MINISTRY OF HEALTH OF THE REPUBLIC OF BELARUS
EDUCATIONAL INSTITUTION
BELARUSIAN STATE MEDICAL UNIVERSITY

APPROVED
by First Vice-Rector, Professor
_____ I.N.Moroz
27.06.2023
Reg.# UD-1.705/2324 /edu.

PHYSICAL AND COLLOID CHEMISTRY

Curriculum of educational institution
in the educational discipline for the specialty:

1-79 01 08 «Pharmacy»

2023

Curriculum is based on the educational program «Physical and Colloid Chemistry», approved 01.07.2022, registration # УД-L.705/2223/уч.; on the educational plan in the specialty 1-79 01 08 «Pharmacy», approved 17.05.2023, registration #7-07-0912-01/2324/mf.

COMPILERS:

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RECOMMENDED FOR APPROVAL:

by the Department of General Chemistry of the Educational Institution «Belarusian State Medical University»
(protocol # 5 of 18.05.2023);

by the Scientific and Methodical Council of the Educational Institution «Belarusian State Medical University»
(protocol # 6 of 27.06.2023)

EXPLANATORY NOTE

«Physical and Colloid Chemistry» is the educational discipline of the Chemical Module containing systematized scientific knowledge on properties of different systems and regularities of physical and chemical processes in them, that studies interconnections between chemical processes and physical events accompanying them.

The aim of the discipline «Physical and Colloid Chemistry» is the formation of basic professional competencies that are necessary for understanding basic regularities of different processes; the development of physical and chemical thinking in future pharmacist that is necessary for studying general professional and special disciplines.

The objectives of the discipline «Physical and Colloid Chemistry» are to form students' scientific knowledge about fundamental laws and theories of physical and colloid chemistry, skills and abilities needed to conduct a chemical experiment and to solve practical problems in professional activity.

The knowledge, skills, and abilities acquired during the study of the academic discipline «Physical and Colloid Chemistry» are necessary for successful mastering of the following educational modules: «Pharmaceutical Technology», «Pharmaceutical Chemistry and Pharmacognosy».

Studying the educational discipline «Physical and Colloid Chemistry» should ensure the formation of students' basic professional competency:

BPC. Apply knowledge of the basic physical, chemical and biological laws for quality control of medicines and medicinal plant raw materials.

As a result of studying the discipline «Physical and Colloid Chemistry» the student should

know:

basic concepts and laws of physical and colloid chemistry;

the role and significance of physical and colloid chemistry methods in pharmacy;

basics of chemical thermodynamics, chemical and phase equilibria;

properties of nonelectrolytes and electrolytes;

electrochemical processes and methods used in medicine and pharmacy;

basics of chemical kinetics and catalysis;

applications of adsorption and other surface phenomena in pharmacy;

properties of colloid solutions;

dispersed systems used as medicines;

methods of obtaining and usage of biopolymers in pharmacy;

be able to:

work with main types of equipment used in physical and colloid chemistry;

process, analyze and generalize the data of physical and chemical observations and measurements;

master:

safety fundamentals and basic approaches and methods of physical and chemical experiments conduction;

skills of production of buffer and colloid solutions, solutions of biopolymers.

Total number of hours for the study of the discipline is 220 academic hours. Classroom hours according to the types of studies: lectures – 16 hours (including 5 hours of supervised student independent work), laboratory studies - 111 hours, student independent work (self-study) – 93 hours.

Intermediate assessment is carried out according to the syllabus of the specialty in the form of a credit (3rd semester) and exam (4th semester).

Form of higher education – full-time.

ALLOCATION OF ACADEMIC TIME ACCORDING TO SEMESTERS OF STUDY

Code, name of the specialty	semester	Number of academic hours						Form of intermediate assessment
		total	in-class	including			out-of-class self-studies	
				lectures (including supervised independent work)	supervised student independent work	laboratory studies (practical classes and seminars)		
7-07-0912-01 «Pharmacy»	3	110	63	6	2	57	47	credit
	4	110	64	10	3	54	46	exam

THEMATIC PLAN

Section (topic) name	Number of class hours	
	lectures	laboratory
1. Physical Chemistry	**10**	**78**
1.1. Main concepts and laws of thermodynamics. Thermodynamics of chemical equilibrium	2	18
1.2. Thermodynamics of phase transitions	2	15
1.3. Kinetics of chemical reactions and catalysis	-	12
1.4. Properties of dilute solutions of nonelectrolytes and electrolytes	2	12
1.5. Electrochemistry	2	9
1.6. Physical and chemical basics of surface phenomena	2	12
2. Colloid Chemistry	**6**	**33**
2.1. Dispersed systems. Classification of dispersed systems. Production, purification, properties, stability and coagulation of colloid solutions	2	15
2.2. Different types of colloid systems	2	6
2.3. Biopolymers and their solutions	2	12
Total hours	**16**	**111**

CONTENT OF THE EDUCATIONAL MATERIAL

1. Physical Chemistry

1.1. Main concepts and laws of chemical thermodynamics. Thermodynamics of chemical equilibrium

The history of physical chemistry development. The place of physical chemistry among other scientific disciplines and its impact into the development of pharmacy.

