Topics of Subjects Included in the Entrance Examination for Master Degree Study Programmes

ANALYTICAL CHEMISTRY

1. Selection of analytical method and its parameters, signal calibration, sampling, sample treatment, sample decomposition, evaluation of measurement results
2. Qualitative analysis, gravimetry and titrimetry
3. Electroanalytical methods (potentiometry, voltamperometry, polarography, coulometry, flow analysis) - fundamentals, instrumentation, qualitative and quantitative analysis, applications
4. Separation methods (liquid chromatography, gas chromatography, electrophoresis) - fundamentals, instrumentation, qualitative and quantitative analysis, applications
5. Atomic emission and absorption spectrometry - fundamentals, instrumentation, qualitative and quantitative analysis, applications
6. Molecular absorption spectrometry - fundamentals, instrumentation, qualitative and quantitative analysis, applications
BIOCHEMISTRY

   1.1. Inorganic components: cations and anions, trace elements, their occurrence in living organisms and their function, role of water.

   2.1. Nucleic acids:
      2.1.1. Nitrogen-containing nucleobases, nucleosides, nucleotides, ribonucleotides and deoxyribonucleotides, their structure and properties.
   2.2. Proteins:
      2.2.1. Amino acids: structure, physical and chemical properties, their chemical reactions. Formation and properties of peptide bond.
      2.2.2. Proteins and polypeptides. Physical and chemical properties, primary structure. N-terminal amino acid analysis (Sanger’s method) and Edman degradation of proteins and determination of primary structure. Secondary structure of proteins and conditions of its formation. α-helix, β-sheet and collagen structure. Tertiary and quaternary structure. Synthesis of proteins.
   2.3. Saccharides and polysaccharides:
      2.3.1. Structural series of tetroses, pentoses, hexoses, their chirality and stereochemistry: enantiomers, diastereoisomers, anomers, tautomeric forms, conformation isomers. Biologically important monosaccharides and their derivatives - esters, acids and lactones, alditols, amino-sugars, glycosides.

3. Enzymes.
   3.2. Enzymes as a protein molecules. Substrate specificity. Active centre/site of enzyme and its reaction with substrate. Apoenzymes and coenzymes, vitamins as the coenzymes and reaction mechanisms. Antimetabolites.
   3.3. Inhibition of enzyme reactions. Difference toward enzyme regulation. Competitive, non-competitive and uncompetitive inhibition.
   3.4. Enzyme classification by IUBMB.

   4.2. Control mechanisms of metabolic pathways.
      4.2.1. Regulation of metabolic reaction flow by change of enzyme molecules number. Jacob - Monod - model of operon. Concept of inducer, repressor, promoter and regulator.
      4.2.2. Regulation by the change of enzymatic activity. Velocity of allosterically regulated enzyme reaction. Hill equation. Allosteric inhibition and activation, allosteric effectors and their role in metabolic pathways as a feedback regulatory elements.
4.2.3. Covalent modifications of enzyme activity. Protein phosphorylation and its enzyme prerequisites. Adenylation, acylation and partial proteolysis.

5. Energy metabolism of cell.
5.2. Oxidative decarboxylation of pyruvate, its mechanism, formation of acetyl coenzyme A. Citric acid cycle, its intermediates and enzymes. Formation of reduced reducing equivalents. Anaplerotic reactions. The glyoxylate cycle, its importance and enzymatic prerequisites.
5.5. Utilization of fatty acids. Degradation of triacylglycerols, activation of fatty acids, β - oxidation of fatty acids, its enzymatic, energetic and transport aspects. α- a ω- oxidation of fatty acids. Biosynthesis of fatty acids.
5.6. Photosynthetic phosphorylation and carbon fixation.
CHEMICAL ENGINEERING


Fluid transport, pumps. Pump types, their function, advantages and disadvantages. Suction and working height of a pump. Pump pressure and power. Tube characteristics, liquid flow rate.

Fluid flow through a particle bed, applications: sedimentation, filtration, fluidization. Particle fall velocity, threshold rate of fluidization, filtration rate, filtration at constant pressure/temperature. Filter and settler types.

