for their higher energy density, and hybrid capacitors for a balance between the two. The choice of super-capacitor type depends on the specific requirements of the application, such as power demand, energy storage needs, and desired performance characteristics.

4 b) Differentiate between intrinsic and extrinsic semiconductors-5M

Definition	Pure semiconductor material (e.g., Si, Ge)	Semiconductor doped with impurities
Carrier Generation	Electrons and holes generated by thermal excitation	Additional electrons or holes introduced by intentional doping
Doping	Not intentionally doped	Doped with specific impurities (e.g., donor or acceptor atoms)
Types	None	n-type (donor-doped), p-type (acceptor-doped)
Conductivity	Relatively low due to thermal excitation of carriers	Higher due to increased number of free charge carriers
Temperature Dependence	Conductivity increases with temperature	Conductivity can be controlled by doping type and level
Examples	Silicon (Si), Germanium (Ge)	Silicon doped with Phosphorus (n-type), Boron (p-type)
Application	Found in natural state and used in some optical devices	Used in most semiconductor devices and electronics

OR

5 a) Compare and contrast Properties of fullerenes with those of graphenes-5M

Property	Fullerenes	Graphenes
Structure	Spherical, cage-like structure of carbon atoms	Planar, two-dimensional sheet of carbon atoms
Carbon Allotrope	3-dimensional structure	2-dimensional structure
Atomic Arrangement	Carbon atoms arranged in hexagonal rings	Carbon atoms arranged in hexagonal lattice
Bonding	Sp^2 hybridized carbon atoms	Sp^2 hybridized carbon atoms
Electrical Conductivity	Generally conductive due to π-electrons	Excellent conductivity due to delocalized π-electrons
Mechanical Strength	Moderate strength	Exceptionally strong and flexible
Flexibility	Less flexible compared to graphenes	Highly flexible
Surface Area	Moderate surface area	High surface area (single-layer)
Applications	Drug delivery systems, catalysts, nanotubes	Electronics, sensors, composites, membranes
Electronic Properties	Varied depending on size and structure	High electron mobility, suitable for electronics
Optical Properties	Optical absorption in UV-visible range	Excellent light absorption and transparency
Thermal Properties	Moderate thermal conductivity	High thermal conductivity

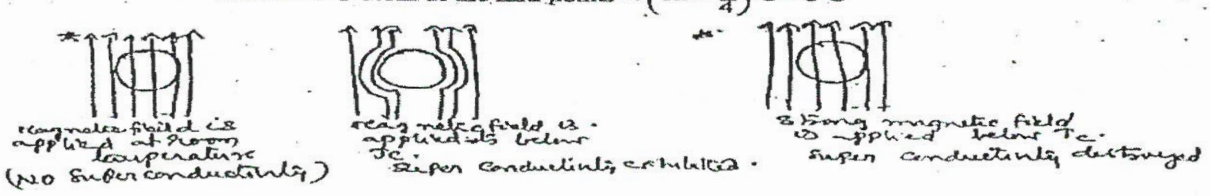
5 b) Discuss the structure of high temperature super conductors with the help of neat diagram and mention its applications-5M

Structure: Structure of high temperature superconductors : The structure of 1: 2: 3 compound is akin to that of ABO_3 structure of mineral perovskite ($CaTiO_3$). The A-type perovskite structure see figure 4.21) contains A atom in the centre, B atoms at the corners of the unit cell and O atoms occupy the mid-points of the edges. Composition of the unit cell can be deduced as follows:

Atom at the centre of unit cell = 1 A

$$\text{Effective atoms at the 8 corners} = \left(8 \times \frac{1}{8}\right) B = 1B$$

$$\text{Effective O atom at the mid-points} = \left(12 \times \frac{1}{4}\right) C = 3\ O$$



Applications:

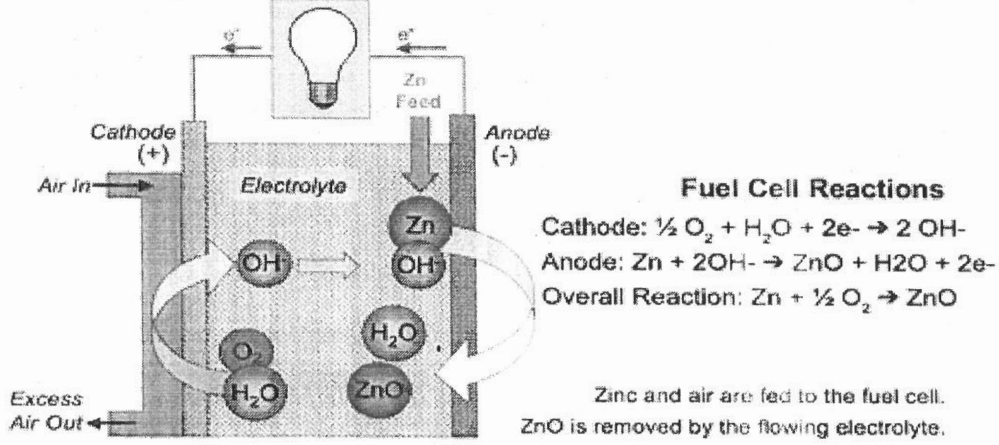
1.MRI: Strong magnetic fields for medical imaging.
2.Particle Accelerators: Powerful magnets for particle acceleration.
3.Maglev Trains: Frictionless, high-speed travel.
4.Power Transmission: Efficient electricity transmission.
5.Quantum Computing: Basis for qubits in quantum computers.
6.Medical Diagnostics: Sensitive magnetic field measurements.
7.Energy Storage: Quick energy storage and release.
8.Scientific Research: High magnetic fields for experiments.

