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M.SC. II SEM

PHYSICAL CHEMISTRY II

- 400+ MCQs
- Brief and Intensive Notes

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Physical Chemistry II

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UNIT I	**Chemical dynamics** Method of determining rate law, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation and activated complex theory, and ionic reaction, kinetic salt effects, steady state kinetics, kinetics and thermodynamiccontrol of reaction, treatment of uni molecular reactions. Dynamic chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of Ethane) , photochemical (hydrogen -bromine and hydrogenchlorine reactions) and oscillatory reaction (Belousov-Zhabotinsky Reactions), homogeneous catalysis, kinetics of enzyme reactions, general feature of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis and the nuclear magnetic resonance method. Dynamics of molecular motion, probing the transition state, dynamics of barrier less chemical reactions in solution, dynamics of uni molecular reactions (Lindemann- Hinshelwood Kerala and Rice RamspergerKassel-Marcus [RRKM]. Theory of unimolecular reactions).
UNIT II	**Surface chemistry** A. Adsorption Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation) , Gibbs adsorption isotherm , estimation of surface area (BET equation), surface film on liquids (Electrokinetic phenomenA), catalytic activity at surfaces. B. Micelles Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factor affecting the the CMC of surfactant, counter ion binding to micelles, thermodynamics of micellization-phase separation and mass action models, solubilization, micro emulsion, reverse micelles. C. Macromolecules Polymer- definition, types of polymers, electrically conducting, fire resistant, liquid crystal polymers, kinetics of polymerization, mechanism of polymerization.Molecular mass, number and mass average molecular mass, molecular mass determination (osmometry viscometry, diffusion and light scattering methods), sedimentation, chain configuration of macro molecules, calculation of average dimensions of various chain structures.
UNIT III	**Electrochemistry** Electrochemistry of solution, Debye-Huckel-Onsager treatment and its extension, ion solvent interactions, Debye-Huckel-Jerum mode. Thermodynamics of electrified interface equations. Derivation of Electro-capillarity, Lippmann equations (surface excess), methods of determination. Structure of electrified interfaces. GuoyChapman, Graham- Devanathan-Mottwatts, Tobin, Bockris, Devanathan models.Over potentials, Exchange current density, derivation of Butler-Volmer equation, Tafel plot.Quantum aspects of charge transfer at electrodes-solution interfaces, quantization of charge transfer, tunneling. Semiconductor interfaces- theory of double layer at semiconductor, electrolytic solution interfaces, structure of double layer interfaces. Effect of light at semiconductor solution interface.

	Electro-catalysis- influence of various parameters. Hydrogen electrode. Bio-electrochemistry, threshold membrane phenomenon, Nernst-Planck equation, Hodges-Huxley equations, core conductor models, Electrocardiography. Polarography theory, Ilkovic equation; Half wave potential and its significance. Introduction to corrosion, homogenous theory, forms of corrosion, corrosion monitoring and prevention methods.

UNIT I

UNIT I
Chemical dynamics

Method of Determining Rate Law:
Rate law:

$rate = k[A]^m[B]^n$

Determining orders of reaction experimentally:
initial rate method, method of half-life, and isolation method.
Collision Theory of Reaction Rates:
Rate of reaction is proportional to the number of collisions between reactant molecules.
Factors affecting collision frequency: concentration, temperature, and the presence of a catalyst.
Steric Factor:
The fraction of collisions with proper orientation for reaction to occur.
Accounts for the effectiveness of collisions in reaction rate.
Activated Complex Theory:
Transition state theory: molecules must acquire a certain amount of energy (activation energy) to form an activated complex.
Describes the transition state between reactants and products.
Arrhenius Equation:

$k = A \cdot e^{-E_a/RT}$

Relates the rate constant of a reaction to temperature and activation energy.
Ionic Reactions:
Reaction mechanisms involving ions in solution.
Examples: acid-base reactions, precipitation reactions, redox reactions.
Kinetic Salt Effects:
Influence of added salts on reaction rates.
Often seen in reactions involving charged species.
Steady State Kinetics:
Assumption that concentrations of intermediates remain constant over time.
Used to simplify complex reaction mechanisms.
Kinetics and Thermodynamic Control of Reaction:
Kinetic control: determines the rate at which products are formed.
Thermodynamic control: determines the equilibrium distribution of products and reactants.
Treatment of Unimolecular Reactions:
Rate law for unimolecular reactions:

$rate = k[A]$
Examples: first-order decay, radioactive decay.

Dynamic Chain Reactions:
Hydrogen-Bromine Reaction:
Involves the formation of HBr and Br radicals. The overall reaction is:

$$H_2 + Br_2 \rightarrow 2HBr.$$

The reaction proceeds via a chain mechanism involving initiation (breaking of H-Br bond by UV light), propagation (formation of H and Br radicals), and termination steps (recombination of radicals).

Pyrolysis of Acetaldehyde: The pyrolysis of acetaldehyde (CH_3CHO) involves the decomposition of the molecule into smaller fragments such as CH_4, CO, and H_2. The reaction is initiated by heat and proceeds via radical intermediates.

Decomposition of Ethane: Ethane (C_2H_6) can undergo thermal decomposition at high temperatures to form ethylene (C_2H_4) and hydrogen gas. The reaction involves breaking the C-C bond in ethane.

Photochemical Reactions:
Hydrogen-Bromine and Hydrogen-Chlorine Reactions: These reactions involve the photo dissociation of hydrogen halides (HBr and HCl) into hydrogen and halogen radicals upon absorption of light energy. The overall process proceeds via chain mechanisms similar to dynamic chain reactions.

Oscillatory Reactions:
Belousov-Zhabotinsky Reactions: These are oscillatory chemical reactions exhibiting periodic changes in color or other properties. The reaction involves a series of complex oxidation-reduction reactions, often involving transition metal catalysts, organic substrates, and bromine-based oscillators.

Homogeneous Catalysis:
Catalysis where the catalyst is in the same phase as the reactants. It involves the formation of transient intermediate species which lower the activation energy of the reaction. Example: the reaction between hydrogen peroxide and iodide ions catalyzed by iodine in aqueous solution.

Kinetics of Enzyme Reactions:
Enzyme reactions follow Michaelis-Menten kinetics, where the rate of reaction depends on the concentration of substrate and enzyme. The reaction velocity increases with substrate concentration until it reaches a maximum rate (Vmax) when all enzyme active sites are saturated.

General Features of Fast Reactions:
Fast reactions typically occur in milliseconds to microseconds. They often involve reactive intermediates and can be studied using various experimental techniques such as stopped-flow, relaxation, flash photolysis, and nuclear magnetic resonance (NMR).

<u>Study of Fast Reactions by Various Methods:</u>

Flow Method: Allows the rapid mixing of reactants to initiate a reaction, followed by rapid quenching to stop the reaction for analysis.

Relaxation Method: Measures the rate of change of a property (e.g., concentration, absorbance) as the system returns to equilibrium after a perturbation.

Flash Photolysis: Uses short-duration light pulses to initiate a reaction, followed by monitoring the transient species formed using spectroscopic techniques.

Nuclear Magnetic Resonance (NMR) Method: Detects changes in the magnetic properties of nuclei in a molecule, providing information about reaction kinetics and intermediate species.

These methods provide insights into reaction mechanisms, intermediate species, and reaction kinetics of fast reactions.

Dynamics of molecular motion: This refers to the study of how molecules move and interact with each other. Reactions occur when molecules collide with sufficient energy and proper orientation. The reaction rate depends on factors like temperature and concentration.
Probing the transition state: Transition state theory describes the intermediate state that molecules pass through during a chemical reaction. Probing this state involves experimental techniques to understand its structure and properties, which provides insights into reaction mechanisms and kinetics.
Dynamics of barrierless chemical reactions in solution: Barrierless reactions are those that proceed without overcoming an energy barrier. In solution, molecules are surrounded by solvent molecules, which can affect the reaction dynamics. Understanding the dynamics of barrierless reactions in solution involves studying how solvent molecules influence the reaction rate and mechanism.
Dynamics of unimolecular reactions: Unimolecular reactions involve the decomposition or rearrangement of a single molecule. Lindemann-Hinshelwood and RRKM theories are two approaches to understanding the dynamics of these reactions.
Lindemann-Hinshelwood theory: This theory proposes that unimolecular reactions proceed through a two-step process involving the formation of an activated complex.
RRKM theory (Rice-Ramsperger-Kassel-Marcus): This theory provides a statistical framework for describing the kinetics of unimolecular reactions. It considers the distribution of energies among reactant molecules and predicts the rate constants for different reaction pathways.
Reactions: These topics involve a mix of chemical kinetics and theoretical frameworks. Each has its set of equations and reactions. For example, the Arrhenius equation relates reaction rate to temperature, while transition state theory uses the Eyring equation to calculate rate constants. RRKM theory involves statistical mechanics equations to describe energy distributions among reactant molecules.
Some points to remember:

- ❖ Rate law determination involves experimental determination of the mathematical relationship between reactant concentrations and reaction rate.
- ❖ Collision theory proposes that chemical reactions occur when reactant molecules collide with sufficient energy and proper orientation.
- ❖ Steric factor accounts for the influence of molecular orientation on reaction rates, considering how molecular shape affects collision effectiveness.
- ❖ Activated complex theory suggests that reactions proceed through transient, high-energy intermediate states known as activated complexes.
- ❖ The Arrhenius equation relates the rate constant of a reaction to temperature and activation energy.
- ❖ Ionic reactions involve the transfer of electrons between ions in solution.
- ❖ Kinetic salt effects refer to changes in reaction rates caused by the presence of ionic salts in a solution.
- ❖ Steady-state kinetics analyzes reaction mechanisms under conditions where concentrations of intermediates remain constant.
- ❖ Kinetics and thermodynamic control of reactions consider how both kinetic and thermodynamic factors influence reaction pathways and product distributions.
- ❖ Unimolecular reactions involve the transformation of a single molecule into one or more products.

- Rate constant represents the proportionality constant between the rate of a reaction and the concentrations of reactants.
- Transition state theory describes the activated complex as a transition state between reactants and products.
- Temperature dependence of reaction rates is described by the Arrhenius equation, where higher temperatures increase reaction rates.
- Activation energy is the minimum energy required for a chemical reaction to occur.
- Effective collision occurs when reactant molecules collide with proper orientation and sufficient energy to overcome the activation energy barrier.
- Maxwell-Boltzmann distribution describes the distribution of kinetic energies among molecules in a system.
- Reaction mechanism outlines the step-by-step sequence of elementary reactions leading from reactants to products.
- Catalysts increase reaction rates by providing an alternate reaction pathway with lower activation energy.
- Homogeneous catalysts are in the same phase as the reactants, while heterogeneous catalysts are in a different phase.
- Reaction order describes the relationship between the concentration of reactants and the rate of reaction.
- Complex reactions involve multiple elementary steps and intermediate species.
- Rate-determining step is the slowest step in a reaction mechanism, determining the overall rate of the reaction.
- Reaction intermediates are species formed and consumed during the course of a reaction but do not appear in the overall balanced equation.
- Rate constant units depend on the overall reaction order and are determined experimentally.
- Rate law expresses the relationship between the rate of a reaction and the concentrations of reactants raised to certain powers, determined experimentally.
- Dynamic chain reactions involve a chain of events where reactive intermediates continuously regenerate, like in the hydrogen-bromine reaction.
- Pyrolysis of acetaldehyde is a process where acetaldehyde breaks down into simpler compounds under high temperature.
- Ethane decomposition involves the breaking of ethane molecules into smaller fragments.
- Photochemical reactions occur under the influence of light, such as the hydrogen-bromine and hydrogen-chlorine reactions.
- Oscillatory reactions, like the Belousov-Zhabotinsky Reactions, exhibit periodic changes in concentration over time.
- Homogeneous catalysis involves catalysts in the same phase as the reactants.
- Kinetics of enzyme reactions study the rate at which enzymes catalyze biochemical reactions.
- General features of fast reactions include rapid changes in concentration and short reaction timescales.
- Fast reactions can be studied using various methods, including the flow method, relaxation method, flash photolysis, and nuclear magnetic resonance.
- The flow method involves continuously mixing reactants and analyzing the product stream.
- Relaxation methods study the return of a system to equilibrium after a disturbance.
- Flash photolysis uses short bursts of light to initiate reactions and study reaction intermediates.

- ❖ Nuclear magnetic resonance (NMR) spectroscopy can provide insights into reaction kinetics by analyzing changes in molecular structure over time.
- ❖ In dynamic chain reactions, initiation, propagation, and termination steps occur continuously.
- ❖ The rate of a chain reaction depends on factors like temperature, pressure, and concentrations of reactants.
- ❖ Pyrolysis reactions often produce radicals, which are highly reactive species with unpaired electrons.
- ❖ Ethane decomposition is an important step in various industrial processes, including the production of ethylene.
- ❖ Photochemical reactions are influenced by the intensity and wavelength of light.
- ❖ Oscillatory reactions are examples of nonlinear dynamics in chemical systems.
- ❖ Homogeneous catalysis can increase reaction rates by providing alternative reaction pathways with lower activation energies.
- ❖ Enzyme kinetics follow Michaelis-Menten kinetics, where enzyme-substrate complexes form and break down.
- ❖ Fast reactions typically proceed to completion in a short period, making them challenging to study experimentally.
- ❖ The flow method allows for precise control of reaction conditions and can be used to study reaction kinetics under various scenarios.
- ❖ Relaxation methods measure the time it takes for a system to return to equilibrium after a disturbance.
- ❖ Flash photolysis provides detailed information about reaction intermediates and their lifetimes.
- ❖ NMR spectroscopy can detect changes in chemical shifts and peak intensities to monitor reaction progress.
- ❖ Chain reactions can be autocatalytic, where reaction products catalyze further reactions.
- ❖ Pyrolysis reactions are important in the production of various chemicals, including plastics and synthetic rubber.
- ❖ Ethane decomposition is a key step in steam cracking, a process used to produce ethylene and other valuable chemicals.
- ❖ Photochemical reactions play a crucial role in atmospheric chemistry, influencing ozone depletion and pollutant formation.
- ❖ Oscillatory reactions have applications in chemical clocks and as models for biological oscillators.
- ❖ Homogeneous catalysis is widely used in the synthesis of pharmaceuticals, polymers, and fine chemicals.
- ❖ Enzyme kinetics are crucial for understanding metabolism, drug interactions, and disease mechanisms.
- ❖ Fast reactions are often studied using techniques that can capture rapid changes in concentration or molecular structure.
- ❖ Understanding reaction kinetics is essential for optimizing industrial processes, designing new materials, and elucidating biological pathways.
- ❖ Molecular motion is dynamic and influenced by various factors.
- ❖ Transition states are crucial in understanding reaction mechanisms.
- ❖ Probing the transition state helps elucidate reaction pathways.
- ❖ Barrier-less chemical reactions occur without an energy barrier.
- ❖ In solution, chemical reactions are influenced by solvent dynamics.
- ❖ Uni-molecular reactions involve a single molecule in the reaction.

- Lindemann-Hinshelwood mechanism describes bimolecular reactions.
- The Rice-Ramsperger-Kassel-Marcus (RRKM) theory explains uni-molecular reactions.
- RRKM theory considers statistical mechanics principles.
- Energy partitioning plays a significant role in uni-molecular reactions.
- Kinetic isotope effects provide insights into reaction mechanisms.
- Activation energy determines the rate of a chemical reaction.
- Quantum mechanical tunneling can occur in barrier-less reactions.
- Isomerization reactions involve molecular rearrangement.
- Collision theory describes the probability of molecular collisions leading to reactions.
- Rate constants quantify reaction rates at different conditions.
- Temperature influences reaction rates through kinetic energy.
- Arrhenius equation relates temperature and rate constants.
- Reaction coordinate diagrams illustrate energy changes during a reaction.
- Transition state theory provides a theoretical framework for understanding reaction rates.
- Rate-determining steps dictate the overall rate of a reaction.
- Catalysis accelerates chemical reactions by lowering activation energy.
- Enzymes are biological catalysts that facilitate biochemical reactions.
- Reaction mechanisms detail step-by-step processes of chemical transformations.
- Molecular dynamics simulations model molecular motion over time.
- Quantum mechanics describes the behaviour of particles at the atomic and subatomic levels.
- Kinetics studies the rates of chemical reactions.
- Thermodynamics relates energy changes to the spontaneity of reactions.
- Equilibrium describes a balance between forward and reverse reactions.
- Gibbs free energy determines the spontaneity of a reaction.
- Rate laws express the relationship between reactant concentrations and reaction rates.
- Elementary reactions involve only a small number of molecules.
- Steady-state approximation simplifies complex reaction mechanisms.
- Hammond postulate relates transition state stability to reaction products.
- Reaction dynamics research contributes to fields such as materials science and drug discovery.