Mixing of liquids. Types of stirrers and their applications in biotechnology. Flow through a stirrer, mixing time, input power to stirrer.


Cooling to temperatures lower than the ambient temperature. Compression cooling, principle of ammonia compression cooling. T-s diagram of ammonia, explanation of the cooling cycle. Cooling agent parameters. Cooling capacity, input power to cooling equipment, cooler and cooling agent vapor condenser. Cooling agent vapor throttling.
CHEMICAL TECHNOLOGY FUNDAMENTALS

Silicates, glass.
Inorganic raw materials for industry. Processing of waste.
Production of HCl and HF.
Aluminium production.
Electrolysis of water.
The inorganic composite components - production of Al(OH)₃ and Mg(OH)₂.
Production of ammonia.
Catalytic processes in inorganic technology.
Production of phosphoric acid. Environmental aspects.
Technical electrochemistry - theoretical fundamentals of electrochemical technologies.
Inorganic binders - cement and lime.
Fertilizers. Chemical residues in food.
Nitric acid production. Environmental aspects of nitrogen oxides.
Production of NaOH. Environmental aspects.
Corrosion and corrosion protection of materials.
Ceramics - materials, chemical composition, properties and uses.
Production of sulfuric acid. Environmental aspects of sulfur oxides.
The chlorine production. Environmental aspects.

Petroleum, refining processes (dehydration, desalting, atmospheric and vacuum distillation), primary products and their use.
Catalytic Processes in utilization of petroleum, thermo-catalytic processes, sweetened petroleum products.
Motor fuels (modern gasoline, diesel, fuel components from renewable sources).
Olefins by pyrolysis, production of hydrocarbons by dehydrogenation (ethene, propene, C₄ and C₅ olefins) and their use.
Oxidation processes of alkanes, alkenes, aromatics and cyclanes
Important hydroperoxides, oxiranes, methylolxirane, formaldehyde, acetaldehyde from ethene, acetic acid, maleic anhydride, phthalic anhydride, aromatic carboxylic acid.
Alkylation processes (ethylbenzene, cumene, MTBE, production of esters), the use of products.
Manufacture of aromatic hydrocarbons (benzene, toluene, C₈-aromatics, cumene, naphthalene), and their use.
Hydrogenation and dehydrogenation processes (cyclohexane, aniline, cyclohexanone and cyclohexanol from the phenol, styrene, n-alkenes).
Sulfonation, sulfation and nitration processes (sulfates, alkylbenzenesulfonates nitrotoluene, nitrobenzene, nitro alcohols).
Use of raw materials from renewable sources for the production of organic matter, biodiesel, chemical utilization of lignocellulose
Natural gas and processing procedures, C₁ chemistry.
Production of synthesis gas from natural gas, petroleum fractions and coal.
Methanol production, processes based on methanol carbonylation, o xo synthesis of carbonyls.
Epoxides - epoxy resins, isocyanates - polyurethanes, diamines, diols and dicarboxylic acids - polyamides and polyesters
Surfactants, pesticides, types.
Coal and its chemical uses, production of acetylene, products based on acetylene.
Halogenation processes, PVC, Teflon, CFCs (halogenated impact on ecology).
Ammonolysis, hydrolysis and alcoholysis of oxiranes, significant polyols, production and uses
Polymer additives, plasticizers, antioxidants.
The polymers (polyethylene, polypropylene, polystyrene, polyacrylonitrile, organic glass, copolymers).
ECONOMICS AND MANAGEMENT