UNIT-III

6 a) How do you differentiate between primary and secondary batteries? Explain the construction and working of Zn-air battery-5M

Primary cells	Secondary cells
Cell reaction in not reversible.	Cell reaction can be reversed.
Cannot be recharged.	Can be recharged.
Can be used as long as the materials are active in their composition.	Can be used again and again by recharging the cell.
Example: Leclanche cell or Dry cell, Alkaline battery, zinc-air battery etc.	Example: Lead acid storage cell, Ni-Cd batteries and Li-ion batteries etc.

Construction and working of Zinc- air battery



Anode - Amalgamated Zinc powder
Cathode – Air|C
Electrolyte - KOH 6M
Zinc – Air battery: Zn| KOH|| Air C
1. Zinc – Air battery is a primary battery i.e. non-rechargeable and the reaction is Irreversible.
2. It is also known as alkaline battery.
3. In this battery the cathode is made up of porous carbon plate which activated by Manganese oxide. Anode is made up of rectangular an pellets which are placed Between two cathodes.
4. Because it is alkaline battery we can use wither KOH or Noah as an electrolyte. But Use KOH only as the ionic conductance of KOH is higher than NoaH.
5. The electrodes are separated by gascade insulating material. The whole assembly is Enclosed in glass or ebonite container coated with Teflon, which is hydrophobic i.e. it Allows only oxygen but not moisture.
6. At cathode the electro active species air i.e. oxygen. During the cell reactions in

Battery the electrolyte concentrations is remains constant.
The reactions occur are as follows:
At anode: At anode the Zn undergoes oxidation in presence of electrolyte to produce zinc Oxide and eater.

$$Zn+2OH^- \longrightarrow ZnO+H_2O+2e^-$$

At cathode, water undergoes reduction reaction in presence of oxygen and electrons to give Up hydroxyl ions, so the OH - ions consumed at anode and liberated at cathode, hence the Overall concentration of electrolyte is constant.

$$1/2\ O_2 + H_2O + 2e^- \longrightarrow 2OH^-$$

The overall reaction is $Zn + 1/2\ O_2 \longrightarrow ZnO$

The output of the Zn-air battery is 1.65V

Advantages:

1. High energy density.
2. Low cost
3. Capacity is independent of load and temperature.

Applications:

1. Power source for hearing aids
2. Used in electric pagers
3. Used in military radio receivers
4. Used in voice transmitters

6 b) Calculate the EMF of the following cell at 25⁰C.
$Cu(s)/Cu^{2+}(0.001M)//\ Ag^+(0.01M)/Ag(s)$ $E^0Cu^{2+}/Cu)=-0.34V$, $E^0(Ag^+/\ Ag)=0.80V$ -5M

To calculate the EMF (electromotive force) of the given cell, we can use the Nernst equation:

$$E_{cell} = E^\circ_{cell} - \frac{0.0592}{n} \log Q$$

where:

- E_{cell} is the cell potential at non-standard conditions.
- E°_{cell} is the standard cell potential.
- n is the number of electrons transferred in the cell reaction.
- Q is the reaction quotient.

First, we need to find the standard cell potential, E°_{cell}:

$$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$$

Given:

- $E^\circ_{cathode} = E^\circ_{Ag^+/Ag} = 0.80\ V$
- $E^\circ_{anode} = E^\circ_{Cu^{2+}/Cu} = -0.34\ V$

$E_{cell} = 0.80\,V - (-0.34\,V) = 0.80\,V + 0.34\,V = 1.14\,V$

Next, we calculate the reaction quotient Q. The cell reaction is:

$Cu(s) + 2Ag^{+}(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$

The reaction quotient Q is given by:

$Q = \frac{[Cu^{2+}]}{[Ag^{+}]^{2}}$

Given:

- $[Cu^{2+}] = 0.001\,M$
- $[Ag^{+}] = 0.01\,M$

Thus,

$Q = \frac{0.001}{(0.01)^2} = \frac{0.001}{0.0001} = 10$

Now, we can use the Nernst equation to calculate the EMF of the cell at 25°C:

$E_{cell} = 1.14\,V - \frac{0.0592}{2}\log 10$

Since $n = 2$ (2 electrons transferred),

$$E_{cell} = 1.14\,V - \frac{0.0592}{2} \times 1$$

$$E_{cell} = 1.14\,V - 0.0296\,V$$

$$E_{cell} = 1.1104\,V$$

Therefore, the EMF of the cell at 25°C is approximately 1.11 V.

