PHYSICAL AND COLLOID CHEMISTRY

Training Plan

Discipline	Exams	Classes			Classes by years and semesters						
	Semester	Total	Lectures	Practical classes	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**
Physical and colloid chemistry	III	90	45	45	-	-	2/3	-	-	-	-

TYPE OF COURSE ACCORDING TO THE UNIFORM STATE REQUIREMENTS:
Mandatory

LEVEL OF EDUCATION:
Master Degree

FORM OF EDUCATION:
Lecture courses, practical courses, self-training

DURATION OF THE COURSE:
1 semester

AUDITORIUM CLASSES:
45 hours of lecture courses, 45 hours of practical classes

TECHNICAL EQUIPMENT APPLIED IN THE TRAINING:
Audiovisual equipment, discussions, seminars, demonstrations of various physicochemical analysis methods to solve practical problems.
TRAINING METHODS: lecture courses, practical classes, seminars, individual work with students.

CONTROL AND EVALUATION:
 Ongoing evaluation – Preliminary control of assignment for the implementation of practical tasks, oral examinations, colloquia on different syllabus sections.
 Final evaluation – combined test , written and oral examination.

Formation of the final grade: The current average grade for the semester is formed based on tests and assignment papers.

Aspects in the formation of the final grade:
Participation in discussions, tests solving, colloquia

Term exam:
Entrance test, written and oral examination

State Exam:
No

Lecturer:
Associated professors at the Department of “Chemical sciences”.

Department:
“Chemical sciences”.

ANNOTATION

The discipline “Physical and colloid chemistry” studies chemical systems and the accompanying energetic changes, from the perspective of general physics principles.
It applies the principles, practices and concepts of physics such as thermodynamics, chemical kinetics, electrochemistry, catalysis, solutions theory, phase equilibrium, surface phenomena, properties of colloidal-dispersion systems, aerosols, dusts, suspensions, emulsions, surfactants and supra-molecular compounds.

COURSE OBJECTIVES

The main goals are to provide specific knowledge and skills for unsupervised application of contemporary physical methods to calculate and experimentally define thermodynamic merms, related to chemical reaction, phase transitions, ideal and real solutions, etc.

The laboratory experiments allow the students to practice important experimental methods in physical chemistry and colloid chemistry – electric measurements, optical methods, refractometry, tensiometry, spectrophotometry, etc.

The acquired knowledge will allow further understanding in the areas of: Pharmaceutical chemistry, Pharmaceutical analysis, Pharmacology and others.

OBLIGATORY COMPETENCIES

At the end of the course the students are expected to have the following knowledge and skills referring to the determination of:

- The universal gas constant R;
- The heat capacity of real gases at P, V = const;
- Molecular refraction of various solvents;
- The viscosity of fluids;
- The distribution coefficient of iodine in organic and inorganic phases;
- Specific and equivalent conductivity of electrolytes;
- and will determine The rate constant of a homogenous chemical reactions kinetics of vitamin C degradation;

- The size of colloidal particles by spectrophotometric method

- The value of ζ potential by electrophoresis;

- The critical micelle concentration (CMC);