MCQ'S

1. Which theory explains the influence of molecular collisions on reaction rates?
A) Arrhenius equation
B) Collision theory
C) Activated complex theory
D) Ionic reaction theory
Answer: B) Collision theory
2. The steric factor in collision theory accounts for:
A) The concentration of reactants
B) The orientation of molecules during collisions
C) The activation energy of the reaction
D) The presence of a catalyst
Answer: B) The orientation of molecules during collisions
3. According to the Arrhenius equation, the rate constant (k) of a reaction:
A) Decreases with increasing temperature

B) Increases with decreasing temperature
C) Increases exponentially with increasing temperature
D) Remains constant regardless of temperature
Answer: C) Increases exponentially with increasing temperature
4. The activated complex theory suggests that: CSJMU 1990
A) Only reactant molecules with enough kinetic energy can react
B) Molecules collide randomly, leading to reactions
C) There is a transitional state between reactants and products
D) The reaction rate is determined by the concentration of products
Answer: C) There is a transitional state between reactants and products
5. Kinetic salt effects refer to:
A) The influence of ionic strength on reaction rates
B) The effect of salt concentration on the rate of a reaction
C) The role of catalysts in salt solutions
D) The behaviour of salts during a reaction
Answer: A) The influence of ionic strength on reaction rates
6. In steady-state kinetics, the concentration of intermediates:
A) Remains constant throughout the reaction
B) Increases linearly with time
C) Decreases exponentially with time
D) Oscillates periodically
Answer: A) Remains constant throughout the reaction
7. Which factor primarily determines the rate of a unimolecular reaction?
A) The concentration of reactants
B) The activation energy barrier
C) The presence of a catalyst
D) The stability of the activated complex
Answer: B) The activation energy barrier
8. The kinetic control of a reaction refers to: Allahabad University 2000
A) Controlling the rate at which the reaction occurs
B) Influencing the position of the equilibrium
C) Determining the products of the reaction
D) Regulating the temperature of the reaction
Answer: A) Controlling the rate at which the reaction occurs
9. Which of the following is NOT a factor affecting the rate of a reaction?
A) Temperature
B) Concentration of reactants
C) Surface area of reactants
D) Color of the reactants
Answer: D) Color of the reactants
10. The rate law of a reaction expresses the relationship between:
A) Rate and time
B) Rate and concentration of reactants
C) Rate and volume of the reaction vessel
D) Rate and pressure of reactants
Answer: B) Rate and concentration of reactants
11. A catalyst increases the rate of a reaction by:
A) Increasing the activation energy
B) Decreasing the activation energy
C) Decreasing the concentration of reactants

D) Increasing the stability of the activated complex
Answer: B) Decreasing the activation energy
12. Which of the following is true about a first-order reaction?
A) Its rate is independent of the concentration of reactants
B) Its rate depends on the square of the concentration of reactants
C) Its rate depends linearly on the concentration of reactants
D) Its rate is inversely proportional to the concentration of reactants
Answer: C) Its rate depends linearly on the concentration of reactants
13. The Arrhenius equation relates the rate constant of a reaction to:
A) Temperature and activation energy
B) Pressure and volume
C) Enthalpy change and entropy change
D) Concentration of reactants and products
Answer: A) Temperature and activation energy
14. The activated complex in a chemical reaction is:
A) A stable intermediate compound
B) A high-energy transitional state
C) A product of the reaction
D) A catalyst for the reaction
Answer: B) A high-energy transitional state
15. The steric factor in collision theory accounts for:
A) The effect of temperature on reaction rate
B) The effect of catalysts on reaction rate
C) The effect of molecular orientation on reaction rate
D) The effect of solvent polarity on reaction rate
Answer: C) The effect of molecular orientation on reaction rate
16. The rate-determining step in a multi-step reaction:
A) Is always the first step
B) Is always the last step
C) Is the step with the highest activation energy
D) Is the step with the lowest activation energy
Answer: C) Is the step with the highest activation energy
17. The steady-state approximation is often used to simplify the analysis of:
A) Homogeneous catalysis
B) Heterogeneous catalysis
C) Enzyme kinetics
D) Transition metal complexes
Answer: A) Homogeneous catalysis
18. Which statement about activation energy is correct?
A) It measures the overall energy change in a reaction
B) It determines the spontaneity of a reaction
C) It is the energy barrier that must be overcome for a reaction to occur
D) It remains constant at different temperatures
Answer: C) It is the energy barrier that must be overcome for a reaction to occur
19. The rate law for a reaction can be determined by:
A) The stoichiometry of the reaction
B) The concentration of the products
C) Experimentally measuring the rate at different conditions
D) The enthalpy change of the reaction
Answer: C) Experimentally measuring the rate at different conditions

20. The Arrhenius equation is used to describe the relationship between:
A) Rate constant and activation energy
B) Rate constant and temperature
C) Rate constant and concentration of reactants
D) Rate constant and pressure of reactants
Answer: B) Rate constant and temperature
21. The collision theory of reaction rates explains the effect of: CSJMU 1991
A) Temperature on reaction rate
B) Catalysts on reaction rate
C) Pressure on reaction rate
D) Molecular collisions on reaction rate
Answer: D) Molecular collisions on reaction rate
22. In the Arrhenius equation, what does the pre-exponential factor represent?
A) The frequency of collisions between reactant molecules
B) The activation energy of the reaction
C) The steric factor of the reaction
D) The stability of the activated complex
Answer: A) The frequency of collisions between reactant molecules
23. A reaction with a large steric factor is likely to:
A) Have a high activation energy
B) Occur rapidly at low temperatures
C) Be sensitive to changes in temperature
D) Proceed with low entropy change
Answer: B) Occur rapidly at low temperatures
24. The activated complex in a reaction is:
A) A stable intermediate
B) A transition state
C) A catalyst
D) A product
Answer: B) A transition state
25. The rate-determining step in a reaction mechanism: CSJMU 2000
A) Has the highest activation energy
B) Is the fastest step
C) Is the slowest step
D) Is the step with the highest concentration of intermediates
Answer: A) Has the highest activation energy
26. The term "kinetic control" refers to:
A) Controlling the rate of a reaction
B) Controlling the position of equilibrium
C) Controlling the temperature of the reaction
D) Controlling the concentration of reactants
Answer: A) Controlling the rate of a reaction
27. The rate constant (k) in the Arrhenius equation depends on:
A) Temperature and pressure
B) Temperature and activation energy
C) Concentration of reactants and products
D) Pressure and volume
Answer: B) Temperature and activation energy
28. A reaction that proceeds with zero order kinetics means that:
A) The rate is independent of the concentration of reactants

B) The rate is proportional to the square of the concentration of reactants
C) The rate is inversely proportional to the concentration of reactants
D) The rate is directly proportional to the concentration of reactants
Answer: A) The rate is independent of the concentration of reactants
29. The Arrhenius equation is often used to:
A) Determine the equilibrium constant of a reaction
B) Predict the rate constant at different temperatures
C) Calculate the activation energy of a reaction
D) Determine the stoichiometry of a reaction
Answer: B) Predict the rate constant at different temperatures
30. Uni-molecular reactions are primarily controlled by:
A) Collision frequency
B) Activation energy
C) Concentration of reactants
D) Surface area of reactants
Answer: B) Activation energy
31. In the hydrogen-bromine reaction, which of the following is a product?
A) HBr
B) H_2
C) Br_2
D) HCl
Answer: C) Br_2
32. What is the main product of the pyrolysis of acetaldehyde?
A) Ethanol
B) Methane
C) Acetylene
D) Formaldehyde
Answer: C) Acetylene
33. In the decomposition of Ethane, what are the primary products?
A) Ethene and Methane
B) Ethanol and Ethylene
C) Ethanol and Hydrogen
D) Ethene and Hydrogen
Answer: A) Ethene and Methane
34. Which reaction belongs to photochemical processes?
A) Hydrogen-bromine
B) Hydrogen-chlorine
C) Decomposition of Ethane
D) Pyrolysis of acetaldehyde
Answer: A) Hydrogen-bromine
35. What is the product of the photochemical reaction between hydrogen and bromine?
A) HBr
B) H_2
C) Br_2
D) HCl
Answer: C) Br_2
36. Which reaction demonstrates oscillatory behaviour?
A) Hydrogen-bromine
B) Pyrolysis of acetaldehyde
C) Belousov-Zhabotinsky

D) Decomposition of Ethane
Answer: C) Belousov-Zhabotinsky
37. What is the primary function of a homogeneous catalyst?
A) Initiate a reaction
B) Increase reaction rate
C) Inhibit a reaction
D) Change the equilibrium constant
Answer: B) Increase reaction rate
38. Which of the following is an example of homogeneous catalysis?
A) Enzymes in biological reactions
B) Transition metal complexes in organic synthesis
C) Acid-catalyzed esterification
D) Palladium in hydrogenation reactions
Answer: C) Acid-catalyzed esterification
39. What is the most common catalytic metal used in homogeneous catalysis?
A) Platinum
B) Palladium
C) Rhodium
D) Ruthenium
Answer: C) Rhodium
40. What role does hydrogen play in the hydrogen-bromine reaction?
A) Catalyst
B) Reactant
C) Product
D) Inhibitor
Answer: B) Reactant
41. In the pyrolysis of acetaldehyde, what is acetaldehyde broken down into?
A) Ethanol and water
B) Acetic acid and carbon monoxide
C) Ethane and hydrogen
D) Acetylene and formaldehyde
Answer: D) Acetylene and formaldehyde
42. What is the key step in the decomposition of Ethane?
A) Oxidation
B) Dehydrogenation
C) Isomerization
D) Polymerization
Answer: B) Dehydrogenation
43. Which of the following reactions is initiated by light? Awadh University 2003
A) Hydrogen-bromine
B) Pyrolysis of acetaldehyde
C) Decomposition of Ethane
D) Hydrogen-chlorine
Answer: A) Hydrogen-bromine
44. What is a characteristic feature of the Belousov-Zhabotinsky reaction?
A) It is irreversible
B) It exhibits oscillatory behaviour
C) It involves only one reactant
D) It produces a constant rate of products
Answer: B) It exhibits oscillatory behaviour

45. In homogeneous catalysis, where is the catalyst located relative to the reactants?
A) It is in a different phase
B) It is in the same phase
C) It is in a solid state
D) It is absent
Answer: B) It is in the same phase
46. Which of the following is NOT a characteristic of homogeneous catalysis?
A) The catalyst is uniformly distributed in the reaction mixture
B) The catalyst and reactants are in the same phase
C) The catalyst speeds up the reaction without being consumed
D) The catalyst forms a separate phase from the reactants
Answer: D) The catalyst forms a separate phase from the reactants
47. Which of the following metals is commonly used as a catalyst in homogeneous catalysis?
A) Gold
B) Platinum
C) Silver
D) Palladium
Answer: B) Platinum
48. Which of the following reactions is an example of homogeneous catalysis?
A) Hydrogenation of alkenes using a platinum catalyst
B) Hydrolysis of sucrose using sulfuric acid
C) Decomposition of hydrogen peroxide using manganese dioxide
D) Combustion of methane in the presence of oxygen
Answer: B) Hydrolysis of sucrose using sulfuric acid
49. What is the purpose of a catalyst in a reaction?
A) To increase the yield of products
B) To decrease the concentration of reactants
C) To increase the rate of reaction
D) To change the equilibrium constant
Answer: C) To increase the rate of reaction
50. Which of the following is a characteristic of a catalyst?
A) It is consumed in the reaction
B) It lowers the activation energy of a reaction
C) It changes the equilibrium constant of a reaction
D) It forms new products in the reaction
Answer: B) It lowers the activation energy of a reaction
51. What type of reaction is the hydrogen-bromine reaction?
A) Photochemical
B) Homogeneous catalysis
C) Dynamic chain
D) Oscillatory
Answer: C) Dynamic chain
52. What is the primary function of a catalyst in the hydrogen-chlorine reaction?
A) To increase the rate of reaction
B) To change the stoichiometry of the reaction
C) To inhibit the formation of products
D) To change the mechanism of the reaction
Answer: A) To increase the rate of reaction
53. Which of the following reactions is an example of oscillatory behaviour?
A) Hydrogen-bromine

B) Hydrogen-chlorine
C) Belousov-Zhabotinsky
D) Decomposition of Ethane
Answer: C) Belousov-Zhabotinsky
54. What is the main product of the photochemical reaction between hydrogen and chlorine?
A) HCl
B) H2
C) Cl2
D) HBr
Answer: C) Cl2
55. Which of the following reactions involves the breaking of chemical bonds through the absorption of light energy?
A) Hydrogen-bromine
B) Hydrogen-chlorine
C) Decomposition of Ethane
D) Pyrolysis of acetaldehyde
Answer: D) Pyrolysis of acetaldehyde
56. Which of the following best describes the kinetics of enzyme reactions?
A) Zero order
B) First order
C) Second order
D) Michaelis-Menten kinetics
Answer: D) Michaelis-Menten kinetics
57. General features of fast reactions include: Ruhelkhand University 2004
A) Long reaction times
B) High activation energy
C) Rapid equilibration
D) Low temperature dependence
Answer: C) Rapid equilibration
58. Which method is commonly used to study fast reactions by continuously flowing reactants together?
A) Flow method
B) Relaxation method
C) Flash photolysis
D) Nuclear magnetic resonance method
Answer: A) Flow method
59. The relaxation method is primarily used to study:
A) Slow reactions
B) Fast reactions
C) Enzyme kinetics
D) None of the above
Answer: B) Fast reactions
60. Flash photolysis involves the use of:
A) Continuous light source
B) Intense, short-duration light pulses
C) Ultraviolet radiation
D) Infrared radiation
Answer: B) Intense, short-duration light pulses
61. Which method relies on the principle of resonance to study molecular structure and dynamics?