OR

7 a) Derive Nernst equation Mention its application in determination of p^H of unknown acid-5M

Nernst Equation:

Suppose the cell reaction involved in any reversible cell, which is represented by the given equation

$$aA + bB \rightarrow xX + yY$$

The free energy change of this reaction is given by the equation.

$$\Delta G = \Delta G^o + RT \ln \frac{aX^x \cdot aY^y}{aA^a \cdot aB^b} \quad \text{----------------} \quad 1$$

Where

ΔG^o = Standard free energy change

aA,bB,aX, & aY represents the activities of A,B,X,&Y respectively in any state.

If the cell reaction involves transference of 'n' moles of electrons, this corresponds to flow of 'nF' faradays of electricity.

If 'E' is the EMF of the cell, then the electrical energy produced in the cell = nFE

Since electrical energy produced is equal to the decrease in the free energy of the cell reaction, we have.

$$-\Delta G = nFE \qquad \text{----------------} \quad 2$$

Similarly for the standard state, we will have

$$-\Delta G^{o} = nFE^{o} \qquad \text{----------------} \quad 3$$

Where E^{o} is the standard EMF of the cell

Substituting the values of ΔG & ΔG^{o} from the equations 2&3 in 1 we get,

$$-nFE = -nFE^{o} + RT\ln\frac{aX^{x}.\ aY^{y}}{aA^{a}.\ aB^{b}} \qquad \text{----------------} \quad 4$$

Divide the equation 4 with '$-nF$'

$$E = E^{o} - \frac{RT}{nF}\ln\frac{aX^{x}.\ aY^{y}}{aA^{a}.\ aB^{b}} \qquad \text{----------------} \quad 5$$

Thus knowing the cell reaction and the standard EMF of the cell ' E^{o} ' .the EMF of the cell for known activities of the various reactants and products can be calculated.

Equation '5' is known as "Nernst equation", which is useful for the calculation of EMF of the cell.

When the concentrations are very dilute, activities'can be replaced by concentrations. Then, equations "5" becomes

$$E = E^{o} - \frac{RT}{nF}\ln\frac{[X]^{x}.\ [Y]^{y}}{[A]^{a}.\ [B]^{b}}$$

Where, R= 8.314 joule $joles.deg^{-}mole^{-}$

F = 96,500 coulombs

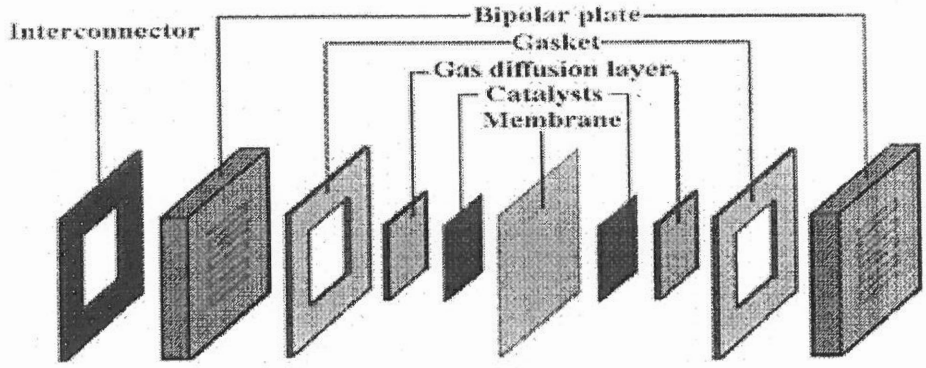
T = 298K at25°

It must be born in mind that the activities or concentrations of the pure liquids or pure solids are taken as unity.

Applications of Nernst Equation:

Nernst equation can be used to study the effect of electrolyte on electrode potential.
It can be used for calculation of the potential of a cell under standard conditions.
Used for determination of unknown concentration.
Used for the determination P^{H} from the measurement of EMF.
Used for the determination of valancy of an ions or number of electrons involved in electrode reaction.

7 b) Make the use of neat diagram to explain the construction, working and applications of polymer electrolyte membrane fuel cell-5M



Polymer Electrolyte Membrane Fuel cells (PEMFC): It offers an order of high power density than any other fuel cells. A solid polymer membrane used as electrolyte. The thin sheet of porous graphite papers used as electrodes. Platinum black coated on electrodes used as catalyst. The poly styrene sulphonic acid used as electrolyte, allows only hydrogen ions. The electrolyte is then sandwiched between anode and cathode, and three components sealed together under heat and pressure to produce membrane and electrode assembly.