Aims and methods of thermodynamics. Main concepts and definitions: systems, states of systems, processes, functions of a state and functions of a process. Internal energy. Work. Heat.

The first law of thermodynamics. Wordings and mathematical expression of the first law of thermodynamics. Enthalpy. Isochoric and isobaric heat of a process, connection between them. Hess's law. Thermochemical equations. Standard enthalpies of formation and combustion of substances and their usage in thermochemical calculations. The heat of neutralization, the heat of the dissolving, the heat of hydration. Enthalpic diagrams. The dependence of heat effect on the temperature. Kirchhoff's equation.

The second law of thermodynamics. Reversible and irreversible processes from the point of view of thermodynamics. Wordings and mathematical expression of the second law of thermodynamics. Maximal heat of a process. Useful work. Entropy. Calculation of the change of entropy in isolated systems, in isothermal processes, due to the change in temperature. Statistical nature of the second law of thermodynamics. Connection of entropy with thermodynamic probability of the state of a system. Boltzmann's entropy formula.

The third law of thermodynamics. Absolute entropy. Standard entropies of solid, liquid and gaseous substances. The usage of standard entropies for the calculation of the standard entropy of a chemical reaction.

Thermodynamic potentials. Helmholtz energy, Gibbs energy, connection between them. The change of Helmholtz and Gibbs free energies in spontaneous processes. The concept of chemical potential.

Thermodynamic characteristics of the state of chemical equilibrium. Constant of chemical equilibrium and different ways to express it. Equation of the isotherm of a chemical reaction. Equations of the isobar and the isochore of a chemical reaction. Consequences of those two equations and their connection with Le Chatelier-Braun principle. Calculation of the constant of chemical equilibrium from the table of standard thermodynamic values. Plotting of van't Hoff isobar. Application of laws of thermodynamics to molecular docking in the process of the design of new biologically active compounds.

1.2. Thermodynamics of phase transitions

Main concepts: homogeneous and heterogeneous systems, the phase, substances and components of a system. The number of independent components of a system, the number of the degrees of freedom. Gibbs phase rule. Phase transitions and equilibria: evaporation, sublimation, melting, the change of allotropic modification. Equations of Clapeyron and Clausius-Clapeyron, their connection with the Le Chatelier-Braun principle.

Unicomponent systems. Phase diagram of water as a sample of phase diagrams for unicomponent systems. Phase diagram of sulfur, carbon, carbon dioxide.

Bicomponent (binary) systems. Concept on physical and chemical analysis, its application to study medicines. Thermal analysis. Cooling curves. Melting diagram for binary systems with unlimited solubility of components in liquid state and mutual insolubility in the solid state. Application of Gibbs phase rule for the analysis of phase diagrams.

Solubility of liquids in liquids. Ideal and real solutions. Saturated vapor pressure upon a solution. Raoult's law. Types of diagrams: "vapor pressure – content", "temperature of boiling – content". The first law of Konovalov. Deviations from Raoult's law. Azeotropes. The second law of Konovalov. Simple and fractional distillation. Concept on rectification. Liquids with limited solubility. Higher and lower critical temperatures of the dissolving. Immiscible liquids. Theoretical basics of the distillation with water vapor.

Tricomponent systems. Phase diagrams for tricomponent systems. The law of distribution by Nernst. The coefficient of distribution. Extraction. Principles of tinctures and decoctions production.

1.3. Kinetics of chemical reactions and catalysis

Subject of chemical kinetics and its importance for pharmacy. Main concepts: simple and multistep reactions, homogeneous and heterogeneous reactions. The rate of chemical reaction and methods to determine it. Dependence of the rate of a chemical reaction on different factors. The law of mass action. The order and the molecularity of a chemical reaction. Kinetic equations of zeroth, first, and second order processes. Half-elimination period. Methods to determine the order of a chemical reaction. Dependence of the rate of a chemical reaction on temperature. The rule of van't Hoff. Temperature coefficient of the rate of a chemical reaction. Express methods to check the best before time for medicines. Arrhenius equation. Basics of the theory of active collisions. Activation energy. Dependence between the rate of a chemical reaction and the activation energy. Steric factor. Methods to determine the activation energy. Basics of the theory of transition state (activated complex). Comparative analysis of the Arrhenius equation and the equation of the transition state complex theory. Concepts on methods to study and model transition state complex.

Multistep reactions: reversible, parallel, consequent, conjugated. Metabolization of a medicine in the organism as the set of consequent processes, constant of absorption and constant of elimination. Chain reactions. Stages of a chain reaction. Nonbranched and branched chain reactions. Photochemical reactions. The law of photochemical equivalence by Einstein.

Characteristic features of heterogeneous reactions. The rate of a heterogeneous reaction. Kinetic and diffuse areas of heterogeneous processes. Factors determining the rate of a heterogeneous reaction.