- The life of the foam and surface activity of different surfactants

LECTURES – Theses

LECTURE № 1 - 3 hours

CHEMICAL THERMODYNAMICS

1. Introduction, Subject, Methods, Features and Importance Of Thermodynamics.

2. Basic concepts – a system, parameters, state functions, a composition, a process. Thermodynamic state.

STATE EQUATION. IDEAL GAS

1. State equation.

2. Ideal gas - volume, pressure, temperature.

3. Ideal Gas Laws - Boyle's law, Gay-Lussac, Charles, Avogadro, Dalton, Mendeleev-Clapeyron.

4. Real gas - properties, an equation of state.

5. Liquefaction of gases. Thermodynamic principles.

1. Zeroth law of thermodynamics.

2. Conservation of energy - energy, work, heat.

3. First law of thermodynamics - formulations, internal energy - properties.

4. Relation between Q_P, Q_V

LECTURE № 2 – 3 hours

THERMOCHEMISTRY

1. Application of the first law of thermodynamics. Hess's law-formulation, consequences.

2. Thermal and physicochemical processes - heats of formation, heat of combustion.

3. Kirchhoff's law—dependence of the reaction enthalpy on temperature, integral and differential form.

THE SECOND LAW OF THERMODYNAMICS

1. Reversible thermodynamic processes.

2. Maximum work. Heat capacity.

3. Formulation of the second thermodynamic law.

4. Carnot cycle.

5. Carnot's theorem. Entropy.

6. Analytical expression of the second thermodynamic law.

7. Statistical interpretation of entropy.

8. Critics of the of universe heat death theory

THE THIRD LAW OF THERMODYNAMICS

1. Nernst`s theorem.

2. Planck`s hypothesis.

LECTURE № 3 – 3 hours

THERMODYNAMIC POTENTIALS

1. Thermodynamic functions. Characteristic functions.

2. Isothermal thermodynamic potentials - Gibbs energy, Helmholtz energy.

3. Thermodynamic potentials charge - criteria for determining the direction of the processes. Conditions of TD equilibrium referring to isochoric and isobaric-isothermal processes.

4. Chemical potential equilibrium conditions for in multicomponent and multiphase open systems.

5. Chemical potential of an ideal gas. Volatility.

6. Chemical potential of an ideal solution. Activity.

LECTURE № 4-3 hours

CHEMICAL EQUILIBRIUM

1. Characteristics of chemical equilibrium.

2. Chemical variable.

3. Kinetic and thermodynamic derivation of the mass action law.

4. Dependence of the chemical equilibrium on temperature and pressure.

Le Chatelier - Brown principle.

5. Relationship between K_P and K_C.

6. The reaction isotherm equation - application.

7. Direction of chemical processes.

LECTURE № 5-3 hours

PHASE EQUILIBRIA. SOLUTIONS

1. Basic concepts. The phase rule.

2. Phase equilibria – one- component systems. Mendeleev- Clapeyron equation.

3. Water phase diagram

4. Two component systems - state diagram.

5. Partially-miscible liquids.

6. Solutions. General characteristics.

7. Partial molar quantities. Equation of Gibbs-Duhem.

8. Ideal solutions. Raoult's law.

9. Real solutions. Deviations from the Raoult's law.

10. Colligative properties of the solutions. Ebullioscopy and Cryoscopy.

11. Activity. Activity coefficient.

LECTURE № 6-3 hours

TERNARY SYSTEMS

1. Gibbs-Rozeboom diagrams.

2. Distribution of the third component in the two-layer system. Extraction.

ELECTROLYTE SOLUTIONS.

1. Definition of electrolytes.

2. Quantitative indicators of dissociation. Strong and weak electrolytes. Van’t Hoff isotonic factor.

3. Electrical conductivity – specific, equivalent.

4. Mobility and transport ions numbers.

LECTURE № 7-3 hours

SURFACE PHENOMENA. ADSORPTION. SURFACE TENSION

1. Adsorption - definition, types of adsorption, distinguishing criteria.

2. Main adsorption dependencies - isotherms, isosteres, isobars.

3. Adsorption heats - determine the isosteric adsorption heat determination.

4. Capillary condensation.

5. Adsorption on solid adsorbent - isotherms of the Langmuir, Freundlich and BET.

6. Adsorption on liquid surface - peculiarities. Gibbs adsorption isotherm.

7. Surface tension and parachor.

8. Surfactants – Shishkovsky’s equation, Traube's rule.

LECTURE № 8-3 hours

CHEMICAL KINETICS

1. Formal kinetics. Basic concepts - rate, order, molecularity.

2. The main postulate of kinetics. Kinetic equations of irreversible reactions under static conditions - zero-order, first-order and second-order reactions.

