Federal State Budgetary Educational Institution of Higher Education
"Privolzhsky Research Medical University"
Ministry of Health of the Russian Federation

APPROVED
Vice-Rector for Academic Affairs
E.S. Bogomolova
31 August 2021

WORKING PROGRAM

Name of the academic discipline: ***PHYSICAL AND COLLOIDAL CHEMISTRY***

Specialty: ***33.05.01*** **PHARMACY**

Qualification: ***PHARMACIST***

Department: ***GENERAL CHEMISTRY***

Mode of study: **FULL-TIME**

Labor intensity of the academic discipline: **216 academic hours**

Nizhny Novgorod
2021

The working program has been developed in accordance with the Federal State Educational Standard for the specialty 33.05.01 PHARMACY approved Order of the Ministry of Science and Higher Education of the Russian Federation No. 219 of March 27, 2018.

Developers of the working program:
1. Kondrashina O.V., Ph.D., Associate Professor
2. Gordetsov A.S., Doctor of Chemistry, Professor, Head of the Department of General Chemistry.

The program was reviewed and approved at the department meeting (protocol No.1, 26.08.2021)

Head of the Department of General Chemistry,
Doctor of Chemistry, Professor Gordetsov A.S. /Gordetsov A.S./

August 26,2021

AGREED
Deputy Head of EMA ph.d. of biology _____ Lovtsova L.V.
(signature)

August 26,2021

1. The purpose and objectives of mastering the academic discipline *PHYSICAL AND COLLOIDAL CHEMISTRY* :

1.1. The purpose of mastering the discipline in the formation the following competencies:

UK-1: The ability to carry out a critical analysis of problem situations based on a systematic approach, to develop an action strategy

GPC-1: the ability to use basic biological, physico-chemical, chemical, mathematical methods for the development, research and examination of medicines, the manufacture of medicines.

1.2. Tasks of the discipline

1.2.1. Readiness to use basic physico-chemical, mathematical and other natural science concepts and methods of solving professional problems;

1.2.2. Readiness to solve standard tasks of professional activity using information, bibliographic resources;

1.2.3. Biomedical and pharmaceutical technology, information and communication technologies and taking into account the basic requirements of information security.

1.3. Requirements to the deliverables of mastering the discipline

As a result of completing the discipline, the student should

Know:

The purpose and objectives of physical and colloidal chemistry, methods of their solution; basic laws of physics and chemistry, physico-chemical phenomena and patterns used in physical and colloidal chemistry; metrological requirements when working with physico-chemical equipment;

safety rules for working in a chemical laboratory and with physical equipment;

solutions and processes occurring in

the basic principles of thermodynamics, thermochemistry, including the role and significance of thermodynamic potentials, consequences of Hess' law;

kinetics of chemical reactions; catalysis; chemical equilibrium, methods of calculating equilibrium constants; phase equilibria.

Fundamentals of physico-chemical analysis; methods for calculating the shelf life, the half-conversion period of medicinal substances;

; physico-chemical foundations of surface phenomena and dispersed phenomena; the influence of various factors on the destruction of medicinal substances; the possibility of using surface phenomena for the preparation of dosage forms;

fundamentals of phase and physical states of polymers, the possibility of their changes for use in medicine, pharmacy; basic properties of high-molecular substances; factors affecting solidification, swelling, thixotropy, syneresis, coacervation, viscosity, periodic reactions in the mechanism of preparation of dosage forms.

Be able to:

independently work with educational and reference literature on physical and colloidal chemistry;

to use the basic techniques and methods of physico-chemical measurements; to work with the main types of devices used in physical and colloidal chemistry; to calculate the thermodynamic functions of the state of the system, thermal effects of chemical processes; to calculate equilibrium constants, equilibrium concentrations of reagents, equilibrium yield of reaction products, the degree of transformation of starting substances; to shift equilibria in solutions;

to assemble the simplest installations for laboratory research;

tabulate experimental data, graphically represent them, interpolate, extrapolate to find the desired values; measure physico-chemical parameters of solutions;

to carry out elementary statistical processing of experimental data in physico-chemical experiments; to process, analyze and summarize the results of physico-chemical observations and measurements; to apply the knowledge gained in the study of analytical, pharmaceutical chemistry, pharmacognosy, pharmacology, toxicology, drug technology.