Catalysis. Positive and negative, homogeneous and heterogeneous catalysis. The mechanism of action for a catalyst during homogeneous catalysis. Activation energy of catalytic reactions. Acid-base catalysis in solutions. Metal-complex catalysis. Enzymatic catalysis and characteristic features of enzymes as catalysts. Inhibition of chemical reactions. Inhibitors. Kinetic way to determine the activity of an enzyme in a sample.

1.4. Properties of dilute solutions of nonelectrolytes and electrolytes

Colligative properties of solutions: relative decrease of saturated vapor pressure upon a solution, freezing temperature depression, boiling temperature elevation, and osmotic pressure of dilute solutions of nonelectrolytes. Cryoscopic and ebullioscopic constants, their connection with heat effect and temperatures of freezing and boiling of a solvent.

Colligative properties of solutions of electrolytes. Isotonic coefficient.

Cryometric, ebulliometric, and osmometric methods of molar mass and isotonic coefficient determination.

Solubility of gases in liquids. Thermodynamics of the dissolving. The law of Henry. Equation of Sechenov.

Theory of strong electrolytes solutions by Debye and Huckel. The concept of ionic atmospheres. Activity of ions and its connection with concentration. Coefficient of activity. Ionic strength of a solution. Limiting law of Debye-Huckel.

Ionization of water. Ionic product of water. Hydrogen index (pH).

Buffer systems and solutions. Content, mechanism of action and calculation of pH for acetic, phosphate, ammonia and bicarbonate buffer solutions. Buffer capacity and factors on which it depends on. Importance of buffer systems for chemistry, biology, and pharmacy.

1.5. Electrochemistry

The concept of electric conductivity. Conductors of the first and second order. Specific and molar electric conductivities of solutions of electrolytes, factors that influence their values. Limiting molar electroconductivity (at maximal dilution). The speed of movement and mobility of ions. The law of Kohlrausch (the law of independent movement of ions). Electric conductivity of nonaqueous solutions.

Conductometry, conductometric determination of the degree and the constant of ionization for a weak electrolyte, of the electroconductivity coefficient for a strong electrolyte, of the solubility of hardly soluble electrolytes. Conductometric titration.

Electrode potentials. Mechanism of the occurrence of a dielectric layer on the boarder between metal and solution. Nernst equation. Standard electrode potentials. Classification of electrodes. Standard hydrogen electrode. Silver chloride electrode as a representative of electrodes of the second order. Redox electrodes and mechanism of potential occurrence upon them. Nernst-Peters equation. Standard and formal redox potential of biological redox systems. Ion selective electrodes. Glass electrode. Construction of pH-meter.

Galvanic elements: chemical and concentrative. Calculation of electro motive force in galvanic elements.

Potentiometry, potentiometric method to measure pH. Potentiometric titration. Application of potentiometry in biology, medicine, and pharmacy.

1.6. Physical and chemical basics of surface phenomena

Surface phenomena and their significance for pharmacy. Surface Gibbs free energy and surface tension. Methods of surface tension determination. Dependence of surface tension on different factors. Surface activity. Surface active substances (SAS), surface inactive substances (SIS), surface nonactive substances (SNS). Ducklo-Traube rule. Isotherm of surface tension. Shishkovsky equation.

Concept of wetting. Wetting angle. Yung equation. Enthalpy of wetting and coefficient of hydrophilicity.

Adsorption on mobile surface of contact between phases (liquid and gas, liquid and liquid). Gibbs isotherm of adsorption equation. Orientation of SAS molecules in the superficial layer. Determination of the area occupied by a molecule of SAS in the saturated adsorption layer, as well as the maximal length of SAS.

Adsorption on solid sorbents. Estimation of adsorption on the boarder between solid and gas, and between solid and liquid. Factors influencing adsorption of gases and solutes. Main statements of monomolecular adsorption theory and equation of Langmuir adsorption isotherm. Equation of Freundlich adsorption isotherm. Determination of constants in equations of Langmuir and Freundlich from experimental data. Polymolecular adsorption. Basics of enzyme-linked immunosorbent assay. Capillary condensation, absorption, chemisorption.

Adsorption of electrolytes from their solutions. Equivalent and selective adsorption of ions. Fajans-Paneth rule. Ion-exchange adsorption. Ionites and teir classification. Exchange capacity. Application of ionites in pharmacy.

Conception of physical and chemical basics of different groups of chromatography methods of analysis: high pressure liquid chromatography, gas chromatography, ion-exchange chromatography, size-exclusion chromatography, affine chromatography. Concept of mass-spectrometry.

2. Colloid chemistry

2.1. Dispersed systems. Classification of dispersed systems. Production, purification, properties, stability and coagulation of colloid solutions

History of colloid chemistry development. Importance of colloid chemistry for pharmacy.

Structure of dispersed systems. Dispersed phase, dispersed medium. Dispersion degree.

Classification of dispersed systems by the aggregation state of dispersed phase and dispersed medium, by the type of interactions between dispersed phase and dispersed medium, by the mobility of dispersed phase.

Methods of production and purification of colloid solutions (filtration, dialysis, electrodialysis, ultrafiltration).