3. Method, for chemical reactions rate determination.

4. Kinetics of complex reactions - reversible, parallel and consecutive reactions.

5. Steady- state method.

6. Dependence of of the chemical reaction rate constant k on the temperature. Arrhenius equation.

7. Activation energy - definition, calculations.

8. Collision theory. Transition-state theory.

9. Theories application to the calculation of the rate constant of chemical processes.

LECTURE № 9-3 hours

CATALYSIS

1. Definition of catalysis and a catalyst. Characteristics of the phenomenon.

2. Homogeneous catalysis - basics, mechanism (elementary steps), kinetics.

3. Acid - base catalysis.

4. Heterogeneous catalysis – mechanism (elementary steps).

5. Activation energy decrease. Apparent and effective activation energy.

6. Balandin multiplet theory. The role of the energy factor in catalysis.

7. Micro heterogeneous catalysis. Enzyme catalytic processes.

LECTURE № 10-3 hours

ELECTROCHEMISTRY

1. Matter and scope of electrochemistry. Faraday's laws of electrolysis.

2. Theory of Arrhenius. Ostwald's law. Disadvantages of the Arrhenius theory.

3. Debye–Hückel theory – the electrophoretic effect and the relaxation effect.

4. Kohlrausch's law.

5. Electrical conductivity of cells and tissues. Application of conductivity in medicine.

LECTURE № 11-3 hours

ELECTROCHEMICAL THERMODYNAMICS

1. Electrochemical elements - classification.

2. Electromotive force (EMF) - generation, dimension, sign, measurement.

3. Causes of occurrence of a potential jump at the phase boundary. Types of electrode potentials. Nernst equation.

4. Standard electrode potential.

5. Types of electrodes.

LECTURE № 12-3 hours

ELECTROCHEMICAL KINETICS

1. Electrode polarization – types, determination.

2. Temperature-kinetic method.

3. Hydrogen overpotential.

LECTURE № 13-3 hours

COLLOIDAL CHEMISTRY

1. Colloidal chemistry as a science.

2. Colloidal systems - classification, methods of preparation and purification.

3. Structure of lyophobic and lyophilic colloids.

LECTURE № 14-3 hours

PROPERTIES OF COLLOIDAL SOLUTIONS

1. Optical properties - scattering, adsorption, opalescence.

2. Ultra-microscopy, nephelometry, turbidimetry.

3. Color of colloids.

4.Molecular-kinetic properties - osmosis, sedimentation. Brownian motion. Einstein and Smoluhovsky's formula.

5. Electro kinetic properties. Electrical double layer. Stability of coagulation. Coagulation of colloidal solutions by electrolytes.

6. Electro - kinetic phenomena - electrophoresis, electro-osmosis.

LECTURE № 15-3 hours

AEROSOLS

1. Aerosols - classification, formation, destruction.

2. Emulsions – types, rheological properties, stabilization.

3. Foams - formation, stabilization, destruction.

PRACTICAL COURSE SYLLABUS

PRACTICAL № 1 - 3 hours

DETERMINATION OF THERMODYNAMIC PROPERTIES OF VISCOUS FLOW

BY STUDYING THE VISCOSITY / TEMPERATURE RELATION

1. Viscosity - introducing the concept. Newton's law. Definition of viscosity. Types of viscosity.

2. Equations for calculating the viscosity and density of the fluid.

3. Relationship between the viscosity and $\Delta S, \Delta H, \Delta G$

4. Determination of the viscosity by Ostwald's method.

5. Experimental treatment.

PRACTICAL № 3 – 3 hours

DETERMINATION OF THE SURFACE TENSION OF LIQUIDS. PARACHOR

1. Surface tension - definition.

2. Temperature dependence of the surface tension on - analytical expression.

3. Parachor - characteristic.

4. Rebinder's method for determination of the surface tension – equations, experimental procedure, experimental treatment.

PRACTICAL № 4 - 3 hours

ADSORPTION OF A SOLUTION ON A SOLID ADSORBENT

1. Adsorption - definition, basic concepts, types of adsorbtion.

2. Freundlich adsorption isotherm.

3. Adsorption of acetic acid on activated charcoal– experimental procedure.

4. Experimental treatment.

PRACTICAL № 5 - 3 hours

DETERMINATION OF THE DISTRIBUTION COEFFICIENT OF IODINE BETWEEN WATER AND AN ORGANIC SOLVENT

1. The distribution coefficient - Nernst's distribution law. Deviations from the law. The linear form of the law.

2. Determination of the distribution coefficient of iodine in organic and aqueous phases – an experimental procedure.

3. Experimental treatment.

PRACTICAL № 6 - 3 hours

KINETIC STUDY OF THE OXIDATION OF HYDROIODIC ACID BY HYDROGEN PEROXIDE

1. Preparation of hydroiodic acid – reaction characteristics, reaction rate.

2. Kinetics of the oxidation. Arrhenius equation - application.

3. Determination of the equilibrium constant - experimental procedure and processing of the experimental results.

PRACTICAL № 7 - 3 hours

CONDUCTOMETRIC STUDY OF VITAMIN C DEGRADATION RATE

1. Ascorbic acid - role in living organisms.

2. Properties of the ascorbic acid. Oxidation. Kinetics of oxidation.

3. Determination of the rate constant of ascorbic acid degradation -

experimental procedure.