Possess:

methods of statistical processing of experimental results of physico-chemical studies;

the methodology for estimating the errors of physico-chemical measurements;

methods of colorimetry, polarimetry, potentiometry, spectrophotometry, refractometry, cryometry, chromatography;

skills of interpretation of calculated values of thermodynamic functions in order to predict the possibility and direction of chemical processes; technique of conducting basic physico-chemical experiments; technique of experimental determination of pH of solutions using indicators and instruments;

physico-chemical methods of analysis of substances forming true solutions and dispersed systems; preparation skills, quality assessment, ways to increase the stability of dispersed systems; skills of conducting scientific research to establish the relationship of physico-chemical properties and pharmacological activity.

2. Position of the academic discipline in the structure of the General Educational Program of Higher Education (GEP HE) of the organization.

2.1. The discipline *PHYSICAL AND COLLOIDAL CHEMISTRY* :
refers to the core part *(*or *the part formed by the participants of educational relations)* of Block 1 of GEP HE (Academic discipline index).

The discipline is taught in 2-3 semester 1-2 year of study.

2.2. The following knowledge, skills and abilities formed by previous academic disciplines are required for mastering the discipline:

1. General and inorganic chemistry
2. Physics
3. Mathematics

2.3. Mastering the discipline is required for forming the following knowledge, skills and abilities for subsequent academic disciplines:

1. Biochemistry
2. Toxicological chemistry
3. Pharmaceutical chemistry
4. Pharmacognosy

3. Deliverables of mastering the academic discipline and metrics of competence acquisition

The process of studying the discipline is aimed at the formation of the following universal (UC), general professional (GPC):

№ п/п	Competence code	The content of the competence (or its part)	Code and name of the competence acquisition metric		
			know	be able to	possess
1.	UC-1	the ability to carry out a critical analysis of problem situations based on a systematic approach, to develop an action strategy	How to put into practice the methods of humanitarian, natural sciences, biomedical and clinical sciences in various types of professional and social activities	Analyze socially significant problems and processes	The methods of humanitarian natural sciences, biomedical and clinical sciences
2.	GPC-1	the ability to use basic biological, physico-chemical, chemical, mathematical methods for the development, research and examination of medicines, the manufacture of medicines	How to apply the basic methods, methods and means of obtaining storage, processing of scientific and professional information; receive information from various sources, including using modern computer tools, network technologies, databases and knowledge	Work with scientific literature analyze information, conduct searches, turn what is read into tool for solving professional problems Use the rules for constructing chemical formulas, graphs, tables using appropriate computer programs, including for creating computer presentations.	Ability and willingness to participate in the formulation of scientific problems and their experimental implementation Computer programs for constructing chemical and stereochemical formulas of organic compounds and other types of illustrative material.

3. Sections of the academic discipline and competencies that are formed when mastering them

№ п/п	Competence code	Section name of the discipline	The content of the section in teaching units
1-2	UC-1 GPC-1	Basic concepts of chemical thermodynamics. Zero and the first beginning of thermodynamics.	1.Subject, tasks, sections, methods, history of the development of physical chemistry. 2.1. Ideal and real gases. 2.2. Basic concepts of chemical thermodynamics. 2.3. Zero origin (zero law) of thermodynamics. 2.4. The first principle (first law) of thermodynamics. 2.5. Non-circular processes. 2.6. Thermochemistry. Hess's law. 2.7. Dependence of thermal effects on temperature. Kirchhoff's equation (law).
3.	UC-1 GPC-1	The second and third principles of thermodynamics. Entropy. Characteristic functions..	3.1. Formulations of the second principle of thermodynamics. 3.2. Entropy. 3.3. Carnot cycle. 3.4. The general relation for the first and second principles of thermodynamics. 3.5. Entropy change in various processes in a closed system. 3.6. The third principle of thermodynamics. 3.7. Characteristic functions. Thermodynamic potentials. Helmholtz energy (free energy). Gibbs energy (free enthalpy). 3.8. Thermodynamic conditions of spontaneous flow of the process and the achievement of a state of equilibrium. 3.9. Chemical potential. Fugitiveness and activity. The standard state of the substance. 3.10. Gibbs-Helmholtz equations.
4.	UC-1 GPC-1	Chemical equilibrium	4.1. The concept of chemical equilibrium. 4.2. Conditions of chemical equilibrium. 4.3. The law of acting masses and its thermodynamic justification. 4.4. The relationship between chemical equilibrium constants expressed in various ways. 4.5. Conditional equilibrium constant. 4.6. Equation of the chemical reaction isotherm (Van't-Hoff isotherm). 4.7. Dependence of the chemical equilibrium constant on temperature. Isobar and Van't-Goff isochore. 4.8. Integration of the Van't-Goff isobar (isochore) equation. 4.9. Features of heterogeneous chemical equilibria. 4.10. Methods of calculating chemical equilibria.
5-10	UC-1 GPC-1	Phase equilibria	5.1 Basic concepts. 5.2. Conditions of phase equilibrium. 5.3. Gibbs phase rule.