Reactions: Hydrogen gas is consumed at anode, yielding the electrons at anode and producing hydrogen ions, which enter the electrolyte. At the cathode, oxygen combines with electrons and hydrogen ions to produce water. The water rejected out from the cell.

At the anode: $H_2 \rightarrow 2H^+ + 2e^-$

At the cathode: $\frac{1}{2} O_2 + 2H^+ + 2e^- \rightarrow H_2O$

Overall reaction: $H_2 + \frac{1}{2} O_2 \rightarrow H_2O$ $E^\circ cell = 1.23$ V

Applications of Polymer Electrolyte Membrane Fuel Cells :
Automotive Industry: Used in fuel cell electric vehicles (FCEVs) for zero-emission transportation.
Portable Power: Provides power for portable electronic devices and equipment, such as laptops, smartphones, and military gear.
Backup Power: Supplies reliable backup power for critical infrastructure, including hospitals, data centers, and telecommunications.
Residential Power: Used in residential fuel cell systems for home energy supply and heating.
Stationary Power Generation: Provides clean and efficient power for commercial and industrial buildings.
Public Transportation: Powers buses, trains, and other public transit vehicles for eco-friendly urban transport.
Aerospace and Defense: Used in drones, unmanned aerial vehicles (UAVs), and other aerospace applications for extended flight times and reduced emissions.
Material Handling Equipment: Powers forklifts and other material handling equipment in warehouses and distribution centers.

UNIT-IV

8a) Differences between Thermoplastics and Thermosetting plastics - 5M

Thermo Plastics	Thermo Settings
Formed by either addition (or) condensation polymerisation.	Formed by condensation polymerisation.
They are linear (or) branched linked structures.	They are cross linked (or) three dimensional structures.
Polymers chains are held together by weak attractive forces.	Polymers chains are held together by covalent cross links.
They soften on heating and stiffen on cooling.	They don't soften on heating.
They are soluble.	They are not soluble.
They can be remoulded, reshaped and reused.	They cannot be remoulded.
They can be recycled.	They cannot be recycled.
They are tough.	They are brittle.
They have low melting points.	They have high melting points.
Ex: PE, PS, PVC etc	Ex: Bakelite, UF resin

8B) Write a note on synthesis of poly lactic acid and mention its properties and applications-5M

Polylactic acid, also known as poly(lactic acid) or polylactide (PLA), is

a thermoplastic polyester wit backbone formula $(C_3H_4O_2)_n$ or $[–C(CH_3)HC(=O)O–]_n$

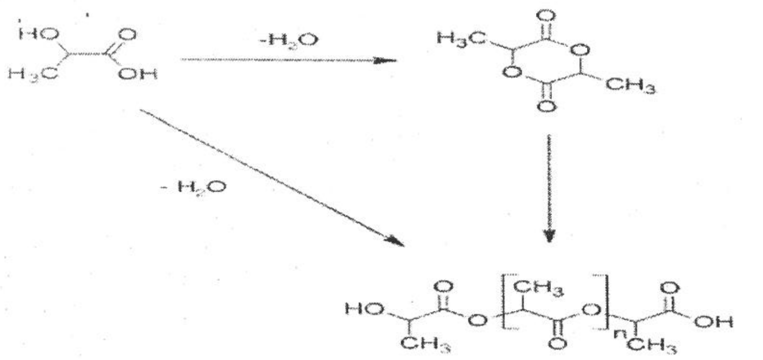
PLA has become a popular material due to it being economically produced from renewable resources.

The monomer is typically made from fermented plant starch such as from corn, sugarcane or sugar beet pulp.

Two main monomers are used for synthetic preparation: lactic acid, and the cyclic di- ester, lactide.

The most common route to PLA is the ring-opening polymerization of lactide with various metal catalysts (typically tin octoate) in solution or as a suspension.

The metal-catalyzed reaction tends to cause racemization of the PLA.



Properties

- PLA and its degradation products, mostly H_2O and CO_2, are neither carcinogenic nor toxic to the human body, hence making it a perfect polymer for biomedical applications including clips, sutures, and drug delivery systems.
- It has low melting point
- high strength, low thermal expansion, and good layer adhesion.
- PLA may be subjecte to thermal degradation.
- PLA can be formulated by several techniques such as melt extrusion, film casting, blow molding, and fiber spinning due to its greater thermal processability in comparison to other known biomaterials