The production process, segmentation of production processes and inputs classification.
Long-term assets – as a capacity, depreciation, fixed assets investment.
Current assets - turnaround indicators, standards and norms, funding of current assets.
Costs - costing, pricing, point gain/ breaking point
Funding business, sources of funding and its basic rules.
What is business, business plan, legal forms of business in Slovakia.
Basic criteria for financial decision-making.
Evaluation of investment effectivity
Equity capital of a company.
Foreign capital of a company - long-term and short-term.
Strategic and tactical financial goals of the company and their measurement.
The methods of financial planning
The causes and degrees of financial difficulties. Formal and informal procedures for crisis management a company.
Quality, brand of the quality, approach to defining quality, quality as a dynamic category.
Basic concepts of quality management system - PDCA Deming Cycle.
The principles of management of quality - ISO Standards Council 9000th
Processed approach to the management of quality, auditing and certification.
Economy of quality, the cost of quality.
The triad of the fundamental problems of the economic development of society.
Basic categories of the market mechanism: demand, supply, price.
Microeconomic theory of the consumers.
The technological company optimum.
Explicit and implicit costs. Fixed and variable costs. The total, average and marginal costs.
The equilibrium of a company in the conditions of perfect and imperfect competition.
The basic macroeconomic indicators and ways to measure economic growth.
The state budget as the main instrument of fiscal policy.
What is inflation and the ways to measure inflation, types of inflation.
The unemployment forms. The Okun law.
Instruments of the foreign - trade policy of the state - tariffs, quotas and so on.
International monetary system. European Monetary System.
Economic cycles. The countercyclical economic policy of the state.
INORGANIC CHEMISTRY

Objects of inorganic chemistry
1. Atom, molecule, ion, element, chemical compound.
2. Chemical systems and their composition.

Electron configuration of atoms
3. Composition and structure of atoms; Schrödinger equation, quantum numbers, atomic orbitals.
4. Electronic structure of atoms; Pauli exclusion principle, Building-up principle, Hund’s rule of maximum spin multiplicity.
5. Electronic structure of polyelectronic atoms and ions.
6. Classification of elements based on electronic structure of their atoms and ions.
7. Periodic law and periodicity of the elements.

Chemical bond
9. Experimental knowledge on the chemical bond; bond order, energy and length.
10. Ionization energy, electron affinity, electronegativity; chemical bond polarity.
11. LCAO method and conditions of MO construction, classification of MO in dinuclear particles based on symmetry, bond nature, and energy; bond order.
12. Electron configuration of dinuclear particles (Li₂⁺ → Ne₂⁺, HF, CO and their analogs).
13. The Valence-Shell Electron-Pair Repulsion (VSEPR) model, shape of polynuclear molecules and ions.
14. Electron structural formula and shape of N₂, O₂, F₂, HF, CO₂, SO₂, NO₂⁻ and their analogs.
15. Electron structural formula and shape of BF₃, NO₃⁻, SO₃, NH₃, NH₄⁺, SO₄²⁻ and their analogs.
16. Electron structural formula and shape of ClF₃, XeF₄, PF₅, SF₆ and their analogs.
17. Electron structural formula and shape of H₂O, HNO₃, H₂O₂ and H₂SO₄.
18. Metallic bond, enthalpy of atomization.
19. Ionic bond; properties of ions; structure type of NaCl, CsCl, ZnS and CaF₂; Niggli structural formulas.
20. Hydrogen bond and its impact on physical properties of chemical compounds.

Structure of solid substances
21. Types of crystalline solids based on particles nature and interparticle attractive forces.
22. Polymorphism, allotropy and isomorphism.

Physical properties of chemical substances
23. Electrical properties of molecules; dipole moment and molecular geometry.
24. Electrical conductivity; conductors, semiconductors, insulators.
25. Electrical properties of substances; polarity of solvents.
26. Magnetic properties, diamagnetism, paramagnetism; magnetic moment.
27. Optical properties, Lambert-Beer law.
28. Thermal properties of inorganic substances; thermal decomposition.
29. States of matter, their changes and relation to attractive interparticle forces.

Systems of chemical compounds
30. Solutions; dissolution of gaseous and solid substances in liquids; solvatation, solubility and solubility curves.
31. Electrolytes and their ionization in solutions.

Chemical reactions – Thermodynamics
32. Internal energy, enthalpy, entropy and Gibbs energy – importance for chemistry.
33. Criteria of spontaneity of chemical and physical processes.
34. Equilibrium of chemical reactions, reaction quotient, equilibrium constants Kᵦ, Kₑ and Kᵦₑ.
35. Composition of systems in equilibrium and its changes due to alteration of temperature, pressure, addition or take-off or and system component.