A) Flow method
B) Relaxation method
C) Flash photolysis
D) Nuclear magnetic resonance method
Answer: D) Nuclear magnetic resonance method
62. The Michaelis-Menten equation describes the relationship between:
A) Substrate concentration and enzyme activity
B) Enzyme concentration and substrate activity
C) Product concentration and enzyme activity
D) Temperature and enzyme activity
Answer: A) Substrate concentration and enzyme activity
63. Fast reactions typically have: CSIR NET 2004
A) Low activation energy
B) High activation energy
C) No activation energy
D) Constant activation energy
Answer: B) High activation energy
64. The primary advantage of flow method in studying fast reactions is:
A) Ability to control reaction temperature
B) Continuous monitoring of reaction progress
C) Simplicity of experimental setup
D) High sensitivity to reactant concentrations
Answer: B) Continuous monitoring of reaction progress
65. Relaxation method relies on the principle of:
A) Rapid mixing
B) Slow equilibration
C) Temperature increase
D) Pressure change
Answer: A) Rapid mixing
66. Flash photolysis is used to study:
A) Chemical equilibrium
B) Fast photochemical reactions
C) Slow reactions in the dark
D) Enzyme-substrate interactions
Answer: B) Fast photochemical reactions
67. Which method allows for the direct observation of transient species?
A) Flow method
B) Relaxation method
C) Flash photolysis
D) Nuclear magnetic resonance method
Answer: C) Flash photolysis
68. The Michaelis constant (Km) in enzyme kinetics represents:
A) Maximum velocity of the reaction
B) Substrate concentration at half-maximal velocity
C) Enzyme concentration at half-maximal velocity
D) Rate of enzyme-substrate complex formation
Answer: B) Substrate concentration at half-maximal velocity
69. Fast reactions are typically characterized by:
A) Long reaction times
B) Slow equilibrium establishment

C) Large activation barriers
D) Rapid completion
Answer: D) Rapid completion
70. Which method is suitable for investigating reaction intermediates and transition states?
A) Flow method
B) Relaxation method
C) Flash photolysis
D) Nuclear magnetic resonance method
Answer: C) Flash photolysis
71. The turnover number of an enzyme represents: CSIR NET 2009
A) Maximum velocity of the reaction
B) Rate of enzyme-substrate complex formation
C) Number of substrate molecules converted to product per unit time
D) Rate constant of the enzyme-substrate interaction
Answer: C) Number of substrate molecules converted to product per unit time
72. The rate constant of a first-order reaction is:
A) Independent of reactant concentration
B) Directly proportional to reactant concentration
C) Inversely proportional to reactant concentration
D) Quadratically related to reactant concentration
Answer: A) Independent of reactant concentration
73. The relaxation method is based on the principle of:
A) Rapid mixing
B) Slow mixing
C) Continuous illumination
D) Slow temperature change
Answer: A) Rapid mixing
74. In flash photolysis, the transient species are generated by:
A) Continuous light source
B) Intense, short-duration light pulses
C) Heat energy
D) Slow chemical reactions
Answer: B) Intense, short-duration light pulses
75. The primary advantage of nuclear magnetic resonance method is its ability to:
A) Measure reaction rates directly
B) Probe molecular structure and dynamics
C) Generate transient species
D) Control reaction temperature precisely
Answer: B) Probe molecular structure and dynamics
76. Which factor does not affect the rate of a first-order reaction?
A) Temperature
B) Concentration of reactant
C) Presence of catalyst
D) Activation energy
Answer: B) Concentration of reactant
77. The half-life of a first-order reaction is:
A) Independent of initial concentration
B) Directly proportional to initial concentration
C) Inversely proportional to initial concentration
D) Quadratically related to initial concentration

Answer: C) Inversely proportional to initial concentration
78. The rate constant of a second-order reaction is:
A) Independent of reactant concentration
B) Directly proportional to reactant concentration
C) Inversely proportional to reactant concentration
D) Quadratically related to reactant concentration
Answer: B) Directly proportional to reactant concentration
79. What is the order of the reaction if the rate is directly proportional to the square of the concentration of a single reactant? Awadh University 2007
A) Zero order
B) First order
C) Second order
D) Third order
Answer: C) Second order
80. The primary disadvantage of relaxation method in studying fast reactions is:
A) Complexity of experimental setup
B) Limited time resolution
C) High cost of equipment
D) Sensitivity to experimental conditions
Answer: B) Limited time resolution
81. Which technique is commonly used to probe the transition state in chemical reactions?
A) NMR spectroscopy
B) IR spectroscopy
C) Mass spectrometry
D) UV-Vis spectroscopy
Answer: C) Mass spectrometry
82. The Lindemann-Hinshelwood mechanism is associated with which type of reaction?
A) Uni molecular reactions
B) Bi molecular reactions
C) Termolecular reactions
D) Trimolecular reactions
Answer: A) Uni molecular reactions
83. RRKM theory is primarily used to describe the dynamics of which type of reaction?
A) Uni molecular reactions
B) Bi molecular reactions
C) Termolecular reactions
D) Trimolecular reactions
Answer: A) Uni molecular reactions
84. Which factor is crucial in determining the rate of barrierless chemical reactions in solution?
A) Temperature
B) Pressure
C) Concentration
D) Catalyst presence
Answer: C) Concentration
85. What is the primary focus of studying the dynamics of molecular motion?
A) Identifying reaction intermediates
B) Determining reaction mechanisms
C) Understanding bond dissociation energies
D) Investigating reaction kinetics

Answer: B) Determining reaction mechanisms
86. In the Rice-Ramsperger-Kassel-Marcus (RRKM) theory, what does the "K" stand for?
A) Kinetic
B) Rate
C) Transition state
D) Constant
Answer: D) Constant
87. Which spectroscopic technique is commonly used to study the vibrational modes of molecules involved in chemical reactions? CSIR NET 2010
A) NMR spectroscopy
B) IR spectroscopy
C) Mass spectrometry
D) UV-Vis spectroscopy
Answer: B) IR spectroscopy
88. The Lindemann-Hinshelwood mechanism proposes a relationship between the rate constant and which parameter?
A) Pressure
B) Temperature
C) Concentration
D) Activation energy
Answer: B) Temperature
89. Which term best describes a chemical reaction that occurs without an energy barrier?
A) Exothermic
B) Endothermic
C) Barrierless
D) Equilibrium
Answer: C) Barrierless
90. What is the primary goal of probing the transition state in chemical reactions?
A) Identifying reactants
B) Determining reaction mechanisms
C) Measuring reaction rates
D) Calculating activation energies
Answer: B) Determining reaction mechanisms
91. Which theory provides a statistical description of uni-molecular reaction rates?
A) Lindemann-Hinshelwood mechanism
B) Rice-Ramsperger-Kassel-Marcus theory
C) Transition state theory
D) Arrhenius equation
Answer: B) Rice-Ramsperger-Kassel-Marcus theory
92. In barrierless chemical reactions, the rate is primarily dependent on:
A) Temperature
B) Pressure
C) Catalyst concentration
D) Solvent polarity
Answer: A) Temperature
93. Uni-molecular reactions involve the decomposition or rearrangement of:
A) One molecule
B) Two molecules
C) Three molecules
D) Four molecules

Answer: A) One molecule
94. The Lindemann-Hinshelwood mechanism describes the kinetics of which type of reaction?
A) Bi-molecular
B) Uni-molecular
C) Termolecular
D) Quadrimolecular
Answer: B) Uni-molecular
95. RRKM theory is based on which fundamental principle of statistical mechanics?
A) Boltzmann distribution
B) Maxwell's equations
C) Gibbs free energy
D) Planck's constant
Answer: A) Boltzmann distribution
96. Which technique is commonly used to measure reaction rates in solution?
A) NMR spectroscopy CSIR NET 2006
B) IR spectroscopy
C) Mass spectrometry
D) UV-Vis spectroscopy
Answer: C) Mass spectrometry
97. The Lindemann-Hinshelwood mechanism suggests that the rate of a reaction is proportional to:
A) The concentration of reactants
B) The activation energy
C) The frequency of collisions
D) The Gibbs free energy change
Answer: C) The frequency of collisions
98. RRKM theory is particularly useful in describing the dynamics of which type of reaction?
A) Slow, highly activated reactions
B) Fast, barrierless reactions
C) Equilibrium reactions
D) Redox reactions
Answer: B) Fast, barrierless reactions
99. The term "transition state" refers to: CSIR NET 1998
A) A stable intermediate in a reaction
B) A state with the highest potential energy along the reaction pathway
C) A state of equilibrium between reactants and products
D) A state where the reaction rate is zero
Answer: B) A state with the highest potential energy along the reaction pathway
100. Which of the following is NOT a factor influencing the dynamics of barrierless chemical reactions?
A) Temperature
B) Pressure
C) Concentration
D) Catalyst presence
Answer: B) Pressure

UNIT II

UNIT II
Surface chemistry

Adsorption:

Adsorption refers to the process where molecules or particles adhere to the surface of a solid or liquid substance.

This phenomenon is crucial in various areas like catalysis, chromatography, and purification processes.

Gibbs adsorption isotherm describes the relationship between the surface excess of adsorbate and the surface pressure.

Surface tension

Surface tension is the force per unit length acting perpendicular to an imaginary line drawn on the surface of a liquid. It arises due to the cohesive forces between liquid molecules.

- Capillary action is the ability of a liquid to flow in narrow spaces without the assistance of external forces, due to adhesive and cohesive forces.
- The Laplace equation relates the pressure difference across a curved liquid surface to the surface tension and curvature.
- The Kelvin equation describes the relationship between vapour pressure and curvature of a droplet or a small particle.
- BET equation is used to estimate the surface area of solids based on gas adsorption data.
- Electrokinetic phenomena involve the movement of ions and particles in response to an electric field at the interface between a solid and a liquid.
- Catalytic activity at surfaces refers to the increased reaction rates observed when reactant molecules adsorb onto the surface of a catalyst.

Micelles:

Micelles are aggregates of surfactant molecules in a colloidal solution, where the hydrophobic tails are shielded from the surrounding solvent by the hydrophilic heads.

- Surfactants are compounds that reduce the surface tension of a liquid and are classified based on their ionic charge (anionic, cationic, nonionic, amphoteriC).
- Critical micellar concentration (CMC) is the minimum concentration of surfactant required for micelle formation.
- Factors affecting CMC include temperature, presence of electrolytes, and molecular structure of the surfactant.
- Thermodynamics of micellization involves phase separation and mass action models, describing the equilibrium between monomers and micelles.
- Micelles can solubilize hydrophobic compounds, forming stable colloidal solutions.
- Microemulsions are thermodynamically stable mixtures of oil, water, and surfactant, whereas reverse micelles have a hydrophobic core surrounded by polar solvent molecules.

Macromolecules: These are large molecules typically composed of repeating structural units called monomers. Examples include proteins, nucleic acids (DNA, RNA), carbohydrates, and synthetic polymers.

Polymer : A polymer is a large molecule composed of repeating structural units or monomers linked together through covalent bonds.

Types of Polymers: Polymers can be classified into several types based on their structure and properties:

Natural Polymers: Derived from natural sources like cellulose, proteins, and rubber.

Synthetic Polymers: Man-made polymers like polyethylene, PVC, and nylon.

Thermoplastics: Polymers that can be melted and reshaped.
Thermosetting Polymers: Polymers that become permanently hardened upon heating.
Elastomers: Polymers with rubber-like elasticity.
Conducting Polymers: Polymers that can conduct electricity, such as polyaniline and polypyrrole.
Liquid Crystal Polymers: Polymers with ordered structures resembling liquid crystals, often used in electronics and optics.
Electrically Conducting Polymers: These polymers have π-conjugated backbones that allow the delocalization of electrons, facilitating electrical conductivity.
Fire-Resistant Polymers: Polymers engineered to resist ignition, combustion, or reduce the spread of flames. Flame retardants are often incorporated into the polymer matrix to achieve this property.
Kinetics of Polymerization: Refers to the study of the rates and mechanisms of polymerization reactions, including initiation, propagation, and termination steps.
Mechanism of Polymerization: Describes the step-by-step process by which monomers are joined together to form polymers, which can occur through various mechanisms like addition polymerization, condensation polymerization, or ring-opening polymerization.
Molecular Mass: The mass of a molecule, typically expressed in atomic mass units (amu) or Daltons (DA).
Number and Mass Average Molecular Mass: Two ways to calculate the average molecular mass of a polymer sample, considering either the number of molecules or the mass of molecules present in the sample.
Molecular Mass Determination: Techniques used to determine the molecular mass of polymers, including osmometry, viscometry, diffusion, light scattering methods, and sedimentation.
Some extra points to remember:

- Chain Configuration of Macromolecules: Refers to the spatial arrangement of polymer chains, which can be linear, branched, or crosslinked.
- Calculation of Average Dimensions of Various Chain Structures: Involves determining the average length, radius of gyration, and other dimensions of polymer chains based on their configurations and molecular properties.
- Adsorption phenomena occur at the interface between phases.
- Surface tension is the force acting to minimize the surface area of a liquid.
- Capillary action is the movement of a liquid in a narrow space.
- Laplace equation describes the pressure difference across a curved surface.
- Kelvin equation relates vapour pressure to the curvature of a droplet.
- Gibbs adsorption isotherm describes the distribution of adsorbate molecules at the interface.
- BET equation estimates the surface area of adsorbents.
- Electro kinetic phenomena involve the movement of charged particles at interfaces.
- Catalytic activity occurs at surfaces due to active sites.
- Micelles are aggregates of surfactant molecules.
- Surface active agents lower the surface tension of liquids.
- Surfactants are classified based on their hydrophilic and hydrophobic parts.
- Micellization is the formation of micelles in solution.
- Hydrophobic interactions drive micelle formation.
- Critical micelle concentration (CMC) is the minimum concentration of surfactant required for micelle formation.
- Factors affecting CMC include temperature, ionic strength, and surfactant structure.
- Counter ions can bind to micelles, affecting their properties.

- Thermodynamics of micellization involves entropy and enthalpy changes.
- Phase separation models describe micelle formation.
- Mass action models describe the equilibrium between monomers and micelles.
- Solubilization is the process of incorporating insoluble compounds into micelles.
- Micro emulsions are stable dispersions of oil and water stabilized by surfactants.
- Reverse micelles contain water droplets dispersed in a nonpolar solvent.
- Surface chemistry plays a crucial role in various industrial processes.
- Adsorption isotherms describe the relationship between adsorbate concentration and surface coverage.
- Langmuir adsorption isotherm models monolayer adsorption.
- Freundlich adsorption isotherm describes multilayer adsorption.
- Chemisorption involves the formation of chemical bonds between adsorbate and surface.
- Physisorption involves weak van der Waals forces between adsorbate and surface.
- Surface area affects the rate of adsorption.
- Surface energy influences the wettability of a solid.
- Contact angle measures the degree of wetting on a solid surface.
- Heterogeneous catalysis occurs at the interface between a solid catalyst and reactants.
- Homogeneous catalysis occurs in the same phase as reactants.
- Enzymes are biological catalysts that operate at surfaces.
- Surface modification techniques alter the properties of materials for specific applications.
- Self-assembled monolayers form spontaneously on surfaces.
- Nanoparticles have high surface area to volume ratios, leading to unique properties.
- Surface plasmon resonance is a technique used for studying adsorption and binding events.
- Zeta potential measures the electrokinetic potential of colloidal particles.
- Langmuir-Blodgett films are formed by transferring monolayers onto solid substrates.
- Atomic force microscopy can image surfaces at the nanoscale.
- Surface-enhanced Raman spectroscopy amplifies Raman signals at rough metal surfaces.
- Surface tension gradients drive Marangoni convection in liquids.
- Molecular dynamics simulations provide insights into surface phenomena at the molecular level.
- Macromolecules are large molecules typically composed of repeating subunits called monomers.
- Molecular Mass: Mass of a molecule, often expressed in atomic mass units (AMU) or grams per mole (g/mol).
- Number Average Molecular Mass (Mn): Average mass of molecules in a sample, calculated by summing the masses of each molecule and dividing by the total number of molecules.
- Mass Average Molecular Mass (Mw): Average mass of molecules in a sample, weighted by the number of molecules of each mass.
- Molecular Mass Determination: Techniques include osmometry, viscometry, diffusion, and light scattering methods.
- Osmometry: Measures the osmotic pressure of a solution to determine molecular mass.
- Viscometry: Measures the viscosity of a solution to determine molecular mass.
- Diffusion Methods: Utilizes the rate of diffusion of molecules to determine molecular mass.