Applications

- PLA and its degradation products, mostly H_2O and CO_2, are neither carcinogenic nor toxic to the human body, hence making it a perfect polymer for biomedical applications including clips, sutures, and drug delivery systems
- PLA is used for Packaging.
- A numerous variety of single use products including lids, hot and cold cups, plates and bowls, cutlery set ,strays, straws and containers is commercially available in the recent years.
- Fully biodegradable PLA gloves, bags of all kinds, gift boxes as well as animal wastes PLA brings together the ecological advantages along with the excellent performance in textiles and fills the gap between synthetic and natural fibers.
- Fibers made of PLA find a wide range of uses, from pharmaceutical and medical applications to environmentally friendly films and fibers for packaging, clothing, and houseware.
- PLA presents great physical, chemical, biomechanical and degradation properties which make it a suitable material for bone, cartilage, ligaments, skin, blood vessels, nerves, and muscles fixation.
  - PLA is the most widely used plastic filament material in FDM 3D printing.

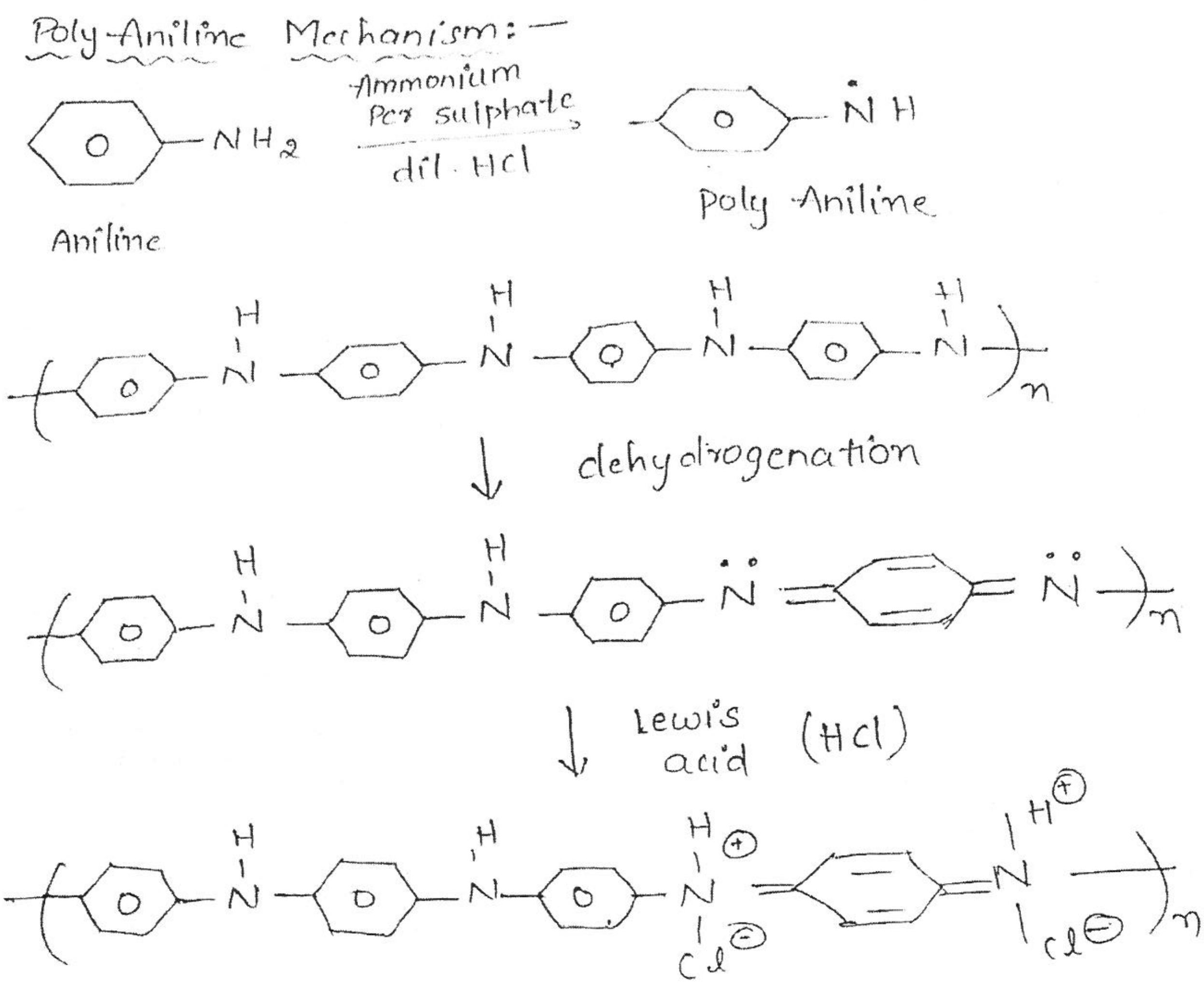
OR

9A) What are conducting polymers? Discuss the mechanism of conduction in polyaniline-5M

Conducting polymers are a class of polymers that conduct electricity. These materials combine the electronic properties of metals or semiconductors with the mechanical properties and processing advantages of polymers. Conducting polymers have conjugated double-bond structures along the polymer backbone, allowing for delocalized electrons and thus electrical conductivity. Examples include polyaniline, polypyrrole, and polythiophene.