			5.4. Phase transitions. 5.5. Single-component closed systems. 5.6. The Clapeyron–Clausius equation 6.1. Basic concepts. 6.2. Diagrams of the state of binary systems – fusibility diagrams. 6.2.1. Binary systems of non-isomorphically crystallizing substances with simple eutectic (not forming chemical compounds). 6.2.2. Systems of components infinitely soluble in each other (crystallizing isomorphically) both in liquid and solid state, which do not form chemical compounds. Classification of binary liquid solutions. 7.3. Raoul's law and its thermodynamic justification. 7.4. The dependence of the saturated vapor pressure above the solution on the composition of the solution. Konovalov's laws. Binary systems in which the mutual solubility of liquids increases with increasing temperature. 8.2. Binary systems in which the mutual solubility of liquids increases with decreasing temperature. 8.3. Binary liquid systems with upper and lower critical dissolution temperatures. 9.1. Nernst distribution law. The distribution constant. 9.2. Extraction. The distribution coefficient. Degree of extraction (extraction factor, extraction percentage). The factor of separation of two substances. Conditions for the separation of two substances. 10.1. Colligative properties of solutions. 10.2. An increase in the boiling point of a solution of a non-volatile substance compared to the boiling point of a pure solvent. Ebulioscopy (ebuliometry). 10.3. Lowering the freezing point of a solution of a non-volatile substance in comparison with the freezing point of a pure solvent. Cryoscopy. 10.4. Osmosis. Reverse osmosis. Ultrafiltration. 10.5. Determination of the molar mass of the solute by the relative decrease in the pressure of saturated solvent vapor above the solution. 10.6. Solubility of gases in liquids. Henry's law. The Sechenov equation.
11 - 13	UC-1 GPC-1	Equilibria in electrolyte solutions	11.1. Conductors of the first and second kind. 11.2. S. Arrhenius' theory of electrolytic dissociation. 11.3. Ostwald's law of breeding. 11.4. Activity and activity coefficients of electrolytes. 11.5. Ionic strength (ionic strength) of the solution. 11.6. The theory of strong electrolytes of Debye and Hückel (statistical theory of solutions of strong electrolytes). 12.1. Protolytic equilibria in aqueous solutions. 12.2. Protolytic equilibria in non-aqueous solvents.