- ❖ Light Scattering Methods: Measures the scattering of light by molecules to determine molecular mass.
- ❖ Sedimentation: Technique involving the settling of particles in a solution, often used in molecular mass determination.
- ❖ Chain Configuration of Macromolecules: Refers to the arrangement of monomer units within a polymer chain.
- ❖ Calculation of Average Dimensions: Methods to determine average dimensions include end-to-end distance and radius of gyration.
- ❖ End-to-End Distance: Average distance between the two ends of a polymer chain.
- ❖ Radius of Gyration: Measure of the spatial distribution of the mass of a polymer chain.
- ❖ Monomers: The repeating units that make up a polymer chain.
- ❖ Covalent Bonds: Chemical bonds formed by the sharing of electron pairs between atoms.
- ❖ Polymerization: Process of combining monomers to form a polymer chain.
- ❖ Addition Polymerization: Polymerization where monomers add to the growing polymer chain one at a time.
- ❖ Condensation Polymerization: Polymerization where monomers combine with the loss of a small molecule, such as water or alcohol.
- ❖ Polyethylene: Common synthetic polymer used in various applications including packaging and insulation.
- ❖ Polystyrene: Another synthetic polymer used in packaging, insulation, and consumer goods.
- ❖ Polypropylene: Versatile polymer used in packaging, textiles, and automotive components.
- ❖ Polyvinyl Chloride (PVC): Polymer known for its versatility, used in construction, healthcare, and consumer goods.
- ❖ Polymer Blends: Mixtures of two or more polymers, often combined to achieve specific properties.
- ❖ Cross-Linking: Chemical bonding between polymer chains to improve mechanical strength and durability.
- ❖ Polymer Composites: Materials composed of a polymer matrix reinforced with fibers or particles.
- ❖ Polymer Degradation: Breakdown of polymer chains due to environmental factors such as heat, light, or chemicals.
- ❖ Biopolymers: Polymers produced by living organisms, including proteins, nucleic acids, and polysaccharides.
- ❖ Polymer Rheology: Study of the flow and deformation of polymers under stress.
- ❖ Polymer Crystallinity: Measure of the degree of molecular order in a polymer chain.
- ❖ Thermoplastics: Polymers that can be repeatedly melted and molded into new shapes.
- ❖ Thermosets: Polymers that undergo irreversible chemical reactions upon heating, becoming rigid and durable.
- ❖ Elastomers: Polymers with elastic properties, able to return to their original shape after deformation.
- ❖ Polymerization Rate: Rate at which monomers combine to form polymer chains.
- ❖ Polymer Structure-Property Relationships: Correlation between the molecular structure of a polymer and its physical and chemical properties.
- ❖ Polymer Solubility: Ability of a polymer to dissolve in a solvent.
- ❖ Polymer Grafting: Attachment of side chains or functional groups onto a polymer backbone.

- ❖ Polymer Nanocomposites: Materials where nanoparticles are dispersed within a polymer matrix to enhance mechanical, thermal, or barrier properties.

MCQ’s

1. Which of the following phenomena is associated with the tendency of molecules to adhere to a surface?
A) Evapouration
B) Condensation
C) Adsorption
D) Sublimation
Answer: C) Adsorption
2. What is the equation used to estimate surface area in adsorption studies?
A) Boyle's Law
B) Charles's Law
C) Langmuir Equation
D) BET Equation
Answer: D) BET Equation
3. The phenomenon of adsorption is commonly utilized in which of the following processes?
A) Catalysis
B) Distillation
C) Filtration
D) Polymerization
Answer: A) Catalysis
4. Which of the following is NOT a factor influencing adsorption?
A) Temperature
B) Pressure
C) Time
D) Atomic number
Answer: D) Atomic number
5. The Laplace equation is related to which of the following properties?
A) Adsorption
B) Surface tension
C) Vapour pressure
D) Electro kinetic phenomena
Answer: B) Surface tension
6. The Kelvin equation is used to describe the vapour pressure of droplets based on which factor? ALLAHABAD UNIVERSITY 2002
A) Temperature
B) Pressure
C) Volume
D) Surface area
Answer: D) Surface area
7. Which equation is used to describe the distribution of ions in the electrical double layer?
A) Poisson's equation
B) Laplace's equation
C) Nernst equation
D) Maxwell's equation
Answer: A) Poisson's equation
8. Gibbs adsorption isotherm describes the change in which quantity upon adsorption?

A) Volume
B) Entropy
C) Enthalpy
D) Gibbs free energy
Answer: D) Gibbs free energy
9. Electrokinetic phenomena are associated with the movement of which of the following?
A) Ions
B) Gases
C) Liquids
D) Solids
Answer: A) Ions
10. Capillary action is primarily driven by which force?
A) Gravitational force
B) Magnetic force
C) Surface tension
D) Electrostatic force
Answer: C) Surface tension
11. What property of adsorbents makes them suitable for use in gas masks?
A) High surface area
B) Low surface tension
C) High pressure difference
D) Low vapour pressure
Answer: A) High surface area
12. Which type of adsorption involves the formation of a monolayer of adsorbate molecules on the adsorbent surface?
A) Physical adsorption
B) Chemical adsorption
C) Covalent adsorption
D) Dipole adsorption
Answer: A) Physical adsorption
13. Which equation describes the relationship between the amount of adsorbate on a surface and the pressure of the gas? CSJMU 2017
A) Langmuir isotherm
B) Freundlich equation
C) BET equation
D) Gibbs adsorption isotherm
Answer: A) Langmuir isotherm
14. The process of adsorption is commonly used in which of the following applications?
A) Air conditioning
B) Food preservation
C) Water desalination
D) All of the above
Answer: D) All of the above
15. Which of the following is a characteristic of chemisorption?
A) Reversible
B) Weak bonding
C) Multilayer formation
D) Involves electron sharing
Answer: D) Involves electron sharing

16. The BET equation is used to describe the adsorption of molecules onto which type of surface?
A) Porous
B) Smooth
C) Hydrophobic
D) Hydrophilic
Answer: A) Porous
17. The term "hysteresis" in adsorption refers to which phenomenon?
A) The dependence of adsorption on temperature
B) The lag in adsorption or desorption during a change in pressure
C) The rate of adsorption
D) The formation of a monolayer
Answer: B) The lag in adsorption or desorption during a change in pressure
18. Which equation describes the variation of adsorption with pressure, concentration, or temperature?
A) Langmuir isotherm
B) BET equation
C) Freundlich equation
D) Gibbs adsorption isotherm
Answer: C) Freundlich equation
19. Adsorption isotherms are plots of which of the following?
A) Pressure versus temperature
B) Temperature versus surface area
C) Amount of adsorbate versus pressure
D) Volume versus concentration
Answer: C) Amount of adsorbate versus pressure
20. What is the primary factor determining the adsorption capacity of an adsorbent?
A) Surface area
B) Density
C) Temperature
D) Viscosity
Answer: A) Surface area
21. Which of the following is NOT a type of adsorption isotherm?
A) Langmuir
B) Freundlich
C) Arrhenius
D) BET
Answer: C) Arrhenius
22. The phenomenon of adsorption is most prominent at which of the following temperatures?

A) High temperatures
B) Low temperatures
C) Moderate temperatures
D) Constant temperatures
Answer: B) Low temperatures
23. In which of the following processes is adsorption used to remove contaminants from a fluid?
A) Distillation
B) Filtration
C) Chromatography

D) Adsorption chromatography
Answer: D) Adsorption chromatography
24. The term "adsorbate" refers to which component of the adsorption process?
A) The substance being adsorbed
B) The surface on which adsorption occurs
C) The energy required for adsorption
D) The temperature of the adsorption system
Answer: A) The substance being adsorbed
25. Which of the following factors affects the rate of adsorption?
A) Pressure
B) Temperature
C) Surface area
D) All of the above
Answer: D) All of the above
26. The process of adsorption is commonly used in which of the following applications?
A) Gas separation
B) Water treatment
C) Drug delivery
D) All of the above
Answer: D) All of the above
27. Which of the following is a characteristic of physisorption?
A) Formation of chemical bonds
B) Low specificity
C) High activation energy
D) Irreversible process
Answer: B)
28. What are micelles primarily composed of?
A) Water molecules
B) Hydrophobic tails of surfactants
C) Hydrophilic heads of surfactants
D) Both B) and C)
Answer: D) Both B) and C)
29. What is the critical micellar concentration (CMC)?
A) The concentration of micelles in a solution
B) The concentration of surfactants at which micelles start forming
C) The concentration of water molecules in a micelle
D) The concentration of solvents required for micellization
Answer: B) The concentration of surfactants at which micelles start forming
30. Which factor affects the CMC of a surfactant?
A) Temperature
B) Pressure
C) pH
D) All of the above
Answer: D) All of the above
31.What is the main driving force for micelle formation?
A) Electrostatic interaction
B) Hydrophobic interaction
C) Van der Waals forces
D) Dipole-dipole interaction
Answer: B) Hydrophobic interaction

32. What is the thermodynamic basis for micellization?
A) Increase in entropy
B) Decrease in entropy
C) Decrease in enthalpy
D) Decrease in free energy
Answer: A) Increase in entropy
33. What is the classification of surface-active agents based on their charge?
A) Anionic, cationic, nonionic, amphoteric
B) Acidic, basic, neutral
C) Polar, nonpolar
D) Ionic, covalent, metallic
Answer: A) Anionic, cationic, nonionic, amphoteric
34. What type of binding can counter ions exhibit with micelles?
A) Covalent bonding
B) Hydrogen bonding
C) Van der Waals interaction
D) Electrostatic attraction
Answer: D) Electrostatic attraction
35. Which model describes micellization based on the principles of phase separation?
A) Thermodynamic model
B) Mass action model
C) Kinetic model
D) Molecular model
Answer: A) Thermodynamic model
36. What is solubilization in the context of micelles?
A) Formation of colloidal particles
B) Increase in solute concentration in micellar phase
C) Breaking down of micelles into smaller units
D) Dissolution of solute in micellar phase
Answer: B) Increase in solute concentration in micellar phase
37. What is the structure of a micro emulsion?
A) Large droplets dispersed in a continuous phase
B) Small droplets dispersed in a continuous phase
C) Continuous phase dispersed in small droplets
D) Continuous phase dispersed in large droplets
Answer: B) Small droplets dispersed in a continuous phase
38. What is the primary function of surface-active agents?
A) Increase solubility of hydrophobic substances in water
B) Decrease solubility of hydrophobic substances in water
C) Increase solubility of hydrophilic substances in nonpolar solvents
D) Decrease solubility of hydrophilic substances in nonpolar solvents
Answer: A) Increase solubility of hydrophobic substances in water
39. What is the significance of the hydrophilic head group in a surfactant molecule?
A) It stabilizes micelles in solution
B) It enhances the hydrophobic interaction between surfactant molecules
C) It facilitates solubilization of hydrophobic substances
D) It forms hydrogen bonds with water molecules
Answer: D) It forms hydrogen bonds with water molecules
40. What determines the size of micelles formed in a solution?
A) Concentration of surfactant molecules

B) Temperature of the solution
C) pH of the solution
D) Molecular weight of the surfactant
Answer: A) Concentration of surfactant molecules
41. Which type of surface-active agent has both hydrophilic and hydrophobic properties?
A) Anionic
B) Cationic
C) Nonionic
D) Amphoteric
Answer: D) Amphoteric
42. What is the consequence of exceeding the critical micellar concentration (CMC) of a surfactant?
A) Formation of reverse micelles
B) Precipitation of surfactant molecules
C) Decrease in surface tension
D) Increase in solution viscosity
Answer: C) Decrease in surface tension
43. How do reverse micelles differ from regular micelles?
A) They have a hydrophilic core and a hydrophobic shell
B) They have a hydrophobic core and a hydrophilic shell
C) They are smaller in size
D) They have a higher critical micellar concentration
Answer: B) They have a hydrophobic core and a hydrophilic shell
44. Which parameter affects the stability of micelles in solution? CSJMU 2013
A) pH
B) Ionic strength
C) Temperature
D) All of the above
Answer: D) All of the above
45. What is the primary driving force for the formation of microemulsions?
A) Hydrophobic interaction
B) Electrostatic interaction
C) Phase separation
D) Thermodynamic stability
Answer: C) Phase separation
46. What role do surfactants play in emulsification processes?
A) They stabilize emulsions by reducing interfacial tension
B) They increase the viscosity of emulsions
C) They decrease the solubility of dispersed phase
D) They promote flocculation of dispersed phase
Answer: A) They stabilize emulsions by reducing interfacial tension
47. How do surfactants enhance the solubility of hydrophobic substances in water?
A) By forming micelles with hydrophobic cores
B) By increasing the temperature of the solution
C) By decreasing the surface area of the solution
D) By decreasing the pH of the solution
Answer: A) By forming micelles with hydrophobic cores
48. Which factor does not influence the critical micellar concentration (CMC) of a surfactant?
A) Temperature
B) Molecular weight of surfactant

C) Ionic strength of the solution
D) Pressure
Answer: D) Pressure
49. What determines the shape of micelles formed by surfactant molecules?
A) Hydrophobic interactions
B) Electrostatic interactions
C) Molecular weight of the surfactant
D) Entropy changes
Answer: C) Molecular weight of the surfactant
50. What is the primary difference between micro emulsions and macro emulsions?
A) Size of dispersed phase droplets
B) Composition of continuous phase
C) Stability in solution
D) Surface tension at the interface
Answer: A) Size of dispersed phase droplets
51. How does the addition of electrolytes affect micelle formation?
A) Increases micelle size
B) Decreases micelle size
C) Enhances micelle stability
D) Reduces micelle stability
Answer: D) Reduces micelle stability
52. What is the significance of the critical micellar concentration (CMC) in surfactant solutions?
A) It represents the maximum concentration of surfactants in solution
B) It marks the onset of micelle formation
C) It indicates the stability of micelles in solution
D) It measures the solubility of surfactants in water
Answer: B) It marks the onset of micelle formation
53. Which type of surfactant forms positively charged micelles in solution?
A) Anionic
B) Cationic
C) Nonionic
D) Amphoteric
Answer: B) Cationic
54. How do surfactants affect the surface tension of a solution?
A) Increase it
B) Decrease it
C) Keep it constant
D) Depend on the concentration of surfactants
Answer: B) Decrease it
55. Which model describes micellization based on the principles of molecular interactions?
A) Thermodynamic model
B) Mass action model
C) Kinetic model
D) Molecular model
Answer: D) Molecular model
56. What determines the critical micellar concentration (CMC) of a surfactant?
A) Nature of the solvent
B) Temperature and pressure
C) Molecular structure of the surfactant

D) All of the above
Answer: D) All of the above
57. What is the primary mechanism by which surfactants stabilize emulsions?
A) Adsorption at the interface
B) Formation of covalent bonds with dispersed phase
C) Increase in solution viscosity
D) Aggregation into larger structures
Answer: A) Adsorption at the interface
58. What is a polymer?
A) A single molecule
B) A small molecule
C) A large molecule made up of repeating subunits
D) A complex mixture of molecules
Answer: C) A large molecule made up of repeating subunits
59. Which of the following is not a type of polymer? RUHELKHAND UNIVERSITY 2000
A) Thermoplastics
B) Thermosets
C) Elastomers
D) Monomers
Answer: D) Monomers
60. Which type of polymer is known for its ability to conduct electricity?
A) Thermoplastics
B) Elastomers
C) Liquid crystal polymers
D) Thermosets
Answer: C) Liquid crystal polymers
61. Which type of polymer is typically fire-resistant?
A) Thermoplastics
B) Elastomers
C) Liquid crystal polymers
D) Thermosets
Answer: D) Thermosets
62. What is the process by which monomers join together to form a polymer? SSC 2019
A) Polymerization
B) Monomerization
C) Condensation
D) Depolymerization
Answer: A) Polymerization
63. Which technique is commonly used to determine the molecular mass of polymers?
A) Spectroscopy
B) Chromatography
C) Viscometry
D) Titration
Answer: C) Viscometry
64. What is the average molecular mass of a polymer called?
A) Monomeric mass
B) Polymeric mass
C) Number average molecular mass
D) Mass average molecular mass
Answer: D) Mass average molecular mass

65. Which method can be used to determine molecular mass based on the rate of diffusion?
A) Osmometry
B) Viscometry
C) Diffusion
D) Light scattering
Answer: C) Diffusion
66. What is the process of settling of polymer particles in a solution called?
A) Sedimentation
B) Filtration
C) Precipitation
D) Condensation
Answer: A) Sedimentation
67. What term describes the arrangement of atoms within a polymer chain? CSJMU 2019
A) Conformation
B) Configuration
C) Confirmation
D) Conjugation
Answer: A) Conformation
68. Which method can be used to calculate the average dimensions of polymer chains?
A) NMR spectroscopy
B) X-ray crystallography
C) Light scattering
D) Sedimentation
Answer: C) Light scattering
69. Which type of polymer has a highly ordered structure resembling that of a crystal?
A) Thermoplastics
B) Thermosets
C) Elastomers
D) Liquid crystal polymers
Answer: D) Liquid crystal polymers
70. What is the primary driving force behind polymerization reactions?
A) Entropy
B) Enthalpy
C) Gibbs free energy
D) Activation energy
Answer: D) Activation energy
71. Which type of polymer undergoes irreversible hardening upon heating?
A) Thermoplastics B.Ed Entrance 2019
B) Thermosets
C) Elastomers
D) Liquid crystal polymers
Answer: B) Thermosets
72. Which technique is used to measure the viscosity of polymer solutions?
A) Spectroscopy
B) Chromatography
C) Viscometry
D) Titration
Answer: C) Viscometry
73. Which factor does not affect the kinetics of polymerization reactions?
A) Temperature