The nature of electric events in dispersed systems. Mechanism of occurrence of electric charge upon colloid particles. Structure of dielectric layer. Micelle, the structure of the micelle of a sol. The charge, electrothermodynamical and electrokinetical potentials of a colloid particle. The influence of electrolytes on electrokinetical potential. Phenomenon of colloid particles recharging.

Electrokinetical events. Electrophoresis. Electroosmosis. Connection between the speed of colloid particles electrophoresis and electroosmosis with electrokinetical potential of colloid particles (Helmholtz-Smoluchovsky equation). Electrophoretic mobility. Practical application of electrophoresis and electroosmosis in pharmacy. Potential of sedimentation and potential of streaming.

Brownian motion, diffusion, osmotic pressure. Sedimentation. Sedimentation stability and sedimentation equilibrium. Centrifugation as the method to study colloid systems. Sedimentation analysis.

Light scattering and light absorption. Rayleigh equation. Nephelometry. Ultramicroscopy and electron microscopy of colloid systems. Determination of a shape, size, and mass of colloid particles.

Kinetic and aggregative stability of colloid systems. Factors of stability. Coagulation and factors that can cause it. Slow and fast coagulation. Coagulation threshold and its determination. The rule of Schulze and Hardy. Alternation of coagulation areas. Coagulation of sols by mixtures of electrolytes. Additivity, antagonism and synergy of ions during the coagulation by mixtures of electrolytes. Colloid protection.

Theories of coagulation. Adsorption theory of Freundlich. Theory of Deryagin-Landau-Ferway-Overbeck.

2.2. Different types of colloid systems

Aerosols: methods of obtaining, molecular kinetic, optical and electrokinetic properties. Aggregative stability of aerosols and factors that determine it. Destruction of aerosols. Application of aerosols in pharmacy. Photophoresis and thermophoresis.

Powders and their properties. Caking, granulation and sprayability of powders. Application of powders in pharmacy.

Suspensions: methods of production, molecular kinetic, optical and electrokinetic properties. Stability of suspensions and factors that determine it. Flocculation. Sedimentation analysis of suspensions. Foams. Pastes.

Emulsions. Types of emulsions. Emulsifiers and mechanisms of their action. Conversion of emulsion phases. Stability of emulsions and its disturbance. Factors determining stability of emulsions. Coalescence. Properties of concentrated and highly concentrated emulsions. Application of suspensions and emulsions in pharmacy.

Micellar colloid systems formed by surface active substances: solutions of soap, detergents, dyes. Formation of micelles in solutions of SAS. Critical micelle concentration and its determination. Solubilization and its importance for pharmacy. Micellar colloid systems in pharmacy.

2.3. Biopolymers and their solutions

Methods of production of biopolymers. Classification of biopolymers. Flexibility of chains of biopolymers. Internal rotation of subunits in chains of biopolymers. Crystal and amorphous states of biopolymers. Thermodynamics of folding of proteins and nucleic acids.

Swelling and dissolving of biopolymers. The mechanism of swelling. Thermodynamics of swelling and dissolving of biopolymers. Influence of different factors on the swelling degree. Lyotropic series of ions.

Viscosity of biopolymers solutions. Deviations of properties of biopolymers solutions from laws of Newton and Poiseuille. Causes of abnormal viscosity of solutions of biopolymers. Relative, specific, reduced, characteristic viscosity. Staudinger equation and its modification. Estimation of average molecular mass of a biopolymer with the help of viscosimetry method.

Polymeric nonelectrolytes and polyelectrolytes. Polyampholytes. Isoelectric point of polyampholytes and methods to determine it.

Osmotic properties of biopolymers solutions. Osmotic pressure of polymeric nonelectrolytes solutions. Deviations from van't Hoff's law. Equation of Galler. Estimation of molar mass of polymeric nonelectrolytes. Polyelectrolytes. Osmotic pressure of polyelectrolytes. Membrane equilibrium of Donnan.

Factors of stability for solutions of biopolymers. Salting out, salting out thresholds. Dependence of salting out thresholds of polyampholytes on pH of a medium. Coacervation. Microcoacervation. Microcapsulation. Gelatination. Influence of different factors on the speed of gelatination. Tixotropy of jellies and gels. Syneresis of jellies. Diffusion and periodic reactions in jellies and gels. Concept of electrophoresis of proteins in polyacrylamide gel.