Chemical reactions – Kinetics
36. Rate of chemical reaction, rate law.
37. Influence of temperature, catalyst and concentration of compounds involved in reaction on chemical reaction rate.
38. Catalysts, types of catalysis.

Acid-base reactions
39. Acids, bases and products of their reactions from the viewpoint of Brönsted and Lewis conceptions.
40. Autoprotolysis, quantities pH, pOH and pKw.
41. Ionization of Brönsted acids and bases, constants Ka and Kb, strength of oxoacids.
42. Hydrolysis of cations and anions.
43. Amphiprotic and amphoteric compounds.

**Complex forming reactions**
44. Complex, coordination compound; complex forming reactions, stability constants.

**Redox reactions**
45. Oxidation, reduction; electrode potential, Nernst equation.
46. Electrode potential of metals, electrochemical potential series.
47. Reactions of metals with water, acids and hydroxides.

**Precipitation and gas-releasing reactions**
48. Types of precipitation and gas-releasing reactions; modes of precipitation.
49. Solubility of slightly soluble, strong electrolytes and solubility product Ks.

**Periodic properties**
50. Mendeleev’s periodic law; periodicity of the elements and chemical compounds.
51. Atomic and ionic radius, ionization energy, electronegativity.
52. Inert electron pair and its consequences for redox stability of compounds of p-elements of the 6th period.

**Hydrogen**
53. Bonding of hydrogen atom in its compounds; classification of hydrides.
54. Preparation, industrial production and properties of hydrogen.

**Group 18**
55. Bonding modes of noble gas atoms in their compounds.
56. Preparation and properties of noble gases and their compounds.

**Group 17**
57. Bonding modes of halogens in their compounds.
58. Trends in properties of the group 17 elements and their compounds.
59. Preparation, production and properties of halogens.
60. Classification and characterization of halides.
61. Preparation, production and properties of hydrogen halides and their solutions.
62. Preparation and properties of oxoacids of halogens and their salts.

**Group 16**
63. Trends in properties of the group 16 elements and their compounds.
64. Bonding modes of oxygen and sulfur atoms in their compounds.
65. Preparation and properties of oxygen, ozone and sulfur.
66. Classification and characterization of oxides and hydroxides.
67. Physical, protolytic, coordination and hydration properties of water.
68. Preparation and properties of hydrogen sulfide and sulfides.
69. Preparation and properties of sulfur dioxide and sulfur trioxide.
70. Production and properties of sulfuric acid and sulfates.
71. Preparation and properties of oxoacids of selenium and tellurium.

**Group 15**
72. Bonding modes of nitrogen and phosphorus atoms in their compounds.
73. Trends in properties of group 15 elements and their compounds.
74. Preparation and properties of nitrogen and phosphorus.
75. Production, preparation and properties of ammonia and ammonium salts.
76. Preparation and properties of nitrogen(I), nitrogen (II) and nitrogen (IV) oxides.
77. Production, preparation and properties of nitric acid and nitrates.
78. Preparation and properties of phosphorus(III) and phosphorus (V) oxides.
79. Preparation and properties of trihydrogenphosphoric acid and phosphates; production of superphosphate fertilizer.
80. Preparation and properties of oxides and oxoacids of arsenic, antimony, and bismuth.

**Group 14**
81. Bonding modes of carbon and silicon atoms in compounds.
82. Trends in properties of group 14 elements and their compounds.
83. Structural modification of carbon.
84. Production and application of pure silicon.
85. Preparation and properties of carbon oxides and carbonates.
86. Structural modifications, physical and chemical properties of silicon dioxide.
87. Preparation and properties of oxides, hydroxides and sulfides of germanium, tin and lead.

**Group 13**
88. Trends in properties of group 13 elements and their compounds.
89. Mode of bonding of boron atoms in compounds, electron-deficient bonds.
90. Preparation, structure and properties of boron(III) oxide, trihydrogenboric acid and borates.
91. Physical, chemical properties and the use of aluminum.
92. Production of aluminum(III) oxide and aluminum.

**Coordination compounds**
93. Characteristics, classification, coordination polyhedra and isomerism of coordination compounds.
94. Coordination compounds – thermodynamic and kinetic stability of coordination compounds.

