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PROGRAMME

PHYSICAL CHEMISTRY AND COLLOID CHEMISTRY
2024/2025

INTRODUCTION

Physical Chemistry – subject, methods, sub-disciplines

IDEAL AND REAL GASES

Ideal gas. Ideal gas laws. Ideal gas equation. Real gases. Real gas equation. Liquefaction of real gases

CHEMICAL THERMODYNAMICS

Basic terms (thermodynamic systems – classification; thermodynamic variables; state and path functions; equation of state; thermodynamic process; thermodynamic equilibrium). The Zeroth Law of Thermodynamics

The First Law of Thermodynamics. Energy, work and heat. The first law of thermodynamics and some simple processes.

Thermochemistry. Basic terms. Hess's law. Enthalpy of formation and combustion. Kirchhof's law

Second law of thermodynamics. Entropy – statistical interpretation and classical definition. Entropy changes accompanying specific processes
The Helmholtz and Gibbs energies. Conditions for spontaneity and equilibrium. The Gibbs energy and chemical reactions. The concept of maximum work

Thermodynamic potentials. Fundamental equations in TH. Dependence of Gibbs free energy of pressure and temperature. Gibbs-Helmholtz equation

Third law of thermodynamics. Standard/Absolute entropies

CHEMICAL POTENTIAL

Partial molar quantities. Chemical potential.
Gibbs–Duhem equation

CHEMICAL EQUILIBRIUM

Irreversible and reversible (equilibrium) chemical reactions. Characteristics of chemical equilibrium. Equilibrium constant and law of mass action. Chemical variable. Spontaneous and nonspontaneous reactions. Equilibrium expression for homogeneous and heterogeneous systems. Le Châtelier principle and factors that affect chemical equilibrium

PHASE EQUILIBRIA

Basic concepts – system, phase, component, degree of freedom. Gibbs phase rule. One-component systems. Water phase diagram. First- and second-order phase transitions. Clausius-Clapeyron equation. Two-component system phase diagrams. The lever rule

SOLUTIONS (MIXTURES)

General characteristics and classification. Ideal and real solutions. Deviations from Raoult's law. Liquid mixtures with limited solubility. Colligative properties of solutions. Ebullioscopic and cryoscopic constant. Osmosis

THREE-COMPONENT SYSTEMS. EXTRACTION

Gibbs-Roseboom diagrams. Distribution of a third component in a two-phase system. Extraction. Principles and terminology of extraction

ELECTROLYTE SOLUTIONS

Definition. Quantitative indicators for dissociation. Strong and weak electrolytes. Van't Hoff Isotonic factor. Electrical conductivity. Debye and Huckel theory. Kohlrausch laws. Activity. Activity coefficient. Ion transport numbers

SURFACE PHENOMENA. ADSORPTION

Main adsorption dependences – isotherms, isosters, isobars. Adsorption on solid adsorbent – Langmuir, Freundlich and BET isotherms

SURFACE TENSION. ADSORPTION ON LIQUID SURFACE

Surfactants. Gibbs isotherm. Shishkovsky equation, Traube's rule.

CHEMICAL KINETICS

Basic concepts and terminology – reaction rate, rate constant, reaction order and molecularity. Reaction mechanism. Rate law and integrated rate low. Zero-, first- and second-order reactions. Methods for determining the reaction order

DEPENDENCE OF THE RATE CONSTANT ON THE TEMPERATURE

Arrhenius equation. Activation energy. Collision theory. Transition-state theory. Kinetics of complex reactions. Parallel, successive, conjugate and chain reactions – examples

CATALYSIS

Catalysis. Basic terms and definitions (catalyst, catalysis, promoter, poison/catalytic poisoning). Types of catalysis. Features of catalysts and catalytic reactions – key points.

Homogeneous catalysis

Heterogeneous catalysis

Enzyme catalysis

ELECTROCHEMISTRY

Basic terms and definitions. Relationship between cell potential and Gibbs free energy. Temperature dependence of emf. Relationship between cell potential and equilibrium constant - Nernst equation. Reversible and concentration cells. Electrolytic cells. Electrolysis. Faraday's laws of electrolysis

COLLOID CHEMISTRY

Colloid chemistry – basic terms and definitions. Classification, preparation and purification of colloids: dispersion and condensation methods, dialysis and ultrafiltration. Colloids formation. Structure of lyophilic and lyophobic colloids. Significance and Applications

PROPERTIES OF COLLOID SYSTEMS

Optical properties of colloid systems - light scattering, absorption, opalescence, Tyndal effect. Theory of Rayleigh. Ultra-microscopy, nephelometry, turbidimetry – applications. Coloring colloidal dispersion systems

Electrical properties of colloid-dispersed systems. Theories of Double electric layer structure – Helmholtz, Gouy-Chapman and Stern. Coagulation stability. Recharging the sols. Coagulation under the action of electrolytes – flocculation value. Kinetic properties of sols – Brownian motion. Electrokinetic phenomena – electrophoresis, electroosmosis and its applications

EMULSIONS

Classifications, properties, production, applications. Emulsions –properties of dilute and concentrated emulsions. Stabilization of emulsions – emulsifiers

AEROSOLS

Aerosols' types and applications. Foams – properties, production, destruction. Macromolecular compounds. Schulze-Hardy rule. Gels – types, properties and applications

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08.09.2024
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