B) Concentration of monomers
C) Catalysts
D) Polymer chain length
Answer: D) Polymer chain length
74. Which type of polymer exhibits rubber-like elasticity?
A) Thermoplastics
B) Thermosets
C) Elastomers
D) Liquid crystal polymers
Answer: C) Elastomers
75. What is the most common mechanism of polymerization?
A) Condensation polymerization
B) Free radical polymerization
C) Cationic polymerization
D) Anionic polymerization
Answer: B) Free radical polymerization
76. Which method relies on the scattering of light by polymer particles to determine molecular mass?
A) Osmometry
B) Viscometry
C) Diffusion
D) Light scattering
Answer: D) Light scattering
77. What is the term for the process by which polymer chains entangle and become immobile? Lucknow university 2007
A) Crystallization
B) Gelation
C) Cross-linking
D) Vitrification
Answer: B) Gelation
78. Which type of polymer can be reshaped and remolded upon reheating?
A) Thermoplastics
B) Thermosets
C) Elastomers
D) Liquid crystal polymers
Answer: A) Thermoplastics
79. Which method measures the change in volume of a solution upon polymerization?
A) Osmometry
B) Viscometry
C) Dilatometry
D) Light scattering
Answer: C) Dilatometry
80. What is the term for the distribution of molecular weights within a polymer sample?
A) Monomeric dispersion CSJMU 2018
B) Polymeric dispersion
C) Molecular weight distribution
D) Polydispersity index
Answer: C) Molecular weight distribution
82. Which type of polymer has a three-dimensional network structure?
A) Thermoplastics

B) Thermosets
C) Elastomers
D) Liquid crystal polymers
Answer: B) Thermosets
83. What is the term for the average number of monomer units per polymer chain?
A) Polymerization degree
B) Monomer concentration
C) Polymer concentration
D) Polydispersity index
Answer: A) Polymerization degree
84. Which type of polymer is characterized by long, linear chains with little cross-linking?
A) Thermoplastics
B) Thermosets
C) Elastomers
D) Liquid crystal polymers
Answer: A) Thermoplastics
85. Which method measures the rate of polymerization based on changes in solution viscosity?
A) Osmometry
B) Viscometry
C) Dilatometry
D) Light scattering
Answer: B) Viscometry
86. What is the term for the process by which small molecules are removed during polymerization?
A) Depolymerization
B) Polymerization
C) Chain termination
D) Chain initiation
Answer: C) Chain termination
87. Which type of polymer has a glassy, transparent appearance? UPSSSC 2020
A) Thermoplastics
B) Thermosets
C) Elastomers
D) Liquid crystal polymers
Answer: A) Thermoplastics
88. Which method measures the rate of polymerization based on changes in solution concentration?
A) Osmometry
B) Viscometry
C) Dilatometry
D) Light scattering
Answer: A) Osmometry
89. What is the molecular mass of a polymer?
A) The mass of a single polymer molecule
B) The average mass of all polymer molecules in a sample
C) The mass of monomer units in a polymer chain
D) The mass of the repeating unit in a polymer chain
Answer: B) The average mass of all polymer molecules in a sample
90. Which formula calculates the number average molecular mass (Mn) of a polymer?

A) $Mn = \Sigma(mi) / N$
B) $Mn = \Sigma(mi * Ni) / \Sigma Ni$
C) $Mn = \Sigma(mi * Ni) / N$
D) $Mn = \Sigma(mi) / \Sigma Ni$
Answer: B) $Mn = \Sigma(mi * Ni) / \Sigma Ni$
91. In number average molecular mass calculation, what does Ni represent?
A) The mass of each polymer molecule
B) The total number of polymer molecules
C) The number of monomer units in each polymer molecule
D) The number of repeating units in each polymer molecule
Answer: B) The total number of polymer molecules
92. Which term describes the distribution of molecular weights in a polymer sample?
A) Polydispersity index
B) Monodispersity index
C) Polymersity index
D) Distribution index
Answer: A) Polydispersity index
93. A polymer with a high polydispersity index indicates:
A) Uniform distribution of molecular weights
B) Narrow distribution of molecular weights
C) Broad distribution of molecular weights
D) No distribution of molecular weights
Answer: C) Broad distribution of molecular weights
94. What is the ideal PDI value for a monodisperse polymer sample?
A) 0
B) 1
C) 2
D) 10
Answer: A) 0
95. Which statement is true about the molecular mass of polymers?
A) It is always constant for a given polymer.
B) It varies depending on the method of polymerization.
C) It is independent of the number of repeating units.
D) It is unaffected by the presence of additives.
Answer: B) It varies depending on the method of polymerization.
96. Which type of average molecular mass considers the weight of each molecule?
A) Number average molecular mass
B) Mass average molecular mass
C) Distribution average molecular mass
D) Weighted average molecular mass
Answer: D) Weighted average molecular mass
97. What is the molecular mass of a polymer consisting of 1000 monomer units, each with a molecular mass of 100 g/mol?
A) 100 g/mol
B) 10,000 g/mol
C) 100,000 g/mol
D) 1,000,000 g/mol
Answer: C) 100,000 g/mol
98. Which factor does not influence the molecular mass of a polymer?
A) Polymerization method

B) Presence of additives
C) Monomer concentration
D) Temperature and pressure
Answer: D) Temperature and pressure
99. The molecular mass of a polymer is determined by:
A) The number of repeating units in the polymer chain
B) The size of the polymer molecules
C) The weight of the polymer sample
D) The concentration of monomer units
Answer: A) The number of repeating units in the polymer chain
100. What is the main difference between number average molecular mass and mass average molecular mass?
A) Number average considers only the mass of polymer molecules, while mass average considers the number of molecules.
B) Number average considers the weight of each molecule, while mass average considers the size of the molecules.
C) Number average is influenced by the distribution of molecular weights, while mass average is not.
D) Number average gives more weight to larger molecules, while mass average gives more weight to smaller molecules.
Answer: D) Number average gives more weight to larger molecules, while mass average gives more weight to smaller molecules.

UNIT III

UNIT III
Electrochemistry

Electrochemistry: This field deals with the study of chemical processes that involve the movement of electrons, typically occurring at the interface between an electron conductor (usually a metal or a semiconductor) and an ionic conductor (usually an electrolyte solution).
Electrochemistry of Solutions: This encompasses the study of electrochemical processes that occur in solution, where ions are mobile. Key aspects include understanding ion-solvent interactions, the behaviour of ions in solution, and the thermodynamics of electrified interfaces.
Debye-Hückel-Onsager Treatment and Its Extension: Debye-Hückel theory describes the behaviour of electrolyte solutions at low concentrations, considering the effects of ionic interactions and the screening effect due to the surrounding solvent molecules. Onsager extended this theory to include the movement of ions under the influence of an electric field.
Debye-Hückel-Jerum Mode: This mode extends the Debye-Hückel theory to consider the influence of strong electrolytes, where the ions are no longer fully dissociated.
Thermodynamics of Electrified Interface Equations: This involves the study of the thermodynamic principles governing the behaviour of interfaces between two phases, such as solid-liquid or liquid-liquid interfaces, when an electric potential is applied.
Derivation of Electro-capillarity, Lippmann Equations: Electro-capillarity refers to the phenomenon where an electric field affects the surface tension of a liquid. The Lippmann equation describes the relationship between the surface excess charge and the potential at an electrified interface.
Methods of Determination: Various experimental techniques are employed to determine parameters related to electrochemical interfaces, such as surface excess charge or potential. These methods include electrochemical techniques, surface tension measurements, and spectroscopic methods.
Structure of Electrified Interfaces: Different models have been proposed to describe the structure of electrified interfaces, such as the Guoy-Chapman model, Graham-Devanathan-Mottwatts model, Tobin model, Bockris model, and Devanathan model. These models provide insights into the distribution of ions and charge at the interface.
Each of these topics plays a crucial role in understanding the behaviour of electrochemical systems and interfaces, with applications ranging from batteries and fuel cells to corrosion protection and electroplating.

Overpotentials: Overpotentials refer to the excess voltage required to drive a reaction at an electrode compared to the theoretical equilibrium potential. It includes activation overpotential (related to the kinetics of the reaction) and concentration overpotential (due to concentration gradients at the electrode surface).
Exchange Current Density: The exchange current density is a parameter in electrochemistry that represents the rate of an electrochemical reaction at equilibrium. It's the current density at which the rate of the forward reaction equals the rate of the reverse reaction.
Derivation of Butler-Volmer Equation: The Butler-Volmer equation describes the relationship between the reaction rate and overpotential in electrochemical systems. It's derived from principles of chemical kinetics and assumes a simple one-step reaction mechanism at the electrode surface.
Tafel Plot: A Tafel plot is a graph of the logarithm of the reaction rate versus overpotential. It's used to analyze the kinetics of electrochemical reactions and provides information about the reaction mechanism and reaction rate constants.

Quantum Aspects of Charge Transfer at Electrodes-Solution Interfaces: Quantum mechanics plays a role in understanding charge transfer processes at the nanoscale, including phenomena such as quantization of charge transfer and tunneling. These concepts describe how electrons tunnel through energy barriers at the interface between electrodes and electrolyte solutions.

Semiconductor Interfaces: In semiconductor-electrolyte interfaces, the theory of the double layer describes the distribution of charges and ions at the interface. This interface structure influences processes like charge transfer and electron transport. Light can also affect semiconductor-solution interfaces through phenomena such as photoelectrochemistry, where light energy is used to drive electrochemical reactions.

Electrocatalysis: This is the process where a catalyst increases the rate of an electrochemical reaction by providing an alternative pathway for the reaction to occur. Various parameters such as catalyst material, surface area, temperature, pH, and applied potential influence the efficiency of electrocatalysis.

Hydrogen electrode: It's a reference electrode used in electrochemistry to measure the standard electrode potential of other electrodes. It consists of a platinum electrode in contact with a solution of hydrogen ions at unit activity and hydrogen gas at a pressure of 1 atm.

Bioelectrochemistry: This field explores the interaction between biological systems and electrodes. It involves studying electron transfer processes in biological systems and their applications in areas like biosensors, biofuel cells, and neuroprosthetics.

Threshold membrane phenomenon: This refers to the selective permeability of membranes to certain ions or molecules, allowing them to pass through only when the concentration reaches a certain threshold.

Nernst-Planck equation: It's a mathematical equation describing the flux of ions or molecules through a membrane under the influence of concentration gradients and electrical potentials.

Hodgkin-Huxley equations: These are a set of differential equations describing the electrical potentials and currents across the membrane of excitable cells, such as neurons. They are fundamental in understanding the generation and propagation of action potentials.

Core conductor models: These models describe the behaviour of electrical conduction in various systems, including biological tissues and electrochemical cells, by considering them as composed of core conductors surrounded by insulating material.

Electrocardiography: It's the process of recording the electrical activity of the heart over time using electrodes placed on the skin. It's a vital tool in diagnosing cardiac abnormalities and monitoring heart health.

Polarography theory: Polarography is a technique used for measuring the concentration of certain substances in solution based on their electrochemical behaviour. The theory behind polarography involves the study of current-voltage relationships during the electrolysis of solutions.

Ilkovic equation: This equation relates the diffusion current to the concentration of an electroactive species at a rotating electrode in a polarographic experiment.

Half-wave potential and its significance: The half-wave potential is the potential at which half of the electroactive species is oxidized or reduced. It's significant because it provides information about the redox behaviour of a substance and can be used to determine its concentration or kinetic properties.

Corrosion: Corrosion is the degradation of materials due to chemical reactions with their environment. The homogeneous theory suggests that corrosion occurs uniformly over the entire surface of a material.

Forms of corrosion: Corrosion can take various forms, including uniform corrosion, localized corrosion (such as pitting and crevice corrosion), galvanic corrosion, and stress corrosion cracking.
Corrosion monitoring and prevention methods: Various techniques, such as corrosion inhibitors, protective coatings, cathodic protection, and material selection, are employed to monitor and prevent corrosion in different environments and applications.
Some keypoints for revision

- ❖ Electrochemistry involves the study of chemical processes that involve the movement of electrons.
- ❖ Electrochemistry of solutions deals with reactions occurring at the interface between an electrode and an electrolyte solution.
- ❖ The Debye-Hückel-Onsager treatment explains the behaviour of electrolyte solutions, considering both electrostatic and statistical factors.
- ❖ Ion-solvent interactions play a crucial role in determining the behaviour of ions in solution.
- ❖ The Debye-Hückel-Jerum model extends the Debye-Hückel theory to include more complex electrolyte solutions.
- ❖ Thermodynamics of electrified interfaces involves the application of thermodynamic principles to understand the behaviour of interfaces between electrodes and electrolyte solutions.
- ❖ The derivation of electro-capillarity equations describes the relationship between electric potential, surface tension, and interfacial curvature.
- ❖ Lippmann equations quantify the surface excess of ions at the electrode-electrolyte interface.
- ❖ Various methods, such as cyclic voltammetry and chronopotentiometry, are used to experimentally determine electro-capillarity and surface excess.
- ❖ The structure of electrified interfaces refers to the arrangement of ions and solvent molecules near the electrode surface.
- ❖ The Guoy-Chapman model describes the distribution of ions near an electrode surface based on electrostatic interactions.
- ❖ The Graham-Devanathan-Mottwatts model considers the transport of ions in the diffusion layer near the electrode.
- ❖ The Tobin model incorporates the effects of solvent polarization in the double layer.
- ❖ The Bockris model accounts for the non-uniform distribution of ions and solvent molecules near the electrode.
- ❖ The Devanathan model describes the migration of ions and solvent molecules in response to an applied electric field.
- ❖ Electrochemical reactions involve the transfer of electrons between species at an electrode surface.
- ❖ Faraday's laws of electrolysis govern the quantitative relationship between the amount of substance produced or consumed in an electrolytic reaction and the amount of electric charge passed through the cell.
- ❖ The Nernst equation relates the equilibrium potential of an electrochemical cell to the activities of the reactants and products.
- ❖ Overpotential describes the difference between the actual electrode potential and the equilibrium potential.
- ❖ Tafel kinetics describes the relationship between the reaction rate and overpotential.
- ❖ Butler-Volmer equation quantifies the exchange current density and the rates of forward and reverse electrochemical reactions.

- Double-layer capacitance refers to the capacitance arising from the separation of charge at the electrode-electrolyte interface.
- Electrocatalysis involves the use of catalysts to enhance the rates of electrochemical reactions.
- Potentiostat and galvanostat are instruments used to control the potential and current, respectively, in electrochemical experiments.
- Impedance spectroscopy is a technique used to study the electrical properties of electrochemical systems over a range of frequencies.
- Electrophoresis involves the migration of charged particles under the influence of an electric field.
- Electroosmosis refers to the movement of a solvent under the influence of an applied electric field.
- Electrowetting is a phenomenon where the contact angle of a liquid on a solid surface is altered by applying an electric field.
- Electrodeposition is the process of depositing a metal onto an electrode surface from a solution containing its ions.
- Corrosion is the degradation of metals due to electrochemical reactions with their environment.
- Passivation involves the formation of a protective layer on a metal surface, preventing further corrosion.
- Electrochemical energy conversion devices, such as batteries and fuel cells, convert chemical energy into electrical energy and vice versa.
- Electroanalytical techniques, including voltammetry and potentiometry, are used for chemical analysis based on electrochemical principles.
- Bioelectrochemistry explores the role of electron transfer processes in biological systems, such as respiration and photosynthesis.
- Emerging areas in electrochemistry include nanoelectrochemistry, electrochemical sensors, and electrochemical water treatment technologies.
- Overpotentials play a crucial role in electrochemical reactions, representing the deviation of the electrode potential from the thermodynamic equilibrium potential.
- Exchange current density characterizes the rate of electrochemical reactions at equilibrium.
- The Butler-Volmer equation describes the kinetics of electrochemical reactions and is derived from the principles of electrochemical kinetics.
- Tafel plot is a graphical representation used to analyze the kinetics of electrochemical reactions, particularly in determining reaction mechanisms and rate constants.
- Quantum mechanics provides insights into charge transfer processes at electrode-solution interfaces, considering the quantization of charge transfer events.
- Tunneling phenomenon, governed by quantum mechanics, influences charge transfer at interfaces by allowing particles to pass through energy barriers without meeting classical requirements.
- Semiconductor interfaces involve interactions between semiconductors and electrolytic solutions, playing a crucial role in various electrochemical processes and devices.
- The theory of the double layer at semiconductor-electrolytic solution interfaces explains the distribution of charges and electric potential near the interface.
- The structure of double layer interfaces is influenced by factors such as the nature of the semiconductor surface, electrolyte composition, and external conditions like temperature.