**Groups 1 and 2**
95. Bonding modes of s-block atoms in compounds.
96. Trends in properties of s-elements and their compounds.
97. Preparation and properties of oxides, peroxides, superoxides and hydroxides of s-elements.
98. Structure and properties of chlorides, carbonates and sulfates of s-elements.
99. Production and use of sodium hydroxide, sodium carbonate and calcium acetylide.
100. Preparation and properties of oxides and hydroxides of beryllium and magnesium.

**d-elements**
102. Bonding modes of d-block atoms in their compounds.
103. Trends in properties of group 3. elements and their compounds.
104. Preparation and properties of oxides, hydroxides, halides and oxoacid salts of scandium, yttrium and lanthanum.
105. Structural modifications, properties, production and use of titanium dioxide.
106. Preparation and properties of halides and halide-oxides of vanadium, niobium and tantalum.
107. Physical and chemical properties, production and use of chromium, molybdenum and tungsten.
108. Preparation and properties of oxides and hydroxides of chromium, molybdenum and tungsten.
109. Formation, structure and properties of salts of oxoacids of chromium, molybdenum, tungsten and their isopolyanions.
110. Preparation, structure and properties of manganese dioxide and permanganes.
111. Physical and chemical properties of iron, cobalt and nickel; production of iron.
112. Preparation and properties of iron(II), iron(III) cobalt(II), cobalt(III) and nickel(II) salts and complexes.
113. Physical and chemical properties of light and heavy platinum group elements, structure of their complexes.
114. Physical and chemical properties of copper, silver and gold.
115. Preparation and properties of halides, oxides, hydroxides and sulfides of copper, silver and gold.
116. Physical and chemical properties of zinc, cadmium and mercury.
117. Preparation and properties of halides, oxides, hydroxides and sulfides of zinc, cadmium and mercury.

**f-elements**
118. Bonding modes of atoms of lanthanides and actinides in compounds.
119. Physical and chemical properties of lanthanides, their oxides and salts.
120. Lanthanide contraction and its consequences.
MATHEMATICS

Matrices – Basic Concepts, Rank of Matrices, Determinants, Transpose and Inverse of a matrix.
Systems of Linear Equations – Gauss Elimination, Cramer’s Rule.
Sequences - Basic Concepts, Limit of Sequences, Euler’s number “e” and its meaning.
Functions - Basic Concepts, Limit of a Functions, Continuous Functions.
Derivatives of Functions - Basic Concepts, Geometric and Physical Meaning of Derivative.
Local Extremes - how to find them and their importance in optimization.
Taylor’s formula and its importance.
Primitive Functions, - Basic Concepts, Relationship to Derivative, Indefinite integrals.
Definite integrals - Basic Concepts, Methods of Calculation and Application of Definite integrals.
Partial Derivatives - Basic Concepts and Geometric Interpretation.
Gradient of a Scalar Field, Hamilton Del Operator.
Directional Derivatives.
Ordinary Differential Equations First-Order – Variables separable, Linear First-Order Differential Equations - Applications
Linear Differential Equations of Second Order with Constant Coefficients – Homogenous and Nonhomogenous Second Order Equations, Applications.
Double Integral - Geometric Interpretation, Method of Calculation.
Vector Fields, Curves, Velocity.
Line Integral and Work - Basic Concepts.
Path Independence, Conservative (Potential) Fields.
Relationship between Double and Line Integrals – Green’s theorem.
MACROMOLECULAR CHEMISTRY

Basic knowledge on character of macromolecular substances (polymers) and their structure and properties. Individual types of polymers focused also to natural polymers. Relations of polymers to environment, recyclation, biodegradable polymers and polymers in medical applications.