EDUCATIONAL DISCIPLINE CURRICULAR CHART

Section, topic #	Section (topic) name	number of hours				Form of control
		Lectures (including supervised student independent work)	supervised student independent work	laboratory	Self-studies	
	3 semester					
1.	**Physical Chemistry**	**10**	**4**	**78**	**57**	
1.1	**Main concepts and laws of thermodynamics. Thermodynamics of chemical equilibrium**	**2**	**1**	**18**	**10**	
	Laws of thermodynamics	2	1	–	–	Electronic tests
	Main concepts and laws of thermodynamics: the first law of thermodynamics. L.w.: «Determination of the constant of thermostat-calorimeter»	–	–	3	1	Tests, electronic tests, written accounts of laboratory work, control work
	Main concepts and laws of thermodynamics: Hess's law L.w.: «Determination of the heat effect of neutralization of a strong acid by a strong base»	–	–	3	1	Tests, electronic tests, written accounts of laboratory work, control work
	Main concepts and laws of thermodynamics: Kirchhoff's law L.w.: «Calculation of the heat effect of dissociation of a weak electrolyte»	–	–	3	1	Tests, electronic tests, written accounts of laboratory work, control work
	Main concepts and laws of thermodynamics: second law of thermodynamics L.w.: «Estimation of the heat effect of the dissolving of anhydrous copper sulfate»	–	–	3	1	Tests, electronic tests, written accounts of laboratory work, control work, visual control works

	Main concepts and laws of thermodynamics: third law of thermodynamics, absolute entropy L.w.: «Calculation of the heat effect of hydration»	–	–	3	2	Tests, electronic tests, written accounts of laboratory work, control work
	Thermodynamics of chemical equilibrium L.w.: «Calculation of enthalpy and entropy from van't Hoff's plot»	–	–	3	4	Interview, tests, electronic tests, written accounts of laboratory work, control work
1.2	**Thermodynamics of phase transitions**	**2**	**0.5**	**15**	**10**	
	Concept of phase equilibrium	2	0.5	–	–	Electronic tests
	Thermodynamics of phase transitions: unicomponent systems. L.w.: «Estimation of the melting temperatures for diphenylamine and naphthalene»	–	–	3	2	Tests, electronic tests, written accounts of laboratory work, control work
	Thermodynamics of phase transitions: melting diagrams for bicomponent systems. L.w.: «Building the melting diagram for diphenylamine-naphthalene binary system – part 1»	–	–	3	1	Electronic tests, written accounts of laboratory work, control work
	Thermodynamics of phase transitions: melting diagrams for bicomponent systems. L.w.: «Building the melting diagram for diphenylamine-naphthalene binary system – part 2»	–	–	3	2	Interview, electronic tests, control work, written accounts of laboratory work
	Thermodynamics of phase transitions: tricomponent systems. L.w.: «Estimation of the coefficient of distribution of acetic acid between organic solvent and water»	–	–	3	5	Tests, electronic tests, written accounts of laboratory work, visual laboratory work
	Basics of thermodynamics of phase transitions	–	–	3	–	Colloquium
1.3	**Kinetics of chemical reactions and catalysis**	**–**	**–**	**12**	**20**	
	Kinetics of chemical reactions and catalysis: reaction order and half-elimination period L.w. «Determination of the order of a reaction»	–	–	3	5	Interview, electronic tests, written accounts of laboratory work, control work
	Kinetics of chemical reactions and catalysis: active collisions theory L.w. «Study of the kinetics of the reaction of ethyl	–	–	3	5	Tests, electronic tests, written accounts of laboratory work, control work

	acetate saponification by an alkali»					
	Kinetics of chemical reactions and catalysis: transition state complex theory L.w. «Determination of a rate constant, activation energy, enthalpy and entropy of transition state complex formation»	–	–	3	5	Tests, electronic tests, written accounts of laboratory work, control work
	Kinetics of chemical reactions and catalysis: basics of catalysis L.w. «Study of the influence of a catalyst on the rate of a chemical reaction»	–	–	3	5	Tests, electronic tests, written accounts of laboratory work, control work, visual laboratory work
1.4	**Properties of dilute solutions of nonelectrolytes and electrolytes**	**2**	**0.5**	**12**	**7**	
	Thermodynamics of solutions	2	0.5	–	–	Electronic tests
	Properties of dilute solutions of nonelectrolytes and electrolytes: solubility, Raoult's laws. L.w.: «Influenee of temperature on solubility of a salt»	–	–	3	1	Tests, electronic tests, written accounts of laboratory work, control work, control work
	Properties of dilute solutions of nonelectrolytes and electrolytes: osmotic pressure. L.w.: «Cryoscopic estimation of molecular mass of sucrose»	–	–	3	3	Interview, electronic tests, control work, written accounts of laboratory work
	Properties of dilute solutions of nonelectrolytes and electrolytes: buffer systems. L.w.: «Production of buffer solutions with needed pH value and investigation of their properties»	–	–	3	3	Tests, electronic tests, written accounts of laboratory work, control work, control work
	Basics of thermodynamics and kinetics of aquatic solutions	–	–	3	–	Colloquium, credit