			12.3. Equilibria in acid and base solutions. The constant of acidity and pH of solutions of weak acids. The constant of basicity and pH of solutions of weak bases. 12.4. Hydrolysis. Constant and degree of hydrolysis. Calculation of pH values of salt solutions undergoing hydrolysis. 12.5. Buffer systems (solutions). pH values of buffer solutions. A buffer system containing a weak acid and its salt. A buffer system containing a weak base and its salt. Buffer capacity. The value of buffer systems. 13.1. The velocity of ions in solution. Ion transfer numbers. 13.2. Specific electrical conductivity (specific electrical conductivity) of electrolyte solutions. 13.3. Equivalent and molar electrical conductivity (electrical conductivity) of electrolyte solutions. 13.4. Kohlrausch's Law of independent motion of ions. Limiting mobility of ions. 13.5. Application of the theory of strong electrolytes to explain the peculiarities of electrical conductivity of solutions.
14 - 15	UC-1 GPC-1	Electrode potentials and electromotive forces (EMF)	14.1. Basic concepts. 14.2. The mechanism of occurrence of the electrode potential. Double electric layer. 14.3. Dependence of the EMF of the galvanic cell on the activity of the reagents. The Nernst equation. 14.4. Classification of reversible electrodes. The Nernst equations for potentials of electrodes of the first, second kind, redox and membrane (ion – selective) electrodes. 15.1. Chemical galvanic circuits. 15.2. Concentration galvanic circuits. 15.3. Diffusion potential. 15.4. Determination of thermodynamic characteristics and equilibrium constants of reactions based on measurements of EMF of galvanic circuits.
16 - 25	UC-1 GPC-1	Kinetics of chemical reactions	16.1. Basic concepts. 16.2. Formal chemical kinetics of reactions in the gas phase: kinetically irreversible reactions of the first, second, third, fractional, zero order. 16.3. Methods for determining the reaction order (integral, differential). 16.4. Formal kinetics of some complex reactions: reversible, parallel, sequential, conjugate reactions. 17.1. The Van't-Goff rule. 17.2. Arrhenius equation. 17.3. Determination of the activation energy and the pre-exponential factor of the Arrhenius equation. 17.4. The relationship between the Van't–Hoff coefficient and the activation energy. 18.1. Theory of active collisions. 18.2. Theory of the transition state. The main provisions and assumptions of the theory.

		Subject, tasks and methods of colloidal chemistry	The main stages of the development of colloidal chemistry. The role of domestic and foreign scientists in the development of colloidal chemistry (A.V. Dumansky, V. Ostwald, N.P. Peskov, P.A. Rebinder). The importance of colloidal chemistry in the development of pharmacy.
24 - 27	UC-1 GPC-1	Dispersed systems	24.1. The structure of dispersed systems. Dispersed phase, dispersed medium. The degree of dispersion. 24.2. Classification of dispersed systems: by the aggregate state of the dispersed phase and the dispersion medium, by the nature of the interaction of the dispersed phase with the dispersion medium, by the mobility of the dispersed phase. 24.3. Methods of preparation and purification of colloidal solutions. Dialysis, electrodialysis, ultrafiltration. 25.1. Brownian motion, diffusion, osmotic pressure. 25.2. Sedimentation. Sedimentation stability and sedimentation equilibrium. Sedimentation method of analysis. 25.3. Scattering and absorption of light. Rayleigh's equation. Turbidimetry. Nephelometry. Ultramicroscopy and electron microscopy of colloidal systems. Determination of the shape, size and mass of particles of the dispersed phase. 26.1. The nature of electrical phenomena in dispersed systems. The mechanism of occurrence of an electric charge at the interface of two phases. The structure of the double electric layer. Micelle, the structure of the sol micelle. Charge and electrokinetic potential of a colloidal particle. 26.2. The effect of electrolytes on the electrokinetic potential. The phenomenon of overcharging in dispersed systems. 26.3. Electrokinetic phenomena. Electrophoresis. The relationship of the electrophoretic velocity of colloidal particles with their electrokinetic potential (Helmholtz–Smolukhovsky equation). Electrophoretic mobility. Electrophoretic research methods in pharmacy. 26.4. Electroosmos. Electroosmotic measurement of electrokinetic potential. Practical application of electroosmosis in pharmacy. 27.1. Kinetic and thermodynamic stability of dispersed systems. Aggregation and sedimentation of dispersed phase particles. Sustainability factors. Coagulation and the factors causing it. Kinetics of coagulation. Slow and fast coagulation. Coagulation threshold, its definition. The Schulze-Hardy rule. Alternation of coagulation zones. Coagulation of sols with electrolyte mixtures. 27.2. Gelation (gelatinization). Colloidal protection. Heterocoagulation. Peptization. 27.3. Coagulation theories. The adsorption theory of