4. Processing of the experimental results - working equations.

PRACTICAL № 8 - 3 hours

DETERMINATION OF REACTION RATE CONSTANT OF SUGAR INVERSION BY AN OPTICAL METHOD

1. Sugar inversion - characteristic of the process.

2. Principle of the method - optically active substances.

3. Kinetics of the process – reaction order, kinetic equations.

4. Calculation of the activation energy – the Arrhenius equation.

5. Experimental procedure.

6. Processing of the experimental results - working equations, graphics.

PRACTICAL № 9 - 3 hours

CONDUCTOMETRIC STUDY OF WEAK AND STRONG

ELECTROLYTES PROPERTIES

1. Conductors and insulators. First- class and second- class conductors.

2. Weak electrolytes - Arrhenius's theory, Ostwald's dilution law - dissociation constant.

3. Conductivity - specific and equivalent, definitions, analytical expressions.

4. Strong electrolytes - Debye–Hückel theory - electrophoretic effect and relaxation effect

5. Concentration dependence of the electrolyte conductance. - analytical and graphical expressions.

6. Kohlrausch's Laws- the first and the second law. Coefficient of electrical conductivity.

7. Electrical conductivity determination - an experimental procedure.

8. Processing of experimental results - working equations, graphics.

PRACTICAL № 10 - 3 hours

DETERMINATION OF SULFURIC ACID IONS TRANSPORT NUMBERS

1. Electrolysis, electrolytes, electrodes - definitions, characteristics. Ions mobility.

2. Transport numbers - definition. Expression of the transport numbers on the ground of the mobility, the absolute speed, the change of the number of moles in the anode and cathode area and the change of the concentration of cations and anions in the cathode and anode area.

3. Methods for determining the transport numbers – Hittorf’s method.

4. Faraday's law of electrolysis.

5. Practical determination of sulfuric acid ions – an experimental procedure.

6. Processing of experimental results - working equations, sequence of calculations procedure.

PRACTICAL № 11 - 3 hours

DETERMINATION OF THE COLLOIDAL PARTICLES NUMBER

1. Colloidal disperse systems - definition, classification.

2. Optical properties of colloidal disperse systems.

3. The Beer-Bouguer-Lambert law. Light absorbance, molar absorptivity, turbidity.

4. The principle of the method.

5. An experimental procedure - preparation of the sol, spectrophotometric measurements.

6. Processing of the experimental results - working equations, calculations.

PRACTICAL № 12 - 3 hours

ELECTROPHORETIC DETERMINATION OF ζ POTENTIAL BY MOVING BOUNDARY METHOD

1. Disperse systems - composition.

2. Electrophoresis, electro-osmosis - definitions. Electrophoretic mobility.

3. Electrokinetic potential- occurrence. A relation between the electrokinetic potential and the electrophoretic mobility –an analytic expression.

4. An experimental procedure - preparation of the sol, Tchaikovsky method.

5. Processing of the experimental results - equations, calculations.

PRACTICAL № 13 - 3 hours

DETERMINATION OF THE CRITICAL MICELLE CONCENTRATION (CMC) OF WATER-SOLUBLE COLLOIDAL SURFACTANT BY CONDUCTIVITY MEASURMENTS

1. Surfactants – characteristics, types.

2. Micellization - theory of the process. Critical Micelle Concentration (CMC).

3. Principle of the method - a relation between CMC and the specific conductance.

4. Processing of the experimental data -a graphical correlation between the specific conductivity and concentration.

PRACTICAL № 14 - 3 hours

A KINETIC STUDY OF SUSPENSIONS AGGREGATION STABILITY

1. Disperse systems - classification according to the size of the dispersed phase.

2. Sols - definition.

3. Sedimentation - characteristic of the process. Aggregative stable and unstable systems - mechanism of sedimentation.

4. Principle of the method. An experimental procedure.

5. Processing of the experimental data.

PRACTICAL № 15 - 3 hours

PHOTOMETRIC DETERMINATION OF THE COAGULATION THRESHOLD OF A COLLOIDAL DISPERSE SYSTEM

1. Stability of colloidal disperse systems. Coagulation – definition, mechanism of the process.

2. Theory of the coagulation process. The Schulze-Hardy rule.

3. Principle of the method - a relation between the dispersity and optical properties of the system.

4. Experimental procedure - preparation of the working solutions, spectrophotometric measurements.

5. Processing of the experimental data – verification of the Schulze-Hardy rule.

Recommended literature:

1. Physical Chemistry- E. Vulcheva E. Lazarova, St. Veleva, T. Nikolov, Assist. Girginov, "Martilen" Sofia, 1999, ISBN-954-598-061-3

2. Physical Chemistry- D. Mihailova, Tipografika, Sofia, 1994

3. Physical Chemistry (I, II) - D. Damyanov, SUB, Burgas, 1994

4. Physical Chemistry – E.A. Moelwyn-Hughes, Prgmon Pres, London-New York-Paris, 1961

5. Physical Chemistry for biologists- V. Williams, H. Williams, Mir Publisher, Moscow, 1976

6. Physical and Colloid Chemistry- E. Paspaleev, "Science and Art", 1977

7. Physical and Colloid Chemistry- D. Shterev, At. Atanasov, University of Plovdiv, 1981

8. Physical and Colloid Chemistry - A. Belyaev, Moscow, GEOTAR - Media, 2008,

ISBN978-5-9704-0877-3

9. Physical Chemistry – R. Mortimer, Elsevier Academic Press, 2008

10. Atkins' Physical Chemistry – P. Atkins and J. de Paula, Oxford University Press, 2009

11. Physical Chemistry - N. Raev, Academic Publishing UHT - Plovdiv, 2004.

12. Physical Chemistry-E. Sokolova, "Science and Art", 1990

13. Physical and Colloid Chemistry- D. Totomanov, Technologie, Sofia, 1975

14. Physical Chemistry (I, II) – B. Angelov, Academic Publishing UHT – Plovdiv 2007, ISBN-10:954-24-0071-3, ISBN-13: 978-954-24-0071-4

SYLLABUS

1. Subject, sections and methods of Physical Chemistry.

2. Basic concepts – a system, parameters and functions of a state, a composition, a process. Thermodynamic state.

3. Ideal gas. Basic gas laws. An ideal gas state equation.

4. Real gases. A real gas state equation. Liquefaction.

5. Chemical thermodynamics - subject, characteristics and importance. The zeroth and the first law of thermodynamics. Energy, heat and work. Heat content of reaction at P, V = const. Relation between Qp and Qv.

6. Application of the first law of thermodynamics. Hess's law. Corollaries of the Hess's law. Heat of formation and combustion. The Kirchhoff's law.

7. The second law of thermodynamics. Formulation. The Carnot's cycle. Analytical expression of the second law of thermodynamics.

8. Entropy. Determination of the process direction in an adiabatically isolated system. Entropy change calculations.

9. Statistical explanation of the entropy. The second law of thermodynamics - limits of application. Critical approach to the theory of the heat death of the universe. The third law of thermodynamics. The Nernst's theorem. The Planck's hypothesis.

10. Thermodynamic functions - U, H, F, G. Characteristic functions. Thermodynamic potentials. Helmholtz energy /isochoric-isothermal potential /. Gibbs energy / isobaric-isothermal potential/. Dependence of the isochoric-isothertmal and the isobaric-isothermal potentials on the system's parameters – the pressure, the volume and the temperature. Criteria referring to the determination of the direction of isochoric-isothermal and isobaric-isothermal processes as well as the conditions required to reach thermodynamic equilibrium. Gibbs-Helmholtz Equation.

11. Partial molar quantities. Chemical potential - definition, physical meaning. Conditions for equilibrium in multi-component and multiphase systems.

12. Chemical equilibrium - characteristics. The chemical variable. The law of mass action. Chemical equilibrium dependence on the temperature and the pressure. The Le Chatelier - Brown principle. Relation between Kp and Kc. The Van't Hoff's equation. Equilibrium in biochemical and biological systems. Importance.

13. The reaction isotherm equation – application. Standard isobaric potential (standard maximum work). Reaction isobar and isochore equations. Temperature dependence of the equilibrium constant.

14. Phase equilibria - basic concepts. The phase rule. One-component systems. State diagrams. The Clausius-Clapeyron's Equation

15. Binary systems. State diagrams. Liquids of limited miscibility. A solid-liquid equilibrium state.

16. Solutions. General characteristics of solutions. Ideal solutions. Raoult's law. Thermodynamic properties of ideal solutions.

17. Real solutions. Positive and negative deviations from the Raoult's law. Ideally dilute solutions. Colligative properties. Boiling-point elevation and freezing-point depression of ideally dilute solutions of involatile solutes. Ebullioscopy and Cryoscopy.