Structure of polymers
Polymers in solution
Polymers in solid state
Natural polymers – polysaccharides, proteins, nucleic acids, lipids, biodegradable polymers
Polymers and environment, polymers recyclation
Biomedical polymers
ORGANIC CHEMISTRY

Alkanes, conformational analysis, radical substitution reactions of alkanes, free radicals
Delocalized systems, dienes and diene synthesis
Organometallic compounds (Mg, Li, Na) and their utilization in synthesis
Carbonyl compounds, addition and addition-elimination reactions, oxidations and reductions
Esters, amides, peroxyacids, substituted carboxylic acids

Cycloalkanes and their stereochemistry
Benzene, aromaticity, electrophilic substitution reactions-alkylations, reactions of aromatic hydrocarbons
Alcohols, elimination reactions of alcohols, phenols and their derivatives, rearrangements
Reactions of enolates (C-anions), aldol addition and condensation, related reactions
Ketoacids, syntheses starting from acetoacetate, derivatives of carbonic acid

Alkenes, geometric isomerism, hydrogenation, electrophilic and radical addition reactions, polymerization, oxosynthesis
Stereochemistry, enantiomers, diastereoisomers
Ethers and their complexes, oxiranes and their use in synthesis
Unsaturated carboxylic acids, their preparations and reactions
Carboxylic acids and their reactions., amino acids

Alkynes, nucleophilic addition reactions, tautomerism
Halogen derivatives, nucleophilic substitution reactions, elimination reactions
Nitrogen derivatives, nitro compounds, amines, diazonium salts and their use in synthesis
Derivatives of carboxylic acids, salts, chlorides, anhydrides
Targeted synthesis of carboxylic acids and their derivatives, strategies for lengthening and shortening of carbon chain, malonic ester synthesis
PROCESS CONTROL

Laplace transform.
Transfer function and transfer functions of complex systems.
Step response.
Impulse response.
Poles and zeros.
Modelling of tanks.
Modelling of heat exchangers.
On-off controller.
PID controller.
Feed-back control loop.
Stability.
Reference tracking and disturbance rejection.
Control performance.
Analytical methods for controller synthesis.
Experimental methods for controller synthesis.
Measurement of process variables.
Technological schemes with measurement and control loops.
PROGRAMMING

Analysis and design of information system.
Static websites I – HTML.
Static websites II – XHTML.
Websites formatting I – CSS.
Websites formatting II – CSS.
Content Management Systems (CMS, LMS …)
Webhosting and services.
Internet services.
Cloud computing.
Ecommerce.
Safety on the Internet.

C language basics, flow control, type conversion, files, preprocessor, functions, pointers, arrays in C language, one dimensional arrays, multidimensional arrays, strings, structures in C language, structures, unions, types in C language.
PHYSICAL CHEMISTRY

Ideal gas and real gases (ideal gas equation, real gas equations, critical state, the principle of corresponding states, generalized graph)

The first law of thermodynamics (basic conception, reversible and irreversible processes, internal energy, enthalpy, pressure volume work of ideal gas, reversible and irreversible isothermal ideal gas expansion)

Thermal capacity and adiabatic process (thermal capacity, relationship between isochoric and isobaric thermal capacities, Joule-Thomson effect)

Thermochemistry (calculation of reaction enthalpies, Hess's law, Kirchhoff's law)

The second law of thermodynamics (Carnot cycle, entropy and its dependence on temperature and pressure, Clausius equation, statistical interpretation of entropy)

The third law of thermodynamics (Nernst heat theorem, Planck postulate)

Thermodynamic potentials (definition, Gibbs and Helmholtz energies, equilibrium and direction of spontaneous processes)

Combined first and second laws of thermodynamics (Gibbs-Helmholtz equation, Maxwell's equation, chemical potential of ideal gases, fugacity of real gases, fugacity coefficient calculations)

Phase equilibrium of one-component systems (phase diagrams of one-component systems, phase transitions, Clapeyron equation, Clausius-Clapeyron equation)

Simplex mixtures (partial molar quantities, Gibbs-Duhem equation, thermodynamics of ideal gas mixtures, thermodynamics of liquid mixtures, Raoult's Law, Henry's Law, activities)

Colligative properties (cryoscopy, ebullioscopy, osmotic pressure)

Phase equilibria in multicomponent systems (Gibbs phase law, isothermic and isobaric phase diagrams of l-q systems, miscible and non-miscible liquids, azotropes, lever rule, Nernst distribution law)