	4th semester					
1.5	**Electrochemistry**	**2**	**1**	**9**	**5**	
	Electrochemistry	2	1	–	–	Electronic tests
	Electrochemistry: conductometry. L.w.: «Conductometric determination of the degree and constant of dissociation for a weak electrolyte»	–	–	3	1	Electronic tests, written accounts of laboratory work, control work
	Electrochemistry: Conductometric titration. L.w.: «Conductometric determination of zine ions concentration in a solution»	–	–	3	1	Tests, electronic tests, written accounts of laboratory work, control work
	Electrochemistry: potentiometry. L.w.: «Potentiometric determination of the coefficient of activity for an electrolyte»	–	–	3	3	Interview, electronic tests, written accounts of laboratory work, visual laboratory works
1.6	**Physical and chemical basics of surface phenomena**	**2**	**0.5**	**12**	**5**	
	Physical and chemical basics of surface phenomena	2	0.5	–	–	Electronic tests
	Physical and chemical basics of surface phenomena: adsorption on a mobile phase. L.w.: «Stalagmometric determination of the dependence between the length of hydrophobic tail of SAS and surface tension of a solution»	–	–	3	1	Interview, electronic tests, control work, written accounts of laboratory work
	Physical and chemical basics of surface phenomena: adsorption on a stationary phase. L.w.: «Study of the adsorption of a substance from a solution on a solid sorbent»	–	–	3	1	Tests, electronic tests, written accounts of laboratory work, control work, control work, visual laboratory work
	Physical and chemieal basics of surface phenomena: chromatography. L.w. «Analysis of HPLC-MS data»	–	–	3	3	Tests, electronic tests, written accounts of laboratory work, visual laboratory works
	Basics of electrochemical and surface phenomena	–	–	3	–	Colloquium

2	**Coiloid chemistry**	**6**	**1.5**	**33**	**36**	
2.1	**Dispersed systems. Classification of dispersed systems. Production, purification, properties, stability and coagulation of colloid solutions.**	**2**	**0.5**	**15**	**20**	
	Colloid chemistry	2	0.5	–	–	Electronic tests
	Dispersed systems: Classification of dispersed systems, structure of colloid particles L.w.: «Production of colloid solutions by the method of condensation»	–	–	3	5	Tests, electronic tests, written accounts of laboratory work, control work
	Dispersed systems: molecular kinetic properties of colloid solutions L.w.: «Production of colloid solutions by the method of peptization»	–	–	3	5	Tests, electronic tests, written accounts of laboratory work, visual laboratory works
	Dispersed systems: optical properties of colloid solutions L.w.: «Recording and analysis absorption spectra of colloid solutions»	–	–	3	3	Tests, electronic tests, written accounts of laboratory work, control work
	Dispersed systems: electrokinetic events in colloid solutions L.w.: «Estimation of coagulation threshold for a sol by colorimetric method»	–	–	3	5	Interview, electronic tests, control work, written accounts of laboratory work
	Dispersed systems: stability and coagulation of colloid solutions L.w.: «Protective action of gelatin on colloid solutions»	–	–	3	2	Tests, electronic tests, written accounts of laboratory work, control work
2.2	**Different types of colloid systems**	**2**	**0.5**	**6**	**6**	
	Different types of dispersed systems	2	0.5	–	–	Electronic tests
	Different types of dispersed systems: aerosols, powders, suspensions, emulsions L.w.: «Production of emulsions and study of their properties»	–	–	3	3	Interview, electronic tests, control work, written accounts of laboratory work, visual laboratory works

	Different types of dispersed systems: colloid solutions of surface active substances L.w.: «Conductometric estimation of critical micelle concentration»	–	–	3	3	Tests, electronic tests, control work, written accounts of laboratory work
2.3	**Biopolymers and their solutions**	**2**	**0.5**	**12**	**10**	
	Biopolymers and their solutions	2	0.5	–	–	Electronic tests
	Biopolymers and their solutions: structure and classification, isoelectric point of biopolymers L.w.: «Estimation of isoelectric point of a protein»	–	–	3	2	Tests, electronic tests, written accounts of laboratory work, control work
	Biopolymers and their solutions: Thermodynamics of solutions of biopolymers L.w.: «Determination of the dependence between the swelling degree of gelatin and acidity of a medium; salting gelatin out of a solution»	–	–	3	2	Interview, electronic tests, control work, written accounts of laboratory work, visual laboratory works
	Biopolymers and their solutions: osmotic pressure and viscosity of solutions of biopolymers L.w.: «Estimation of molecular mass of polyglucin by the method of viscosimetry»	–	–	3	6	Interview, electronic tests, control work, written accounts of laboratory work
	Basics of physical chemistry of dispersed systems and solutions of biopolymers	–	–	3	–	Colloquium, exam
	Total hours	**16**	**5**	**111**	**93**	

INFORMATION AND INSTRUCTIONAL UNIT

LITERATURE

Basic (relevant):

1. Medical chemistry: textbook / V. O. Kalibabchuk, V. I. Halynska, L. I. Hryshchenko et al.; edited by V. O. Kalibabchuk. – Kyiv : «Medicina», 2020. – 224 p.

Additional:

2. Chemical thermodynamics and kinetics for pharmacists / V. V. Khrustalev, V. V. Kantsiava, S. R. Kazulevich – Minsk : BSMU, 2018 – 115 p.
3. Physical and colloid chemistry of real and colloid solutions / V. V. Khrustalev, V. V. Kantsiava, S. R. Kazulevich – Minsk : BSMU, 2018.– 138 p.
4. Colloquium in medical chemistry / V. V. Khrustalev et al. – Minsk : BSMU, 2023. – 50 p.
5. Essential chemistry for foreign students / S. V. Tkachev, T. V. Latushko, S. R. Kazulevich, E. V. Barkovsky – Minsk : BSMU, 2019. – 168 p.