18. Osmotic pressure - thermodynamics and importance. Activity. Activity coefficient Solubility of gases in liquids. Positive and negative deviations from the Raoult's law. Liquid-vapor Equilibrium. Distillation and rectification of liquid mixtures. Steam distillation.

19. Ternary systems. Gibbs-Rooseboom diagrams. Distribution of the third component between the system's two phases - extraction.

20. Solutions of electrolytes. Strong and weak electrolytes. Electrolyte conductivity. Specific and equivalent conductivity. Mobility and transport numbers of ions.

21. Adsorption and adsorption forces. Types of adsorption. Criteria to distinguish physical from chemical adsorption.

22. Main adsorption dependencies - isotherms, isosteres, isobars. Adsorption heat. Determination of isosteric adsorption heats. Capillary condensation.

23. Adsorption on solid and liquid surfaces. Isotherms of Freundlich ,Langmuir, BET and Gibbs - derivation and application of the isotherms. Surfactants. Thin liquid layers.

24. Surface tension of individual liquids and solutions. Surface tension of solutions. Isotherm of surfactants – the Shishkovsky's equation. The Traube's rule.

25. Chemical kinetics. Basic postulate. Basic concepts - rate, order, molecularity of a chemical reaction. Kinetics of irreversible reactions under static conditions. Reactions of zeroth-, first- and second-order - kinetic equations. Methods for reactions rate determination.

26. Kinetics of complex reactions. First-order parallel, consecutive and reversible reactions. Kinetic equations.

27. Theoretical foundations of chemical kinetics. Dependence of the reaction rate on the temperature. The Arrhenius equation. Activation energy - definition, calculations.

28. Collision theory. Transition-state theory. Application of the rate theories for the calculation of the chemical processes rate constants.

29. Catalysis and catalysts. Characteristics of the phenomenon. Homogeneous catalysis. Basics. Mechanism and kinetics of homogeneous catalysis.

30. Heterogeneous catalysis. Mechanism (elementary steps). Scheme of the activation energy decrease. Apparent and effective activation energy.

31. Theories of heterogeneous catalysis. The Balandin's multiplet theory. Role of the energy and the geometric factor . Micro-heterogeneous catalysis- enzyme catalysis.

32. Electrochemistry. Scope of electrochemistry. Basic concepts Electric dissociation. The Faraday's laws. Theory of Arrhenius.

33. Conductivity of electrolytes solutions. Specific and equivalent conductivity. Factors affecting conductivity. Strong electrolytes. The Debye–Hückel theory. The Kohlrausch's Laws. Transport numbers.

34. Electrochemical thermodynamics. Electrochemical elements – classification. Electromotive force (EMF) - generation, dimension, sign, measurement. Relationship between EMF and other terms.

35. Causes for occurrence of a potential jump on the system's interface. Types of electrode potentials - mechanism of generation and measurement. Thermodynamic derivation of the Nernst's equation .The standard electrode potential. Determination of the direction of oxidation-reduction processes. Types of electrodes.

36. Kinetics of electrochemical processes. Electrode polarization - concentration and electrochemical polarization. The hydrogen overpotential.

37. Colloidal chemistry as a science. Concept of colloidal systems. Classification, preparation and purification of colloids: dispersion and condensation methods, dialysis and ultrafiltration. Colloids formation.

38. Optical properties of colloidal systems. Light scattering. Theory of Rayleigh. Ultra-microscopy, nephelometry, turbidimetry. Coloring colloidal dispersion systems.

39. Molecular-kinetic properties of colloidal systems- osmosis, sedimentation. Brownian motion. The Einstein's and Smoluhovsky's conclusions.

40. Electric properties. Electrical double layer. Coagulation of colloidal solutions by electrolytes. Recharging of sols. Irregular rows. Electro - kinetic phenomena - electrophoresis, electro-osmosis.

41. Stability of colloidal solutions - sedimentation factors and kinetics, sedimentation analysis. Coagulation and peptization.

42. Aerosols - classification, formation, destruction. Thermal precipitation. Thermal phoresis. Photophoresis.

43. Emulsions – classification, properties of dilute and concentrated emulsions. Stabilization of emulsions. Coalescence,

44. Foams - formation, structure and stabilization. Role of surfactants.

45. Solutions of high-molecular compounds. The Schulze-Hardy's rule. Molecular-kinetic properties. Solutions of polyelectrolytes. Gels and gel state.