			Freundlich. The theory of stability of dispersed Deryagin-Landau-Fairway-Overbeck systems.
28 - 29	UC-1 GPC-1	Different classes of dispersed systems Micellar dispersed systems	28.1. Aerosols and their properties. Preparation, molecular kinetic properties. Electrical properties. Aggregate stability and the factors determining it. Destruction. The use of aerosols in pharmacy. 28.2. Powders and their properties. Traceability, granulation and atomizability of powders. Application in pharmacy. 28.3. Suspensions and their properties. Receiving. Sustainability and its determining factors. Flocculation. Sedimentation analysis of suspensions. Foam. Pastes. 28.4. Emulsions and their properties. Receiving. Types of emulsions. Emulsifiers and their mechanism of action. Conversion of phases of emulsions. Stability of emulsions and its violation. Factors of stability of emulsions. Coalescence. Properties of concentrated and highly concentrated emulsions. The use of suspensions and emulsions in pharmacy. 29.1. Colloidal systems formed by surfactants. 29.2. Micelle formation in MPAV solutions. Critical concentration of micelle formation, methods of its determination. 29.3. Solubilization and its significance in pharmacy. 29.4. Micellar colloidal systems in pharmacy.
30.	UC-1 GPC-1	High molecular weight compounds (IUDs) and their solutions	30.1. Molecular colloidal systems. Methods of obtaining an IUD. Navy classes. 30.2. Properties of polymer chains. Flexibility of polymer chains. Internal rotation of the links in the macromolecules of the Navy. 30.3. Crystalline and amorphous state of the IUD. 30.4. Swelling and dissolution of the IUD. The mechanism of swelling. Thermodynamics of swelling and dissolution of the IUD. The influence of various factors on the degree of swelling. Lyotropic series of ions. 30.5. Rheological properties of IUD solutions. Specific, reduced and characteristic viscosity. The Staudinger equation and its modification. Determination of the molar mass of the polymer by the viscometric method. 30.7. Polymer nonelectrolytes and polyelectrolytes. Polyampholites. Isoelectric point of polyampholites and methods of its determination. 30.8. Osmotic properties of IUD solutions. Osmotic pressure of solutions of polymer nonelectrolytes. Deviation from the Van't–Hoff law. Haller's equation. Determination of the molar mass of polymer nonelectrolytes. Donnan's membrane equilibrium. 30.9. Factors of stability of IUD solutions. Salting, salting thresholds. Lyotropic series of ions. Dependence of polyampholite salting thresholds on the pH of the medium.

			30.10. Coacervation. Microcoacervation. Biological significance. Microcapsulation. 30.11. Zastudnevanie. The influence of various factors on the rate of hardening. Thixotropy of jellies and gels. Syneresis of jellies. Jellies in pharmacy. Diffusion and periodic reactions in jellies and gels.

5. Volume of the academic discipline and types of academic work

Type of educational work	Labor intensity		Labor intensity (AH) in semesters	
	volume in credit units (CU)	volume in academic hours (AH)	2	3
Classroom work, including	**5**	**180**	**66**	**44**
Lectures (L)	*0.78*	*28*	*16*	*12*
Laboratory practicum (LP)*				
Practicals (P)	2.28	82	50	32
Seminars (S)	-	-	-	-
Student's individual work (SIW)	1.94	70	42	28
exam				36
TOTAL LABOR INTENSITY	6	216	108	108

6. Content of the academic discipline

6.1. Sections of the discipline and types of academic work:

№	№ semester	Name of the section of the academic discipline	Types of academic work* (in AH)					Evaluation tools
			L	LP	P	S	SIW	
1	2	Fundamentals of thermodynamics	6		16		16	Multiply choice tests, tests or colloquia, survey, exam
2	2	Phase equilibria	6		24		18	Multiply choice tests, tests or colloquia, laboratory works, survey, exam
3	2	Electrolyte solutions and electrochemistry	4		10		8	Multiply choice tests, tests or colloquia, laboratory works, survey, exam

4	3	Kinetics of chemical reactions	4		8		8	Multiply choice tests, tests or colloquia, laboratory works, survey, exam
5	3	Dispersed systems	6		16		12	Multiply choice tests, tests or colloquia, laboratory works, survey, exam
6.	3	High molecular weight compounds	2		8		8	Multiply choice tests, tests or colloquia, laboratory works, survey, exam
		TOTAL	28		82		70	

* - L – lectures; LP – laboratory practicum; P – practicals; S – seminars; SIW – student's individual work