METHODOLOGICAL RECOMMENDATIONS FOR THE ORGANIZATION AND PERFORMANCE OF STUDENT INDEPENDENT WORK (SELF-STUDY ON THE ACADEMIC DISCIPLINE

Time for independent work (self-study) can be used by students for:
preparation for lectures and laboratory studies;
preparation for the colloquium, credit, exam;
solving problems;
note-taking of educational literature.

METHODOLOGICAL RECOMMENDATIONS FOR THE ORGANIZATION AND PERFORMANCE OF SUPERVISED SELF-STUDY ON THE ACADEMIC DISCIPLINE

Main forms of supervised self-study:
studying topics and problems that have not been discussed at the lectures;
computer testing;

Control of supervised self-study is carried out in the forms of:
control work;
colloquium;
tests.

LIST OF AVAILABLE DIAGNOSTIC TOOLS

The following forms are used for competences assessment:
Oral form:
interview.
Written form:
control work;
written accounts of laboratory work;

colloquium.

Oral-written form:

credit;

exam.

Technical form:

electronic tests;

visual laboratory work.

LIST OF AVAILABLE TEACHING METHODS

Traditional method (lecture, laboratory practicals);

Active (interactive) methods:

Problem-Based Learning (PBL);

Team-Based Learning (TBL);

Research-Based Learning (RBL).

LIST OF PRACTICAL SKILLS

1. Estimation of the heat effect of the dissolving of a salt, the heat of neutralization.
2. Estimation of the constant of equilibrium for a homogeneous reaction.
3. Building of the phase diagram for a bicomponent system.
4. Production of buffer solutions with certain pH value.
5. Estimation of buffer capacity for obtained buffer solution per acid and per base.
6. Conductometric titration of strong and weak acids and their mixture.
7. Measurement of pH of a solution by the potentiometric method.
8. Potentiometric titration of strong and weak acids.
9. Calculation of redox potential for an electrode.
10. Determination of the rate constant for a chemical reaction.
11. Production and estimation of coagulation thresholds for sols.
12. Production of emulsions and determination of their types.

LIST OF EQUIPMENT USED

1. Laboratory glassware.
2. Chemical reactants.
3. Personal computer.
4. Calorimeter.
5. Potentiometer.
6. pH-meter.
7. Conductometer.
8. "Thermal analysis" module
9. Separating funnels.
10. Thermometer.
11. Centrifuge.
12. Columns for affine chromatography.
13. Spectrophotometer.

14. Photometer.
15. Spectrofluorometer.
16. Microscope.
17. Chamber for vertical electrophoresis.

LIST OF LECTURES

Semester 3

1. Laws of thermodynamics
2. Concept of phase equilibrium
3. Thermodynamics of solutions

Semester 4

1. Electrochemistry
2. Physical and chemical basics of surface phenomena
3. Colloid chemistry
4. Different types of dispersed systems
5. Biopolymers and their solutions

LIST OF LABORATORY STUDIES

Semester 3

1. Main concepts and laws of thermodynamics: the first law of thermodynamics.

L.w.: «Determination of the constant of thermostat-calorimeter»

2. Main concepts and laws of thermodynamics: Hess's law.

L.w.: «Determination of the heat effect of neutralization of a strong acid by a strong base»

3. Main concepts and laws of thermodynamics: Kirchhoff's law.

L.w.: «Calculation of the heat effect of dissociation of a weak electrolyte»

4. Main concepts and laws of thermodynamics: second law of thermodynamics.

L.w.: «Estimation of the heat effect of the dissolving of anhydrous copper sulfate»

5. Main concepts and laws of thermodynamics: third law of thermodynamics, absolute entropy.

L.w.: «Calculation of the heat effect of hydration»

6. Thermodynamics of chemical equilibrium.

L.w.: «Calculation of enthalpy and entropy from van't Hoff's plot»

7. Thermodynamics of phase transitions: unicomponent systems.

L.w.: «Estimation of the melting temperatures for diphenylamine and naphthalene»

8. Thermodynamics of phase transitions: melting diagrams for bicomponent systems.

L.w.: «Building the melting diagram for diphenylamine-naphthalene binary system – part 1»

9. Thermodynamics of phase transitions: melting diagrams for bicomponent systems.

L.w.: «Building the melting diagram for diphenylamine-naphthalene binary system – part 2»

10. Thermodynamics of phase transitions: tricomponent systems.

L.w.: «Estimation of the coefficient of distribution of acetic acid between organic solvent and water»

11. Basics of thermodynamics of phase transitions.

12. Kinetics of chemical reactions and catalysis: reaction order and half-elimination period.

L.w. «Determination of the order of a reaction»

13. Kinetics of chemical reactions and catalysis: active collisions theory.

L.w. «Study of the kinetics of the reaction of ethyl acetate saponification by an alkali»