Mechanism of Condensation of Polyaniline

Polyaniline (PANI) is a widely studied conducting polymer due to its unique properties, ease of synthesis, and environmental stability. The synthesis of polyaniline typically involves the oxidative polymerization of aniline. Here's a step-by-step mechanism of the condensation process:

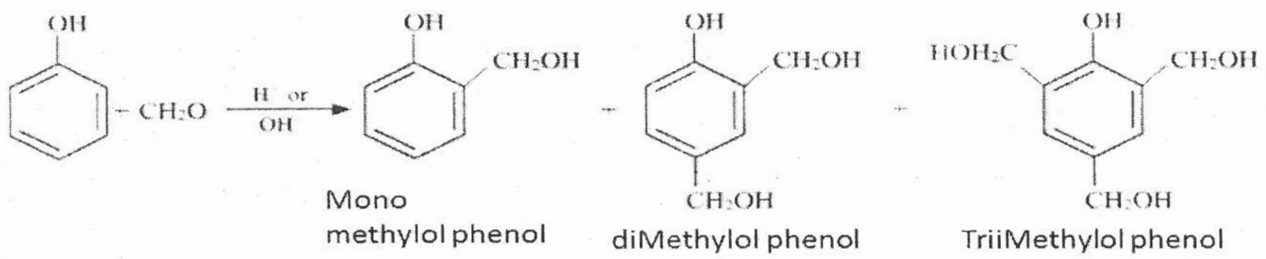


9B) Outline the synthesis of Bakelite Mention its properties and applications-5M

Preparation:

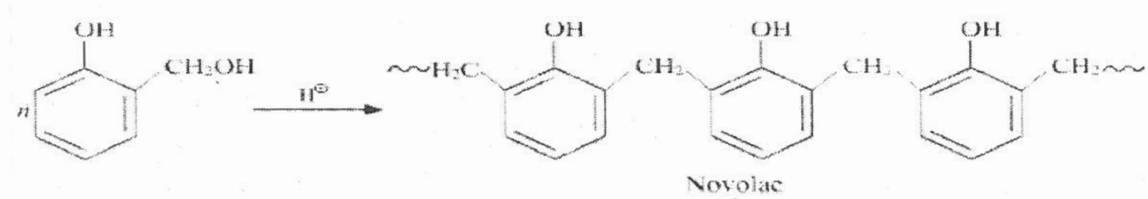
Step-1

The first step is reaction between phenol and formaldehyde to form mono, di and tri- methylol phenols.



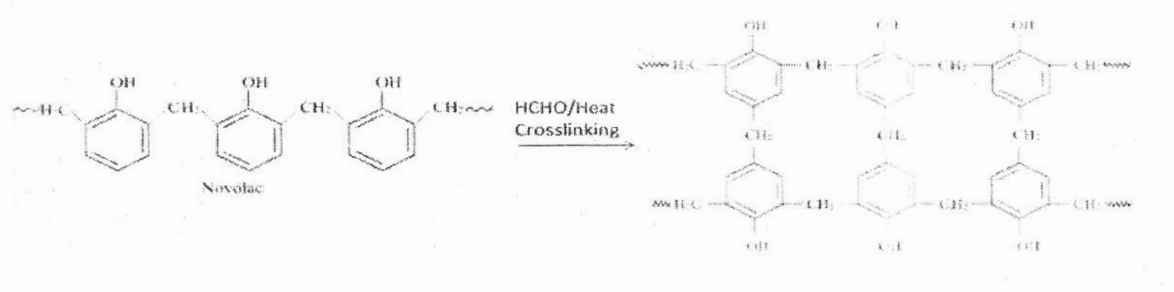
Step-II

When methylol phenols are heated with excess of phenol in presence of acid catalyst, the methylol phenols condense with phenol through methylene linkages to **from linear product novolac** with the elimination of water molecule.



Step-III

Further heating novolac and phenol in the presence of a catalyst(hexamethylenetetramine) leads to formation of hard, rigid, infusible cross linked polymer called bakelite.