6.2. Thematic schedule of educational work types:

6.2.1 Thematic schedule of lectures

№	Name of lecture topics	Volume in AH	
		semester 2	semester 3
1.	Introduction. Basic concepts of chemical thermodynamics. Zero and the first beginning of thermodynamics. Thermochemistry. The second and third principles of thermodynamics. Entropy. Thermodynamic potentials.	2	
2.	Chemical equilibrium. Isotherm equations, isobars of chemical reactions.	2	
3.	The equilibrium constant. Calculation of product yield. Dependence of the equilibrium constant on temperature.	2	
4.	Liquid solution–vapor equilibrium in two-component systems. Double mixtures of liquids with limited mutual solubility.	2	
5.	Properties of dilute solutions. Distribution of the third component between two immiscible phases.	2	
6.	Equilibria in electrolyte solutions. Protolytic equilibria. Buffer systems.	2	
7.	Solutions of electrolytes under nonequilibrium conditions. Electrical conductivity of electrolyte solutions. Electrode potentials and EMF. Galvanic cells and circuits. Potentiometry as a research method.	2	
8.	Kinetics of chemical reactions. Dependence of the chemical reaction rate on concentration and temperature.		2
9.	General theories of chemical kinetics. Kinetics of reactions of some types. Catalysis.		2
10.	Subject, tasks and methods of colloidal chemistry. Dispersed	2	

	systems.		
11.	Molecular kinetic and optical properties of dispersed systems.	2	
12.	Electrokinetic phenomena. Electrophoresis. Electroosmosis. Stability and coagulation of dispersed systems. Gelation. Colloidal protection.	2	
13.	Coagulation theories: Freundlich and DLFO. IUDs and their solutions.	2	
14.	Properties of polymer chains. Phase state of the IUD. Swelling and dissolution of the IUD. Rheological properties. Polyampholites. Osmotic properties.	2	

6.2.2. The thematic plan of laboratory practicums

№	Name of Practicals	Volume in AH	
		Semester 2	Semester 3
1.	The 1st beginning of thermodynamics. Thermochemistry.	2.63	
2.	Entropy. Thermodynamic potentials.	2.63	
3.	Isotherm and isobar of a chemical reaction.	2.63	
4.	Calculation of the reaction product yield.	2.63	
5.	Determination of the enthalpy of salt hydration	2.63	
6.	Control work No. 1 "Thermodynamics. Chemical equilibrium".	2.63	
7.	Phase equilibrium. Single-component systems.	2.63	
8.	Phase equilibrium in condensed systems.	2.63	
9.	Liquid-vapor equilibrium. Konovalov's laws.	2.63	
10.	Investigation of phase equilibrium in the phenol-water system	2.63	
11.	Limited soluble liquids	2.63	
12.	Solutions of nonelectrolytes.	2.63	
13.	Three-component systems. Extraction.	2.63	
14.	Control work No. 2 "Phase equilibria and solutions of nonelectrolytes".	2.63	
15.	Solutions of electrolytes	2.63	
16.	Electrolyte solutions under nonequilibrium conditions	2.63	
17.	Determination of the dissociation constant of a weak electrolyte by the conductometric method	2.63	
18.	Electrode potentials. Galvanic circuits.	2.63	
19.	Control work No. 3 "Electrolyte solutions and electrochemistry"	2.63	
1.	Kinetics of chemical reactions. Dependence of the chemical reaction rate on concentration		2.63
2.	General theories of chemical kinetics. Kinetics of reactions of some types. Catalysis.		2.63
3.	Study of the kinetics of the decomposition reaction of hydrogen peroxide		2.63
4.	Control work No. 4 " Kinetics of chemical reactions "		2.63
5.	Subject, tasks and methods of colloidal chemistry. Dispersed systems.		2.63

6.	Molecular kinetic and optical properties of dispersed systems.		2.63
7.	Sedimentation analysis.		2.63
8.	Electrokinetic phenomena. Electrophoresis. Electroosmosis.		2.63
9.	Stability and coagulation of dispersed systems. Gelation. Colloidal protection. Coagulation theories: Freundlich and DLFO.		2.63
10.	Control work No. 5 " Dispersed systems "		2.63
11.	IUDs and their solutions. Properties of polymer chains. Phase state of the IUD. Swelling and dissolution of the IUD.		3.1
12.	Control work No. 6 "IUD "		2.63
	TOTAL (total 82 AH)		