- ❖ Light has a significant effect on semiconductor-solution interfaces, influencing charge transfer processes and the behaviour of semiconductor-electrolyte interfaces.
- ❖ Photoelectrochemical processes utilize light to induce or enhance electrochemical reactions at semiconductor-electrolyte interfaces.
- ❖ Quantum confinement effects in semiconductors lead to discrete energy levels, affecting charge carrier behaviour and charge transfer kinetics.
- ❖ Band structure engineering in semiconductors involves manipulating energy band alignments to optimize charge transfer processes and device performance.
- ❖ The Schottky-Mott model explains charge transfer at metal-semiconductor interfaces, considering factors like work function and Fermi level alignment.
- ❖ Fermi level pinning occurs when the Fermi level of a semiconductor aligns with a specific energy level within the band gap, affecting charge carrier behaviour and device performance.
- ❖ Surface states play a crucial role in charge transfer processes at semiconductor interfaces, influencing interface properties and device performance.
- ❖ The Helmholtz model describes the distribution of charges and electric potential near the electrode-electrolyte interface, considering the formation of a compact layer of ions.
- ❖ Ionic screening effects influence the behaviour of the electric double layer, affecting charge distribution and electrochemical kinetics at interfaces.
- ❖ The Gouy-Chapman model provides insights into the structure and properties of the electric double layer, considering the distribution of ions near the interface.
- ❖ The Stern model incorporates specific ion adsorption at the electrode-electrolyte interface, accounting for non-ideal behaviour and deviations from the Gouy-Chapman model.
- ❖ The Langmuir model describes adsorption at surfaces, providing a framework for understanding surface reactions and the behaviour of adsorbates at interfaces.
- ❖ The Frumkin model extends the Langmuir model to account for interactions between adsorbates, providing insights into surface processes and electrochemical reactions at interfaces.
- ❖ The Volmer-Heyrovsky-Tafel mechanism describes the steps involved in various electrochemical reactions, considering adsorption, charge transfer, and desorption processes.
- ❖ The Marcus theory of electron transfer provides a framework for understanding charge transfer kinetics, considering factors like reorganization energy and electronic coupling.
- ❖ Electrochemical impedance spectroscopy (EIS) is a powerful technique for studying interfacial processes and characterizing electrode-electrolyte interfaces.
- ❖ The Nernst equation relates the electrode potential to the activities or concentrations of species involved in electrochemical reactions, providing a fundamental basis for electrochemical measurements.
- ❖ The Butler-Volmer equation accounts for the influence of both forward and reverse reaction rates on the overall kinetics of electrochemical reactions.
- ❖ The Tafel equation relates the overpotential to the logarithm of the current density, providing insights into the kinetics of electrochemical reactions and reaction mechanisms.
- ❖ The Butler-Volmer equation can be derived from thermodynamic principles and the assumption of mass action kinetics for the electrochemical reaction.

- Exchange current density represents the rate of the forward and reverse reactions at equilibrium, providing a measure of the intrinsic kinetics of the electrochemical reaction.
- Tunneling phenomena in electrochemistry involve the quantum mechanical penetration of charge carriers through energy barriers, influencing charge transfer processes at interfaces.
- The Helmholtz layer is a region near the electrode-electrolyte interface where the majority of charge separation occurs, influencing the behaviour of the electric double layer.
- Light-induced charge transfer processes at semiconductor-electrolyte interfaces play a crucial role in various photoelectrochemical applications, such as solar energy conversion and environmental remediation.
- Quantum confinement effects in semiconductor nanoparticles lead to discrete energy levels, affecting charge carrier behaviour and the optical properties of semiconductor materials.
- Surface states and defects play a significant role in charge transfer processes at semiconductor interfaces, influencing interface properties and device performance.

- Electrocatalysis involves speeding up electrochemical reactions using catalysts.
- Various parameters influence electrocatalysis, including catalyst type, surface area, and temperature.
- The hydrogen electrode is commonly used as a reference electrode in electrochemistry.
- Bioelectrochemistry studies the interaction between biological molecules and electrodes.
- The threshold membrane phenomenon refers to the minimum potential required to induce ion transport across a membrane.
- The Nernst-Planck equation describes ion flux through a membrane under a concentration gradient.
- The Hodges-Huxley equations model the behaviour of excitable cells, like neurons, in response to stimuli.
- Core conductor models describe the flow of ions in biological systems.
- Electrocardiography measures the electrical activity of the heart using electrodes placed on the skin.
- Polarography theory involves analyzing the behaviour of polarizable electrodes in solution.
- The Ilkovic equation relates the current response of a polarizable electrode to the concentration of the electroactive species.
- Half-wave potential is the potential at which half of the electroactive species are oxidized or reduced during a redox reaction.
- The significance of half-wave potential lies in its use as a measure of the kinetics of the redox reaction.
- Corrosion is the deterioration of materials due to chemical reactions with their environment.
- The homogeneous theory of corrosion suggests that corrosion occurs uniformly over the material's surface.
- Forms of corrosion include uniform, galvanic, pitting, crevice, and stress corrosion.
- Corrosion monitoring methods include weight loss, electrical resistance, and electrochemical techniques.

- Corrosion prevention methods include coatings, inhibitors, alloying, and cathodic protection.
- Electrocatalysis can enhance hydrogen evolution reactions, crucial for fuel cell technology.
- Temperature affects electrocatalytic activity by altering reaction kinetics and adsorption energies.
- Catalyst morphology influences electrocatalytic performance through surface area and active site availability.
- Bioelectrochemistry plays a vital role in biosensors, biofuel cells, and neural interfaces.
- Ion channels' behaviour is modeled using the Nernst-Planck equation in electrobiology.
- The Hodges-Huxley equations describe the propagation of action potentials along nerve cells.
- Core conductor models aid in understanding ion transport in biological systems like neurons.
- Electrocardiography helps diagnose heart conditions by recording the heart's electrical signals.
- Polarography theory underpins modern electroanalytical techniques for trace analysis.
- The Ilkovic equation allows for quantitative determination of analyte concentrations in polarography.
- Half-wave potential indicates the electrode's catalytic activity and redox kinetics.
- Corrosion can lead to significant economic losses in industries such as oil and gas, transportation, and infrastructure.
- Corrosion prevention methods are essential for ensuring the longevity and reliability of structures and equipment.
- Electrocatalysis is crucial for energy conversion and storage technologies such as electrolyzers and batteries.
- Catalyst composition affects electrocatalytic performance by influencing electron transfer kinetics.
- pH and ionic strength are important parameters influencing electrocatalytic reactions.
- Bioelectrochemistry studies electron transfer processes in biological systems, essential for life processes.
- The Nernst-Planck equation accounts for both concentration gradients and electrical potentials in ion transport.
- The Hodges-Huxley equations are foundational for understanding the electrical activity of excitable cells.
- Core conductor models help elucidate ion transport mechanisms in various biological systems.
- Electrocardiography aids in diagnosing arrhythmias, myocardial infarctions, and other heart conditions.
- Polarography theory has applications in environmental monitoring, pharmaceutical analysis, and metallurgy.
- The Ilkovic equation enables accurate determination of trace analyte concentrations in polarographic measurements.
- Half-wave potential provides insights into the kinetics and mechanism of electrochemical reactions.
- Corrosion monitoring techniques allow for early detection and mitigation of corrosion damage.

- ❖ Corrosion prevention strategies are tailored based on the specific environment and material characteristics.
- ❖ Electrocatalysis research aims to develop efficient and cost-effective catalysts for various applications, including clean energy production and environmental remediation.

MCQ's

1. What aspect of electrochemistry does the Debye-Huckel-Onsager treatment focus on?
A) Ion solvation
B) Electrolyte concentration
C) Electrode potential
D) Electrode kinetics
Answer: A) Ion solvation
2. Which equation describes the thermodynamics of electrified interface?
A) Nernst equation
B) Arrhenius equation
C) Butler-Volmer equation
D) Debye-Huckel-Onsager equation
Answer: D) Debye-Huckel-Onsager equation
3. Which model describes the structure of electrified interfaces based on ion distribution?
A) Guoy-Chapman model
B) Tobin model
C) Devanathan model
D) Bockris model
Answer: A) Guoy-Chapman model
4. What does the Butler-Volmer equation derive? CSJMU 2019
A) Overpotentials
B) Exchange current density
C) Electrode potential
D) Electrode kinetics
Answer: D) Electrode kinetics
5. Which plot is derived from the Butler-Volmer equation?
A) Nernst plot
B) Arrhenius plot
C) Tafel plot
D) Debye-Huckel plot
Answer: C) Tafel plot
6. Which equation relates overpotentials to current densities in electrochemical reactions?
A) Nernst equation
B) Arrhenius equation
C) Tafel equation
D) Butler-Volmer equation
Answer: D) Butler-Volmer equation
7. What model focuses on the exchange of ions between the electrode and electrolyte?
A) Guoy-Chapman model
B) Graham-Devanathan-Mottwatts model
C) Tobin model
D) Devanathan model
Answer: B) Graham-Devanathan-Mottwatts model
8. Which equation describes electro-capillarity and surface excess?

A) Nernst equation
B) Arrhenius equation
C) Lippmann equation
D) Debye-Huckel-Onsager equation
Answer: C) Lippmann equation
9. Which model focuses on the structure of electrified interfaces based on ion distribution and solvent interactions?
A) Guoy-Chapman model
B) Tobin model
C) Bockris model
D) Devanathan model
Answer: D) Devanathan model
10. What does the Tafel plot relate?
A) Electrode potential to current density
B) Electrolyte concentration to current density
C) Overpotentials to exchange current density
D) Ion solvation to electrode kinetics
Answer: A) Electrode potential to current density
11. Which equation describes ion-solvent interactions in electrochemistry?
A) Butler-Volmer equation
B) Tafel equation
C) Debye-Huckel-Onsager equation
D) Nernst equation
Answer: C) Debye-Huckel-Onsager equation
12. Which model describes the structure of electrified interfaces based on the distribution of ions in the solution?
A) Guoy-Chapman model
B) Tobin model
C) Bockris model
D) Devanathan model
Answer: A) Guoy-Chapman model
13. What does the Lippmann equation relate to?
A) Electro-capillarity and surface excess
B) Electrode potential and current density
C) Overpotentials and exchange current density
D) Ion solvation and solvent interactions
Answer: A) Electro-capillarity and surface excess
14. Which equation relates the exchange current density to overpotentials?
A) Nernst equation
B) Arrhenius equation
C) Butler-Volmer equation
D) Tafel equation
Answer: C) Butler-Volmer equation
15. What model focuses on the exchange of ions between the electrode and electrolyte, considering the distribution of ions in the solution?
A) Guoy-Chapman model
B) Graham-Devanathan-Mottwatts model
C) Tobin model
D) Bockris model
Answer: B) Graham-Devanathan-Mottwatts model

16. Which equation is used to determine the electrode potential? CSJMU 2015
A) Nernst equation
B) Debye-Huckel-Onsager equation
C) Arrhenius equation
D) Tafel equation
Answer: A) Nernst equation
17. Which model describes the structure of electrified interfaces based on ion distribution and solvent interactions?
A) Guoy-Chapman model
B) Tobin model
C) Devanathan model
D) Bockris model
Answer: C) Devanathan model
18. What does the Debye-Huckel-Onsager treatment primarily focus on?
A) Electrode potential
B) Ion solvation
C) Electrolyte concentration
D) Electrode kinetics
Answer: B) Ion solvation
19. Which equation describes the thermodynamics of an electrified interface?
A) Debye-Huckel-Onsager equation
B) Nernst equation
C) Butler-Volmer equation
D) Arrhenius equation
Answer: A) Debye-Huckel-Onsager equation
20. Which model focuses on the exchange of ions between the electrode and electrolyte, considering the distribution of ions in the solution?
A) Guoy-Chapman model
B) Tobin model
C) Bockris model
D) Graham-Devanathan-Mottwatts model
Answer: D) Graham-Devanathan-Mottwatts model
21. What aspect of electrochemistry does the Debye-Huckel-Onsager treatment primarily address?
A) Ion solvation
B) Electrode potential
C) Electrolyte concentration
D) Electrode kinetics
Answer: A) Ion solvation
22. Which equation relates the exchange current density to overpotentials in electrochemical reactions?
A) Butler-Volmer equation
B) Nernst equation
C) Tafel equation
D) Arrhenius equation
Answer: A) Butler-Volmer equation
23. What does the Tafel plot describe?
A) Relationship between electrode potential and current density
B) Relationship between electrolyte concentration and current density
C) Relationship between overpotentials and exchange current density

D) Relationship between ion solvation and electrode kinetics
Answer: A) Relationship between electrode potential and current density
24. Which equation describes ion-solvent interactions in electrochemistry?
A) Butler-Volmer equation
B) Tafel equation
C) Debye-Huckel-Onsager equation
D) Nernst equation
Answer: C) Debye-Huckel-Onsager equation
25. What does the Lippmann equation relate to?
A) Electro-capillarity and surface excess
B) Electrode potential and current density
C) Overpotentials and exchange current density
D) Ion solvation and solvent interactions
Answer: A) Electro-capillarity and surface excess
26. Which equation is used to determine the electrolyte concentration near an electrified interface?
A) Nernst equation
B) Debye-Huckel-Onsager equation
C) Arrhenius equation
D) Tafel equation
Answer: B) Debye-Huckel-Onsager equation
27. Which model describes the structure of electrified interfaces based on ion distribution and solvent interactions?
A) Guoy-Chapman model
B) Tobin model
C) Devanathan model
D) Bockris model
Answer: C) Devanathan model
28. What does the Debye-Huckel-Onsager treatment primarily focus on? CSJMU 2019
A) Electrode potential
B) Ion solvation
C) Electrolyte concentration
D) Electrode kinetics
Answer: B) Ion solvation
29. Which equation describes the thermodynamics of an electrified interface?
A) Debye-Huckel-Onsager equation
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B) Tobin model
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Answer: D) Graham-Devanathan-Mottwatts model
31. What aspect of electrochemistry does the Debye-Huckel-Onsager treatment primarily address?
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34. Which equation describes ion-solvent interactions in electrochemistry?
A) Butler-Volmer equation
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C) Debye-Huckel-Onsager equation
D) Nernst equation
Answer: C) Debye-Huckel-Onsager equation
35. What does the Lippmann equation relate to?
A) Electro-capillarity and surface excess
B) Electrode potential and current density
C) Overpotentials and exchange current density
D) Ion solvation and solvent interactions
Answer: A) Electro-capillarity and surface excess
36. What is a significant aspect of charge transfer at electrodes-solution interfaces?
A) Quantum mechanics
B) Newton's laws
C) Relativity
D) Thermodynamics
Answer: A) Quantum mechanics
37. What phenomenon deals with the quantization of charge transfer at interfaces?
A) Tunneling
B) Diffusion
C) Convection
D) Adsorption
Answer: A) Tunneling
38. What is the theory explaining the double layer at semiconductor-electrolytic solution interfaces?
A) Quantum mechanics
B) Einstein's theory of relativity
C) Semiconductor interface theory
D) Electrochemistry
Answer: D) Electrochemistry
39. What is the structure of double layer interfaces primarily determined by?
A) Electrostatic interactions

B) Magnetic interactions
C) Gravitational interactions
D) Nuclear interactions
Answer: A) Electrostatic interactions
40. What effect does light have at semiconductor-solution interfaces?
A) Decreases conductivity
B) Increases conductivity
C) No effect on conductivity
D) Changes the semiconductor material
Answer: B) Increases conductivity
41. What aspect of charge transfer involves the discrete nature of electrons transferring between electrodes and solution interfaces?
A) Quantum mechanics
B) Classical mechanics
C) Statistical mechanics
D) Thermodynamics
Answer: A) Quantum mechanics
42. What term describes the process by which charge transfers through a potential barrier that it classically cannot overcome?
A) Diffusion
B) Adsorption
C) Tunneling
D) Conduction
Answer: C) Tunneling
43. What is the primary factor determining the behaviour of the double layer at semiconductor-electrolytic solution interfaces?
A) Temperature
B) pH
C) Electrostatic interactions
D) Magnetic field
Answer: C) Electrostatic interactions
44. Which theory provides a framework for understanding charge transfer at semiconductor interfaces?
A) Quantum mechanics
B) Solid-state physics
C) Electrochemistry
D) Classical mechanics
Answer: B) Solid-state physics
45. How does light affect the behaviour of charge transfer at semiconductor-solution interfaces?
A) It increases the concentration of ions in the solution.
B) It generates electron-hole pairs in the semiconductor.
C) It reduces the surface area of the semiconductor.
D) It increases the thickness of the double layer.
Answer: B) It generates electron-hole pairs in the semiconductor.
46. Which principle explains the discrete energy levels involved in charge transfer at interfaces?