Chemical equilibrium (Gibbs free energy, reaction isotherm, standard state, equilibrium constant and its dependence on temperature and pressure, determination of equilibrium composition, Le Châtelier's principle)

Electrical conductivity of solutions (conductivity, molar conductivity of ions, ion-mobility, ion transport numbers and methods for their determination, electrolysis, Faraday's Laws of electrolysis)

Characteristics of ions in solutions of electrolytes (strong and weak electrolytes, standard states of electrolytes, ionic strength, dissociation constant, Debye-Hückel theory)

Chemical equilibrium in solutions of electrolytes (Ostwald's dilution Law, dissociation of weak and strong acids and bases, hydrolysis of salts, buffer solutions, definition of pH, heterogeneous equilibria, solubility constants)

Electrode potential (electrode potential, electric bilayer, Nernst's equation, standard electrode potential, first and second order electrodes, oxidation-reduction electrodes, reference electrodes)

Electromotive force of galvanic cells (Nernst's equation for galvanic cells, thermodynamics of galvanic cells, application of galvanic cells for the determination of physical-chemical quantities - pH, K_a, K_b, activity coefficients)

Concentration cells and electrode polarization (diffusion potential, concentration cells with/without transported ions, dissociation voltage and potential)

Rate of chemical reactions (definitions, order and molecularity of chemical reactions, experimental determination of the rate of chemical reactions)

Elementary chemical reactions (kinetic equations for the 0, 1st, 2nd and higher order reactions, determination of the order of chemical reactions)

Complex reactions (reversible reactions, parallel reactions, consecutive reactions)

Temperature dependence of rate constants (Arrhenius equation, Theory of absolute reactions rates)

Catalysis (homogeneous and heterogeneous catalysis in gas and liquid phases, autocatalysis, enzyme catalysis)

Dispersed systems and physical chemistry of phase boundaries (definition and properties of dispersed systems, colloid dispersion, distribution curve of polydispersed systems, total surface free energy, drenching)

Adsorption at the gas-solid interfaces (principles, adsorption isotherms, adsorption equilibrium)
PHYSICS

1. Kinematics of a point mass.


2. Dynamics of a point mass.

Inertial forces in noninertial reference frames (frame in linear motion, rotating frame, centrifugal inertial force, Coriolis force. Work, power, efficiency. Conservative and nonconservative forces. Kinetic and potential energy and their relation to work.

Potential energy for gravity and deformation forces. Law of conservation of mechanical energy of a point mass in a field of conservative forces.

3. Dynamics of a mass point system.

4. Dynamics of a rigid body.
Kinetic energy for rotational and combined motion of a rigid body. Rotational inertia about a rotational axis, parallel axis theorem (Steiner rule). Work and power for rotational motion of a rigid body. Relation between the angular velocity and angular momentum. Equation of motion of a rigid body with a fixed axis, as example equation of motion of a physical pendulum.

5. Oscillations.

6. Fluid mechanics.


7. Electrostatic field.
Electric charge, its properties, electric charge density. Coulomb's law. Electric field. Representation of the electric field. Superposition principle, electric field of a system of charges. Flux of the electric field. Gauss' law. Electrostatic field due to an infinite line of charge, charged spherical shell, homogeneously charged sphere, infinite sheet of charge. Work of the force of the electrostatic field, conservativeness of the electrostatic field. Potential energy of a point charge and the electric potential. Integral and differential relation between the electric field and the electric potential. Voltage.


8. Direct electric current.


11. Alternating electric currents.

Displacement current. Set of the Maxwell's equations.

13. Mechanical waves.


TECHNOLOGY OF MATERIALS

Raw materials for production of polymers, principles of production and processing of polymers. Production, properties, processing and application of basic types of plastics: polyolefines, fluoroplastics, polymers based on styrene, acrylates, polyvinylchloride, polyvinylacetate, polyvinylalcohol, polyesters (polyethyleneterephftatalate, polycarbonates), polyamides, polyurethanes, silicones, unsaturated polyesters resin, phenoplastics, aminoplastics, epoxide resins. Production, processing and application of synthetic elastomers, natural rubber, vulcanization.