Properties: These are

Rigid
Hard, resistant to heat
With stand to high temperature
Good insulator

Applications : Used for the preparation of Electrical insulator parts like Switches, Plugs & Handles

UNIT-V

10A) List out the Characteristics of electromagnetic spectrum - 5M

- A technique used to investigate a molecule's properties based on how it reacts to electromagnetic radiations is known as spectroscopy.
- The electromagnetic (EM) spectrum is the range of all types of EM radiation.
- Radiation is energy that travels and spreads out as it goes – the visible light that comes from a lamp in your house and the radio waves that come from a radio station are two types of electromagnetic radiation.
- The other types of EM radiation that make up the electromagnetic spectrum are microwaves, infrared light, ultraviolet light, X-rays and gamma-rays.
- The electromagnetic spectrum is a range of frequencies, wavelengths and photon energies covering frequencies from below 1 hertz to above 1025 Hz, corresponding to wavelengths which are a few kilometres to a fraction of the size of an atomic nucleus in the spectrum of electromagnetic waves.
- Generally, in a vacuum, electromagnetic waves tend to travel at speeds which are similar to that of light.
- However, they do so at a wide range of wavelengths, frequencies and photon energies.
- The electromagnetic spectrum consists of a span of all electromagnetic radiation which further contains many sub ranges, which are commonly referred to as portions.
- These can be further classified as infrared radiation, visible light or ultraviolet radiation.
- Radio: radio captures radio waves emitted by radio stations, bringing your favourite tunes. Radio waves are also emitted by stars and gases in space.
- Microwave: Microwave radiation will cook your popcorn in just a few minutes, but is also used by astronomers to learn about the structure of nearby galaxies.
- Infrared: Night vision goggles pick up the infrared light emitted by our skin and objects with heat. In space, infrared light helps us map the dust between stars.
- Visible: Our eyes detect visible light. Fireflies, light bulbs, and stars all emit visible

light.

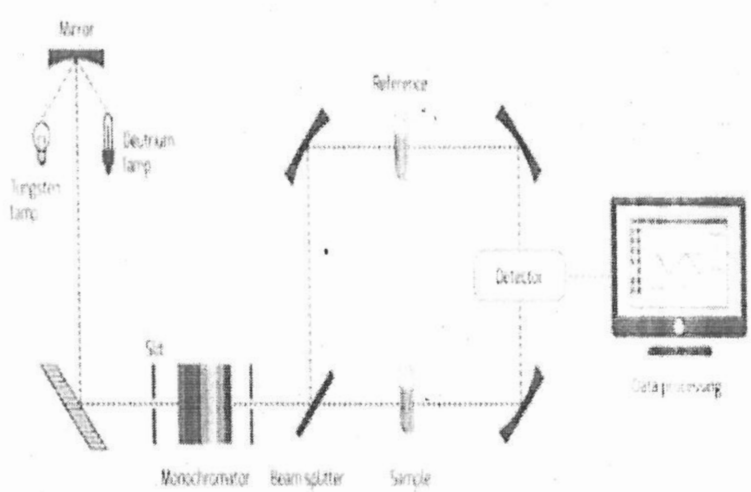
- Ultraviolet: Ultraviolet radiation is emitted by the Sun and are the reason skin tans and burns. "Hot" objects in space emit UV radiation as well.
- X-ray: A dentist uses X-rays to image your teeth, and airport security uses them to see through your bag. Hot gases in the Universe also emit X-rays.
- Gamma ray: Doctors use gamma-ray imaging to see inside your body. The biggest gamma-ray generator of all is the Universe

Electromagnetic radiation can be expressed in terms of energy, wavelength, or frequency. Frequency is measured in cycles per second, or Hertz. Wavelength is measured in metres. Energy is measured in electron volts.

10 B) Describe the principle and instrumentation of u.v-visible spectroscopy with the help of neat diagram-5M

- U.V-Visible spectroscopy is absorption spectroscopy that deals with the recording of the absorption of electromagnetic radiation of the U.V and Visible regions of the electromagnetic spectrum.
- The U.V-region ranges from 200-400 nm whereas the visible region ranges from 400 to 800 nm.
- So, we can say that U.V-Visible spectroscopy utilises a 200-800 nm range for working.
- This technique is widely used for detecting the presence and elucidating the nature of the conjugated multiple bonds and aromatic rings.

Instrumentation of UV-Visible Spectroscopy



1.Radiation source

- Hydrogen-discharge lamp is the most commonly used source of radiation in the U.V region (200-400 nm) whereas a deuterium-discharge lamp is used when more intensity (3-5 times) is desired.
- A tungsten-filament lamp is used when absorption in the Visible region (400-800 nm) is to be determined.

2. Monochromator

- It helps to separate the radiations into separate wavelengths that are only allowed to pass a specific wavelength through it.
- Monochromators are generally made up of prism or grating which is made up of quartz.
- This is so because quartz does not absorb the radiations thus ensuring no loss of intensity and precise results.

3. Beam separator

- As the name suggests, beam separators help to separate the single radiation into two different paths/chambers : the reference chamber and the sample chamber.
- The former is called the reference beam and the latter is known as the sample beam.

4. Detectors

- Detectors have photocells or photomultiplier tubes that generate a voltage proportional to the radiation energy that strikes them.

5. Amplifier

- The spectrophotometer has a balancing electronic amplifier that subtracts the absorption of the solvent from that of the solution electronically.