14. Kinetics of chemical reactions and catalysis: transition state complex theory.

L.w. «Determination of a rate constant, activation energy, enthalpy and entropy of transition state complex formation»

15. Kinetics of chemical reactions and catalysis: basics of catalysis.

L.w. «Study of the influence of a catalyst on the rate of a chemical reaction»

16. Properties of dilute solutions of nonelectrolytes and electrolytes: solubility, Raoult's laws.

L.w.: «Influence of temperature on solubility of a salt»

17. Properties of dilute solutions of nonelectrolytes and electrolytes: osmotic pressure.

L.w.: «Cryoscopic estimation of molecular mass of sucrose»

18. Properties of dilute solutions of nonelectrolytes and electrolytes: buffer systems.

L.w.: «Production of buffer solutions with needed pH value and investigation of their properties»

19. Basics of thermodynamics and kinetics of aquatic solutions.

Semester 2

1. Electrochemistry: conductometry.

L.w.: «Conductometric determination of the degree and constant of dissociation for a weak electrolyte»

2. Electrochemistry: Conductometric titration.

L.w.: «Conductometric determination of zinc ions concentration in a solution»

3. Electrochemistry: potentiometry.

L.w.: «Potentiometric determination of the coefficient of activity for an electrolyte»

4. Physical and chemical basics of surface phenomena: adsorption on a mobile phase.

L.w.: «Stalagmometric determination of the dependence between the length of hydrophobic tail of SAS and surface tension of a solution»

5. Physical and chemical basics of surface phenomena: adsorption on a stationary phase.

L.w.: «Study of the adsorption of a substance from a solution on a solid sorbent»

6. Physical and chemical basics of surface phenomena: chromatography.

L.w. «Analysis of HPLC-MS data»

7. Basics of electrochemical and surface phenomena

8. Dispersed systems: Classification of dispersed systems, structure of colloid particles.

L.w.: «Production of colloid solutions by the method of condensation»

9. Dispersed systems: molecular kinetic properties of colloid solutions.

L.w.: «Production of colloid solutions by the method of peptization»

10. Dispersed systems: optical properties of colloid solutions.

L.w.: «Recording and analysis absorption spectra of colloid solutions»

11. Dispersed systems: electrokinetic events in colloid solutions.

L.w.: «Estimation of coagulation threshold for a sol by colorimetric method»

12. Dispersed systems: stability and coagulation of colloid solutions.

L.w.: «Protective action of gelatin on colloid solutions»

13. Different types of dispersed systems: aerosols, powders, suspensions, emulsions.

L.w.: «Production of emulsions and study of their properties»

14. Different types of dispersed systems: colloid solutions of surface active substances.

L.w.: «Conductometric estimation of critical micelle concentration»

15. Biopolymers and their solutions: structure and classification, isoelectric point of biopolymers.

L.w.: «Estimation of isoelectric point of a protein»

16. Biopolymers and their solutions: Thermodynamics of solutions of biopolymers.

L.w.: «Determination of the dependence between the swelling degree of gelatin and acidity of a medium; salting gelatin out of a solution»

17. Biopolymers and their solutions: osmotic pressure and viscosity of solutions of biopolymers.

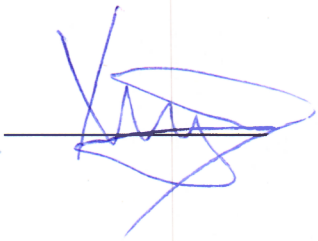
L.w.: «Estimation of molecular mass of polyglucin by the method of viscosimetry»

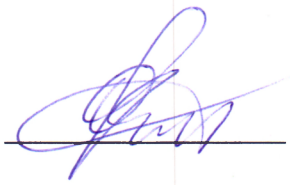
18. Basics of physical chemistry of dispersed systems and solutions of biopolymers

PROTOCOL OF THE CURRICULUM APPROVAL BY OTHER DEPARTMENTS

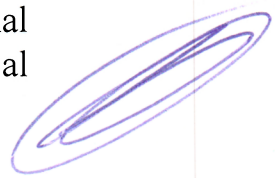
Title of the discipline requiring approval	Department	Amendments to the curriculum in the academic discipline	Decision of the department, which designed the curriculum (date, protocol #)
1. Industrial Technology of Drugs	Pharmaceutical Chemistry	-	protocol # 5 of 18.05.2023

COMPILERS/AUTHORS:

Head of the Department of General Chemistry of the Educational Institution «Belarusian State Medical University», D.Sc., Associate Professor  V.V.Khrustalev

Associate Professor of the Department of General Chemistry of the Educational Institution «Belarusian State Medical University», PhD  O.V.Kantsiava

Curriculum content, composition and accompanying documents comply with established requirements.

Dean of the Medical Faculty of International Students of the Educational Institution «Belarusian State Medical University»  O.S.Ishutin

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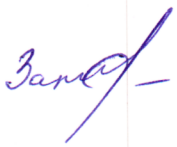
Methodologist of Educational Institution «Belarusian State Medical University»  S.V.Zaturanova

26.06. 2023