A) Heisenberg's uncertainty principle
B) Bohr's atomic model
C) Pauli exclusion principle

D) Avogadro's principle
Answer: C) Pauli exclusion principle
47. What role does temperature play in the quantization of charge transfer at interfaces?
A) It has no effect
B) It increases the tunneling probability
C) It decreases the tunneling probability
D) It changes the material properties
Answer: B) It increases the tunneling probability
48. What is the primary factor determining the thickness of the double layer at semiconductor-electrolytic solution interfaces?
A) Temperature
B) pH
C) Electrostatic interactions
D) Magnetic field
Answer: A) Temperature
49. What phenomenon allows charge to transfer across a potential barrier?
A) Diffusion
B) Adsorption
C) Tunneling
D) Conduction
Answer: C) Tunneling
50. What effect does changing the pH of the electrolytic solution have on the double layer at semiconductor interfaces?
A) It increases the thickness of the double layer.
B) It decreases the thickness of the double layer.
C) It has no effect on the double layer.
D) It changes the material properties.
Answer: B) It decreases the thickness of the double layer
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B) It decreases the thickness of the double layer.
C) It has no effect on the double layer.
D) It changes the material properties.
Answer: B) It decreases the thickness of the double layer
56. What principle describes the behaviour of charge carriers in a semiconductor?
A) Ohm's law
B) Fermi-Dirac statistics
C) Hooke's law
D) Archimedes' principle
Answer: B) Fermi-Dirac statistics
57. What effect does increasing the voltage have on charge transfer at interfaces?
A) Increases tunneling probability
B) Decreases tunneling probability
C) No effect on tunneling probability
D) Changes the material properties
Answer: A) Increases tunneling probability
58. What determines the direction of charge transfer at interfaces?
A) Thermodynamics
B) Electrostatic interactions
C) Magnetic interactions
D) Quantum mechanics
Answer: B) Electrostatic interactions
59. What factor influences the conductivity of a semiconductor? CSJMU 2018
A) Temperature
B) pH
C) Electrostatic interactions
D) Magnetic field
Answer: A) Temperature
60. What effect does light have on the energy levels of charge carriers in a semiconductor?
A) Increases energy levels
B) Decreases energy levels
C) No effect on energy levels
D) Changes the type of charge carriers
Answer: A) Increases energy levels
61. Which theory explains the behaviour of charge carriers in a double layer interface?
A) Classical mechanics
B) Electrochemistry
C) Quantum mechanics
D) Thermodynamics
Answer: B) Electrochemistry
62. What role does temperature play in the behaviour of charge carriers at interfaces?
A) It increases carrier mobility
B) It decreases carrier mobility.

C) It has no effect on carrier mobility.
D) It changes the type of charge carriers.
Answer: A) It increases carrier mobility
63. What determines the magnitude of tunneling current across interfaces?
A) Electrostatic interactions
B) Temperature
C) Voltage
D) Magnetic field
Answer: C) Voltage
64. How does the presence of defects in a semiconductor affect charge transfer at interfaces?
A) Increases tunneling probability
B) Decreases tunneling probability
C) No effect on tunneling probability
D) Changes the material properties
Answer: A) Increases tunneling probability
65. What is the primary mechanism of charge transfer at semiconductor-electrolytic solution interfaces?
A) Diffusion
B) Adsorption
C) Tunneling
D) Conduction
Answer: C) Tunneling
66. What factor primarily determines the thickness of the double layer at semiconductor interfaces?
A) Temperature
B) pH
C) Electrostatic interactions
D) Magnetic field
Answer: A) Temperature
67. What effect does increasing the surface area of a semiconductor have on charge transfer at interfaces?
A) Increases tunneling probability
B) Decreases tunneling probability
C) No effect on tunneling probability
D) Changes the material properties
Answer: A) Increases tunneling probability
68. Which principle governs the behaviour of charge carriers in a semiconductor?
A) Ohm's law
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D) Archimedes' principle
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A) Increases conductivity
B) Decreases conductivity
C) No effect on conductivity
D) Changes the type of charge carriers
Answer: A) Increases conductivity
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A) Increases energy levels

B) Decreases energy levels
C) No effect on energy levels
D) Changes the type of charge carriers
Answer: A) Increases energy levels
71. In electrocatalysis, which of the following parameters has the greatest influence on the reaction rate?
A) Temperature
B) Pressure
C) pH
D) Catalyst surface area
Answer: D) Catalyst surface area
72. Which electrode is commonly used as a reference electrode in electrochemical measurements?
A) Platinum electrode
B) Glass electrode
C) Hydrogen electrode
D) Calomel electrode
Answer: C) Hydrogen electrode
73. What phenomenon describes the minimum voltage required to initiate an electrochemical reaction?
A) Threshold membrane phenomenon
B) Nernst-Planck equation
C) Hodges-Huxley equations
D) Core conductor models
Answer: A) Threshold membrane phenomenon
74. Which equation describes the combined diffusion and migration of ions in solution under the influence of an electric field? CSJMU 2020
A) Nernst-Planck equation
B) Ilkovic equation
C) Henderson-Hasselbalch equation
D) Arrhenius equation
Answer: A) Nernst-Planck equation
75. The Hodges-Huxley equations are primarily used to model:
A) Corrosion processes
B) Bioelectrochemical reactions
C) Electrocardiography signals
D) Polarographic behaviour
Answer: C) Electrocardiography signals
76. Which model is commonly used to describe the electrical properties of biological membranes?
A) Core conductor model
B) Nernst-Planck model
C) Ilkovic model
D) Butler-Volmer model
Answer: A) Core conductor model
77. Electrocardiography is primarily used to measure:
A) Blood pressure
B) Electrical activity of the heart
C) Blood oxygen levels
D) Respiratory rate

Answer: B) Electrical activity of the heart
78. The Ilkovic equation is used to calculate:
A) Half-wave potential
B) Diffusion coefficient
C) Exchange current density
D) Overpotential
Answer: B) Diffusion coefficient
79. The half-wave potential in polarography refers to the potential at which:
A) Half of the electrolyte has reacted
B) Half of the analyte has been oxidized or reduced
C) The reaction rate is half its maximum value
D) The current density is half its maximum value
Answer: B) Half of the analyte has been oxidized or reduced
80. Corrosion monitoring methods include:
A) Spectroscopy
B) Weight loss analysis
C) Electrochemical impedance spectroscopy
D) All of the above
Answer: D) All of the above
81. The homogenous theory of corrosion attributes corrosion to:
A) Differences in metal composition
B) Differences in environmental conditions
C) A uniform attack on the metal surface
D) The presence of microorganisms
Answer: C) A uniform attack on the metal surface
82. Which form of corrosion is characterized by localized attack on metal surfaces, often forming pits?
A) Uniform corrosion
B) Crevice corrosion
C) Galvanic corrosion
D) Intergranular corrosion
Answer: B) Crevice corrosion
83. Which method is commonly used to prevent corrosion by applying a protective coating to the metal surface?
A) Cathodic protection
B) Passivation
C) Anodizing
D) Painting
Answer: D) Painting
84. What is the primary function of a reference electrode in electrochemical measurements?
A) To provide a stable potential
B) To complete the circuit
C) To generate an electrical current
D) To measure the pH of the solution
Answer: A) To provide a stable potential
85. Which equation is used to describe the relationship between the electrode potential and the concentrations of species involved in an electrochemical reaction?
A) Nernst-Planck equation
B) Butler-Volmer equation
C) Henderson-Hasselbalch equation

D) Ilkovic equation
Answer: B) Butler-Volmer equation
86. In bioelectrochemistry, which term describes the movement of charged particles through a semi-permeable membrane?
A) Electrophoresis
B) Diffusion
C) Osmosis
D) Migration
Answer: D) Migration
87. The Hodges-Huxley equations are commonly used to model the behaviour of:
A) Chemical reactions
B) Biological membranes
C) Electrical circuits
D) Mechanical systems
Answer: B) Biological membranes
88. What is the significance of the half-wave potential in polarography?
A) It indicates the maximum reaction rate
B) It determines the equilibrium concentration of reactants and products
C) It represents the midpoint of the electrochemical reaction
D) It predicts the onset of corrosion
Answer: C) It represents the midpoint of the electrochemical reaction
89. Which model describes the flow of electrical current through a biological cell membrane?
A) Nernst-Planck model
B) Butler-Volmer model
C) Hodges-Huxley model
D) Ilkovic model
Answer: C) Hodges-Huxley model
90. Electrocardiography is used to diagnose: SSC 2020
A) Respiratory disorders
B) Cardiovascular diseases
C) Neurological conditions
D) Metabolic disorders
Answer: B) Cardiovascular diseases
91.The Ilkovic equation relates the diffusion current to:
A) Electrolyte concentration
B) Electrode surface area
C) Electrode potential
D) Temperature
Answer: A) Electrolyte concentration
92. What does the half-wave potential indicate in polarography?
A) The rate of electrodeposition
B) The potential at which half of the analyte is oxidized or reduced
C) The onset of passivation
D) The equilibrium potential
Answer: B) The potential at which half of the analyte is oxidized or reduced
93. Which type of corrosion occurs due to the presence of dissimilar metals in contact with each other in an electrolyte?
A) Pitting corrosion
B) Galvanic corrosion
C) Intergranular corrosion

D) Stress corrosion cracking
Answer: B) Galvanic corrosion
94. Corrosion monitoring methods may include:
A) Weight loss analysis
B) Electrochemical impedance spectroscopy
C) X-ray diffraction
D) All of the above
Answer: D) All of the above
95. The homogenous theory of corrosion suggests that corrosion:
A) Occurs uniformly across the surface
B) Is caused by differences in composition
C) Results from localized attack
D) Is influenced by environmental factors
Answer: A) Occurs uniformly across the surface
96. Which form of corrosion is characterized by corrosion occurring around localized areas of differential aeration?
A) Pitting corrosion
B) Crevice corrosion
C) Galvanic corrosion
D) Intergranular corrosion
Answer: A) Pitting corrosion
97. Which method involves applying a sacrificial anode to prevent corrosion of a metal surface?
A) Cathodic protection
B) Passivation
C) Anodizing
D) Painting
Answer: A) Cathodic protection
98. The primary function of a reference electrode in electrochemical measurements is to:
A) Provide a stable potential Allahabad University 2009
B) Generate an electrical current
C) Measure the pH of the solution
D) Complete the circuit
Answer: A) Provide a stable potential
99. Which equation describes the relationship between electrode potential and the concentrations of species involved in an electrochemical reaction?
A) Nernst-Planck equation
B) Butler-Volmer equation
C) Henderson-Hasselbalch equation
D) Ilkovic equation
Answer: B) Butler-Volmer equation
100. In bioelectrochemistry, what does electrophoresis refer to?
A) Movement of charged particles through a semi-permeable membrane
B) Diffusion of particles across a concentration gradient
C) Movement of solvent molecules through a membrane
D) Generation of electrical current by biological systems
Answer: A) Movement of charged particles through a semi-permeable membrane

MODEL TEST PAPER

1. What is the study of the rate at which enzymes catalyze chemical reactions?
A) Kinetics of enzyme reactions
B) General features of fast reactions
C) Study of fast reactions by flow method
D) Relaxation method
Answer: A) Kinetics of enzyme reactions
2. Which method is used to investigate fast reactions by rapidly mixing reactants?
A) Flow method
B) Relaxation method
C) Flash photolysis
D) Nuclear magnetic resonance method
Answer: A) Flow method
3. Which technique involves the sudden release of energy to initiate a chemical reaction?
A) Kinetics of enzyme reactions
B) General features of fast reactions
C) Study of fast reactions by flow method
D) Flash photolysis
Answer: D) Flash photolysis
4. How is the study of fast reactions facilitated by rapidly changing the temperature or pressure of the system?
A) Kinetics of enzyme reactions
B) General features of fast reactions
C) Study of fast reactions by flow method
D) Relaxation method
Answer: D) Relaxation method
5. Which method involves the use of light to initiate chemical reactions and study their kinetics?
A) Kinetics of enzyme reactions
B) General features of fast reactions
C) Flash photolysis
D) Nuclear magnetic resonance method
Answer: C) Flash photolysis
6. What technique allows for the investigation of transient species formed during fast reactions?
A) Flow method
B) Relaxation method
C) Flash photolysis
D) Nuclear magnetic resonance method
Answer: C) Flash photolysis
7. Which method involves the rapid change in a system's conditions to study relaxation phenomena?
A) Kinetics of enzyme reactions
B) General features of fast reactions
C) Study of fast reactions by flow method
D) Relaxation method
Answer: D) Relaxation method
8. What is the primary purpose of using nuclear magnetic resonance in the study of fast reactions?