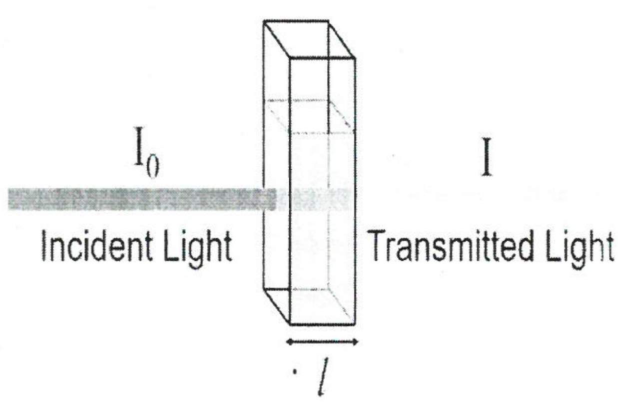
6. Recorder

- A recorder automatically records the spectrum as a plot of the wavelengths of absorbed radiations against absorbance (A) or molar absorptivity (e).

OR

11.A)How does the Beer-Lambert law account for the exponential decrease in light intensity with increasing concentration of absorbing species-5M

Beer-Lambert Law



- The Beer-Lambert Law (also called Beer's Law) is a relationship between the attenuation of light through a substance and the properties of that substance.
- In this article, the definitions of transmittance and absorbance of light by a substance are first introduced followed by an explanation of the Beer-Lambert Law.
- Consider monochromatic light transmitted through a solution; with an incident intensity of I0 and a transmitted intensity of I
- The transmittance, T, of the solution is defined as the ratio of the transmitted intensity, I, over the incident intensity, I0 and takes values between 0 and 1.

Beer Lambert Law Equation:

However, it is more commonly expressed as a percentage transmittance: $T = \frac{I}{I_0}$

$$T(\%) = 100\frac{I}{I_0}$$

The absorbance, A, of the solution is related to the transmittance and incident and transmitted intensities through the following relations:

$$A = \log_{10}\frac{I_0}{I}$$
$$A = -\log_{10} T$$

- The absorbance has a logarithmic relationship to the transmittance; with an absorbance of 0 corresponding to a transmittance of 100% and an absorbance of 1 corresponding to 10% transmittance.
- Additional values of transmittance and absorbance pairings are given in Table 1.
- A visual demonstration of the effect that the absorbance of a solution has on the attenuation light passing through it is shown Figure 2, where a 510 nm laser is passed through three solutions of Rhodamine 6G with different absorbance.
- Attenuation of a 510 nm laser through three solutions of Rhodamine 6G with different absorbance values at 510 nm.
- The yellow glow is the fluorescence emission at ~560 nm.

The Beer-Lambert law is a linear relationship between the absorbance and the concentration, molar absorption coefficient and optical path length of a solution:

$$A = \varepsilon c l$$

A	Absorbance	
ε	Molar absorption coefficient	$M^{-1}cm^{-1}$
c	Molar concentration	M
l	optical path length	cm

- The molar absorption coefficient is a sample dependent property and is a measure of how strong an absorber the sample is at a particular wavelength of light.

11.B) Explain how IR spectroscopy is used to identify functional groups in organic molecules-5M

Infrared (IR) spectroscopy is a powerful analytical technique used to identify functional groups in organic molecules. It works by measuring the absorption of infrared light by a sample, which causes molecular vibrations. Here's how IR spectroscopy is used to identify functional groups:

Basic Principles

Infrared Light Absorption:

Molecules absorb specific frequencies of infrared light that cause their bonds to vibrate.

Different functional groups absorb characteristic frequencies, leading to a unique spectrum for each compound.

Vibrational Modes:

When molecules absorb IR radiation, their bonds undergo various types of vibrations, including stretching and bending.

Stretching vibrations involve changes in bond length, while bending vibrations involve changes in bond angles.

Steps to Identify Functional Groups

Sample Preparation:

The sample can be prepared in different forms, such as a thin film, solution, or pressed into a pellet with a non-absorbing substance like KBr.

Spectrum Acquisition:

The sample is exposed to a range of IR radiation.

The IR spectrometer measures the intensity of transmitted light across different wavelengths, generating an IR spectrum.

Spectrum Analysis:

The IR spectrum is a plot of transmittance (or absorbance) versus wavenumber (inverse of wavelength, measured in cm^{-1})

Peaks in the spectrum correspond to specific vibrations of the molecule's bonds.

Application of IR

1. Determination of Molecular Structure.
2. Studying the Progress of the Reactions.
3. Qualitative Analysis of Functional Groups.
4. Detection of Impurity in a Compound.
5. Shape of Symmetry of a molecule
6. Presence of Water in a Sample
7. Examination of Old Paintings and Artefacts.
8. Identification of Organic Compound.