A) To measure enzyme kinetics
B) To investigate transient species
C) To initiate chemical reactions
D) To study relaxation phenomena
Answer: B) To investigate transient species
9.Which method relies on the detection of changes in nuclear spin states to understand reaction kinetics?
A) Kinetics of enzyme reactions
B) General features of fast reactions
C) Nuclear magnetic resonance method
D) Relaxation method
Answer: C) Nuclear magnetic resonance method
10. In which method are reactants mixed rapidly to study their subsequent reactions?
A) Flow method
B) Relaxation method
C) Flash photolysis
D) Nuclear magnetic resonance method
Answer: A) Flow method
11. Which technique is suitable for studying the dynamics of chemical reactions occurring in the picosecond time scale?
A) Flow method
B) Relaxation method
C) Flash photolysis
D) Nuclear magnetic resonance method
Answer: C) Flash photolysis
12. What is the key characteristic of fast reactions?
A) They occur at equilibrium
B) They have slow reaction rates
C) They are completed in milliseconds or less
D) They involve only one reactant
Answswer: C) They are completed in milliseconds or less
13. Which method allows for the direct observation of reaction intermediates?
A) Flow method
B) Relaxation method
C) Flash photolysis
D) Nuclear magnetic resonance method
Answer: C) Flash photolysis
14. What is the primary advantage of using the flow method to study fast reactions?
A) Precise control of reaction conditions
B) Ability to observe reaction intermediates directly
C) Rapid mixing of reactants
D) Detection of transient species
Answer: C) Rapid mixing of reactants
15. Which technique involves the sudden application of an external force to a system to study its relaxation?
A) Flow method
B) Relaxation method
C) Flash photolysis
D) Nuclear magnetic resonance method
Answer: B) Relaxation method

16. What is the typical time frame for reactions studied using flash photolysis?
A) Milliseconds or less
B) Seconds
C) Minutes
D) Hours
Answer: A) Milliseconds or less
17. Which method is particularly useful for studying enzyme-substrate interactions?
A) Flow method
B) Relaxation method
C) Flash photolysis
D) Nuclear magnetic resonance method
Answer: A) Flow method
18. What is the primary advantage of using the relaxation method in studying fast reactions?
A) Ability to observe reaction intermediates directly
B) Precise control of reaction conditions
C) Rapid mixing of reactants
D) Detection of transient species
Answer: D) Detection of transient species
19. In which method are rapid changes in a system's conditions used to observe its relaxation to equilibrium?
A) Flow method
B) Relaxation method
C) Flash photolysis
D) Nuclear magnetic resonance method
Answer: B) Relaxation method
20. Which technique involves the use of a strong magnetic field to probe the environment of nuclei in molecules?
A) Flow method
B) Relaxation method
C) Flash photolysis
D) Nuclear magnetic resonance method
Answer: D) Nuclear magnetic resonance method
21. What is the main limitation of flash photolysis in studying fast reactions?
A) Inability to control reaction conditions
B) Difficulty in detecting transient species
C) Limited time resolution
D) High cost
Answer: C) Limited time resolution
22.Which method relies on the measurement of relaxation times to understand reaction kinetics?
A) Flow method
B) Relaxation method
C) Flash photolysis
D) Nuclear magnetic resonance method
Answer: B) Relaxation method
23. What is the primary advantage of using the nuclear magnetic resonance method in studying fast reactions?
A) Precise control of reaction conditions
B) Ability to observe reaction intermediates directly
C) Detection of transient species

D) High sensitivity to small changes in the environment
Answer: D) High sensitivity to small changes in the environment
24. Which technique is most suitable for studying reactions occurring in the nanosecond time scale?
A) Flow method
B) Relaxation method
C) Flash photolysis
D) Nuclear magnetic resonance method
Answer: C) Flash photolysis
25. What is the primary limitation of using the relaxation method in studying fast reactions?
A) Inability to control reaction conditions
B) Limited time resolution
C) Difficulty in detecting transient species
D) High cost
Answer: B) Limited time resolution
26. The Lindemann-Hinshelwood mechanism proposes that the rate of a reaction is determined by:
A) The concentration of reactants only
B) The activation energy only
C) Both the frequency of collisions and the activation energy
D) The equilibrium constant
Answer: C) Both the frequency of collisions and the activation energy
27. RRKM theory provides insights into the distribution of:
A) Activation energies
B) Transition states
C) Reaction intermediates
D) Product molecules
Answer: A) Activation energies
28. What is the primary goal of studying the dynamics of uni-molecular reactions?
A) Identifying reaction intermediates
B) Determining reaction mechanisms
C) Investigating reaction kinetics
D) Measuring reaction rates
Answer: C) Investigating reaction kinetics
29. In the context of chemical kinetics, what does the term "RRKM" stand for?
A) Reversible Reaction Kinetic Model
B) Rice-Ramsperger-Kassel-Marcus
C) Rapid Reaction Kinetic Method
D) Reactive Rate Kinetic Mechanism
Answer: B) Rice-Ramsperger-Kassel-Marcus
30. Which theory provides a framework for calculating the rate constants of elementary reactions?
A) Transition state theory
B) Lindemann-Hinshelwood mechanism
C) Rice-Ramsperger-Kassel-Marcus theory
D) Arrhenius equation
Answer: A) Transition state theory
31. The Hodges-Huxley equations are commonly used to model the behaviour of:
A) Chemical reactions
B) Biological membranes

C) Electrical circuits
D) Mechanical systems
Answer: B) Biological membranes
32. What does the half-wave potential represent in polarography?
A) Maximum reaction rate
B) Equilibrium potential
C) Midpoint of the electrochemical reaction
D) Onset of passivation
33. Answer: C) Midpoint of the electrochemical reaction
Which model describes the flow of electrical current through a biological cell membrane?
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D) All of the above
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39. The homogenous theory of corrosion suggests that corrosion:
A) Occurs uniformly across the surface
B) Is caused by differences in composition
C) Results from localized attack

D) Is influenced by environmental factors
Answer: A) Occurs uniformly across the surface
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C) Anodizing
D) Painting
Answer: A) Cathodic protection
42. The primary function of a reference electrode in electrochemical measurements is to:
A) Provide a stable potential
B) Generate an electrical current
C) Measure the pH of the solution
D) Complete the circuit
Answer: A) Provide a stable potential
43. Which equation describes the relationship between electrode potential and the concentrations of species involved in an electrochemical reaction?
A) Nernst-Planck equation
B) Butler-Volmer equation
C) Henderson-Hasselbalch equation
D) Ilkovic equation
Answer: B) Butler-Volmer equation
44. In bioelectrochemistry, what does electrophoresis refer to?
A) Movement of charged particles through a semi-permeable membrane
B) Diffusion of particles across a concentration gradient
C) Movement of solvent molecules through a membrane
D) Generation of electrical current by biological systems
Answer: A) Movement of charged particles through a semi-permeable membrane
45. The Hodges-Huxley equations are commonly used to model the behaviour of:
A) Chemical reactions
B) Biological membranes
C) Electrical circuits
D) Mechanical systems
Answer: B) Biological membranes
46. What phenomenon describes the tendency of liquids to minimize their surface area, resulting in the formation of droplets?
A) Capillary action
B) Surface tension
C) Gibbs adsorption isotherm
D) Kelvin equation
Answer: B) Surface tension
47. Which equation describes the relationship between the pressure difference across a curved surface and the surface tension?

A) Laplace equation
B) BET equation
C) Gibbs adsorption isotherm
D) Kelvin equation
Answer: A) Laplace equation
48. What does the Kelvin equation describe?
A) Vapour pressure of droplets
B) Surface tension
C) Capillary action
D) Gibbs adsorption isotherm
Answer: A) Vapour pressure of droplets
49. Which equation is used for the estimation of surface area in porous materials?
A) Laplace equation
B) Kelvin equation
C) BET equation
D) Gibbs adsorption isotherm
Answer: C) BET equation
50. What principle governs the rise of liquids in narrow tubes due to surface tension?
A) Laplace equation
B) Kelvin equation
C) Capillary action
D) Gibbs adsorption isotherm
Answer: C) Capillary action
51. What term refers to the amount of adsorbate per unit surface area?
A) Surface tension
B) Capillary action
C) Gibbs adsorption isotherm
D) BET equation
Answer: C) Gibbs adsorption isotherm
52. Which equation relates the adsorption of molecules on a surface to the surface excess of the adsorbate?
A) Laplace equation
B) Kelvin equation
C) BET equation
D) Gibbs adsorption isotherm
Answer: D) Gibbs adsorption isotherm
53. What factor does the Kelvin equation consider in determining the vapour pressure of droplets?
A) Temperature
B) Surface tension
C) Pressure difference
D) Curvature
Answer: A) Temperature
54. In which process do molecules adhere to the surface of a solid or liquid?
A) Capillary action
B) Surface tension
C) Adsorption
D) Condensation
Answer: C) Adsorption
55. What does the BET equation stand for?

A) Basic Estimation of Tension
B) Brunauer, Emmett, and Teller equation
C) Better Estimation of Temperature
D) Bonding Energy Theory
Answer: B) Brunauer, Emmett, and Teller equation
56. Which equation relates the thickness of a liquid film to the vapour pressure of the liquid?
A) Laplace equation
B) Kelvin equation
C) Gibbs adsorption isotherm
D) BET equation
Answer: B) Kelvin equation
57. What is the measure of the elastic tendency of a fluid surface?
A) Laplace equation
B) Kelvin equation
C) Surface tension
D) Gibbs adsorption isotherm
Answer: C) Surface tension
58. What term refers to the process of adsorbate molecules accumulating at the surface of a solid or liquid?
A) Capillary action
B) Adsorption
C) Surface tension
D) Vapour pressure
Answer: B) Adsorption
59. What phenomenon allows water to move upward in a narrow tube against the force of gravity?
A) Surface tension
B) Capillary action
C) Gibbs adsorption isotherm
D) BET equation
Answer: B) Capillary action
60. Which equation is used to calculate the pressure difference across a curved surface?
A) Laplace equation
B) Kelvin equation
C) Gibbs adsorption isotherm
D) BET equation
Answer: A) Laplace equation
61. What does the Laplace equation relate to in the context of surface tension?
A) Pressure difference
B) Temperature
C) Surface area
D) Vapour pressure
Answer: A) Pressure difference
62. What parameter does the BET equation help estimate?
A) Surface area
B) Vapour pressure
C) Surface tension
D) Adsorption capacity
Answer: A) Surface area

63. Which equation describes the relationship between the curvature of a droplet and its vapour pressure?
A) Laplace equation
B) Kelvin equation
C) Gibbs adsorption isotherm
D) BET equation
Answer: B) Kelvin equation
64. What phenomenon involves the spreading of a liquid over a solid surface?
A) Capillary action
B) Surface tension
C) Adsorption
D) Wetting
Answer: D) Wetting
65. Which equation describes the relationship between the thickness of a liquid film and the vapour pressure of the liquid?
A) Laplace equation
B) Kelvin equation
C) Gibbs adsorption isotherm
D) BET equation
Answer: B) Kelvin equation
66. What parameter does the Gibbs adsorption isotherm relate to?
A) Pressure difference
B) Surface area
C) Adsorption
D) Temperature
Answer: C) Adsorption
67. Which equation helps determine the elastic tendency of a fluid surface?
A) Laplace equation
B) Kelvin equation
C) Surface tension
D) BET equation
Answer: C) Surface tension
68. What does the BET equation primarily estimate?
A) Vapour pressure
B) Surface area
C) Surface tension
D) Adsorption capacity
Answer: B) Surface area
69. Which equation relates the thickness of a liquid film to the pressure difference across the liquid interface?
A) Laplace equation
B) Kelvin equation
C) Gibbs adsorption isotherm
D) BET equation
Answer: A) Laplace equation
70. In the context of surface tension, what does the Laplace equation describe?
A) Curvature
B) Adsorption
C) Temperature
D) Pressure difference

Answer: A) Curvature
71. Which of the following represents the standard electrode potential for the reduction of hydrogen ions to hydrogen gas?
A) +0.34 V
B) +0.00 V
C) -0.76 V
D) -1.23 V
Answer: B) +0.00 V
72. In a galvanic cell, which electrode serves as the site of oxidation?
A) Anode
B) Cathode
C) Salt bridge
D) Electolyte
Answer: A) Anode
73. Which factor affects the magnitude of electrode potential?
A) Concentration of electrolyte
B) Surface area of the electrode
C) Temperature of the solution
D) Distance between electrodes
Answer: A) Concentration of electrolyte
74. What happens to the electrode potential if the concentration of the ions involved in the half-reaction is increased?
A) It increases
B) It decreases
C) It remains unchanged
D) It becomes negative
Answer: A) It increases
75. Which equation is used to calculate the electrode potential under non-standard conditions?
A) Faraday's law
B) Ohm's law
C) Nernst equation
D) Hess's law
Answer: C) Nernst equation
76. What is the electrode potential of a hydrogen electrode at 25°C when the concentration of hydrogen ions is 0.1 M?
A) +0.059 V
B) -0.059 V
C) +0.0592 V
D) -0.0592 V
Answer: B) -0.059 V
77. Which ion contributes to the electrode potential in a Daniell cell?
A) Zn2+
B) Cu2+
C) H+
D) Cl-
Answer: A) Zn2+
78. What is the standard electrode potential for the reduction of copper ions to copper metal?
A) +0.34 V
B) +0.00 V

C) +0.80 V
D) -0.76 V
Answer: C) +0.80 V
79. In a galvanic cell, electrons flow from:
A) Cathode to anode
B) Anode to cathode
C) Salt bridge to cathode
D) Electrolyte to anode
Answer: B) Anode to cathode
80. What is the half-cell reaction for the standard hydrogen electrode?
A) 2H2O(l) + 2e- -> H2(g) + 2OH-
B) 2H+ + 2e- -> H2(g)
C) H2(g) -> 2H+ + 2e-
D) H2O(l) + 2e- -> 2OH-
Answer: B) 2H+ + 2e- -> H2(g)
81. What is the electrode potential of a cell if the concentrations of all species are 1 M?
A) +0.059 V
B) +0.00 V
C) -0.059 V
D) -0.0592 V
Answer: B) +0.00 V
82. Which factor affects the sign of electrode potential?
A) Temperature
B) Pressure
C) Concentration
D) Surface area
Answer: C) Concentration
83. What is the standard electrode potential for the reduction of oxygen gas to hydroxide ions?
A) +0.34 V
B) +0.00 V
C) +0.40 V
D) -0.76 V
Answer: C) +0.40 V
84. Which equation represents the Nernst equation?
A) E = mc^2
B) E = hv
C) E = E° - (0.0592/n) * log([O2])
D) E = V/I
Answer: C) E = E° - (0.0592/n) * log([O2])
85. What is the standard electrode potential for the reduction of silver ions to silver metal?
A) +0.34 V
B) +0.00 V
C) +0.80 V
D) +0.80 V
Answer: D) +0.80 V
86. Which ion contributes to the electrode potential at the cathode in a Daniell cell?
A) Zn2+
B) Cu2+
C) H+

D) Cl^-
Answer: B) Cu^{2+}
87. What is the half-cell reaction for the standard silver electrode?
A) Ag(s) -> Ag+ + e-
B) Ag+ + e- -> Ag(s)
C) Ag(s) + 2e- -> 2Ag+
D) AgCl(s) + e- -> Ag(s) + Cl-
Answer: B) Ag+ + e- -> Ag(s)
88. What happens to the electrode potential if the temperature of the solution increases?
A) It increases
B) It decreases
C) It remains unchanged
D) It becomes negative
Answer: A) It increases
89. What is the standard electrode potential for the reduction of iron ions to iron metal?
A) +0.34 V
B) +0.00 V
C) -0.44 V
D) -0.76 V
Answer: C) -0.44 V
90. In a galvanic cell, which electrode is the site of reduction?
A) Anode
B) Cathode
C) Salt bridge
D) Electolyte
Answer: B) Cathode
91. What is the electrode potential of a cell when the concentrations of all species are 0.1 M?
A) +0.059 V
B) +0.00 V
C) -0.059 V
D) -0.0592 V
Answer: C) -0.059 V
92. Which factor does not affect the electrode potential?
A) Concentration
B) Surface area
C) Temperature
D) Pressure
Answer: D) Pressure
93. What is the standard electrode potential for the reduction of zinc ions to zinc metal?
A) +0.34 V
B) +0.00 V
C) -0.76 V
D) -0.44 V
Answer: A) +0.34 V
94. Which equation represents the Faraday's law of electrolysis?
A) $E = mc^2$
B) E = hv
C) Q = It
D) Q = ne
Answer: D) Q = ne

95. What is the electrode potential of a cell when the concentrations of all species are 0.01 M?
A) +0.059 V
B) +0.00 V
C) -0.059 V
D) -0.0592 V
Answer: C) -0.059 V
96. Which type of polymerization typically results in a higher polydispersity index?
A) Step-growth polymerization
B) Chain-growth polymerization
C) Radical polymerization
D) Anionic polymerization
Answer: A) Step-growth polymerization
97. A polymer sample with a PDI close to 1 indicates:
A) Monodispersity
B) Heterodispersity
C) Polydispersity
D) Isodispersity
Answer: C) Polydispersity
98. What does the polydispersity index (PDI) quantify?
A) The average molecular mass of a polymer sample
B) The distribution of molecular weights in a polymer sample
C) The number of repeating units in a polymer chain
D) The concentration of monomer units in a polymer solution
Answer: B) The distribution of molecular weights in a polymer sample
99. Which technique is commonly used to determine the molecular mass of polymers?
A) Infrared spectroscopy
B) Gas chromatography
C) Gel permeation chromatography
D) Nuclear magnetic resonance spectroscopy
Answer: C) Gel permeation chromatography
100. Which statement is true about the molecular mass of polymers?
A) It remains constant regardless of the polymerization method.
B) It is inversely proportional to the number of monomer units.
C) It increases with the addition of additives.
D) It varies depending on the polymerization method and conditions.
Answer: D) It varies depending on the polymerization method and conditions.