6.2.3. Thematic plan of practicals: not provided for.
6.2.4. Thematic plan of seminars: not provided for.

6.2.5. Types and topics of student's individual work (SIW)

№	Types and topics of SIW	Volume in AH	
		Semester 2	Semester 3
1.	work with lecture material, which provides for the study of lecture notes and educational literature, work with electronic literature	12	10
2.	completing homework for the lesson	12	8
3.	preparation for the control work	6	5
4.	preparing for testing online	6	3
5.	work with Internet resources, including for the preparation of the report	6	2
	TOTAL (total -70 AH)		

6.2.6. Student's research work:

№	Student's research work:	Semester
1.	Energy of chemical reactions.	2-3
2	Chemical equilibrium.	
3	Solutions - physico-chemical systems. Theories of solutions.	
4	General properties of solutions.	
5	Unusual properties of ordinary water.	
6	Azeotropic solutions.	
7	Catalysis and its significance for industry.	
8	Thermal analysis and melting diagrams of two-component systems.	
9	Chemical equilibrium.	
10	Application of thermal analysis in pharmacy.	
11	Temperature and its measurement.	
12	Physico-chemical bases of obtaining oxygen, nitrogen and noble gases from the air.	

13	Physico-chemical research methods in pharmacy.	
14	Electrolysis of solutions and melts.	
15	Fuel cells: the history of their creation and prospects of application.	
16	Adsorption processes and their use in pharmacy.	
17	Methods of studying the surface tension of liquids.	
18	Langmuir Stockade, or on the structure and properties of the interface of the air-surfactant solution phases.	
19	Physico-chemistry of smog formation and destruction processes.	
20	Physico-chemical research methods in pharmacy.	
21	Energy of chemical reactions.	

7. Types of assessment formats for ongoing monitoring and mid-term assessment

№	Semester No.	Types of control	Name of section of academic discipline	Competence codes		
					types	number of test questions
1.	2	Current monitoring	Fundamentals of thermodynamics	1, 2, 3- Current testing. Testing practical skills. test or colloquium	3	12
2.	2	Current monitoring	Phase equilibria	1 - Current testing. Oral individual survey. 2 - Current testing. Test work or colloquium. 3 - Current testing. Oral individual survey.	4	12
3.	2	Current monitoring	Electrolyte solutions and electrochemistry	1 - Current testing. Oral individual survey. 2 - Current testing. Test work or colloquium. 3 - Current testing. Oral individual survey.	4	12
4.	3	Current monitoring	Kinetics of chemical reactions	1 - Current testing. Oral individual survey. 2 - Current testing. Test work or colloquium. 3 - Current testing. Oral individual survey.	4	12
5.	3	Current monitoring	Dispersed systems	1 - Current testing. Oral individual survey. 2 - Current testing. Test work or	4	12

				colloquium. 3 - Current testing. Oral individual survey.		
6.	3	Current monitoring	High molecular weight compounds	1 - Current testing. Oral individual survey. 2 - Current testing. Test work or colloquium. 3 - Current testing. Oral individual survey.	3	12
8.	3	Exam	All topics	Computer testing	12	60 (option is formed by random sampling)
				Exam cards	3	30

8. Educational, methodological and informational support for mastering the academic discipline (printed, electronic publications, the Internet and other network resources)

8.1. Key literature references

№	Name according to bibliographic requirements	Number of copies	
		at the department	in the library
1.	Zurabyan S.E. Fundamentals of bioorganic chemistry:Textbook for medical students. - Moscow 2003,2006.: GEOTAR-MED,-320c.	-	50
2.	Ebbing, D. D. General Chemistry / D. D. Ebbing, S. D. Gammon. – 11th ed. – Australia : Cengage Learning, 2019. – 864 p. : il. – ISBN 978-1-3055-8034-3.	-	50

8.2. Further reading

№	Name according to bibliographic requirements	Number of copies	
		at the department	in the library
	Kharitonov Yu.Ya. Physical chemistry. Textbook. – M.:GEOTAR-Media, 2009. – p. 608	2	2
	Tasks in physical chemistry: textbook/ V.V.Eremin, S.I.Kargov, I.A.Uspenskaya, N.E.Kuzmenko, V.V.Lunin. – M.:Exam, 2003. – p.320	1	1

	Zimon A.D. Physical chemistry. – M.: Agar, 2003. – p.320	2	1

8.3. Electronic educational resources for teaching academic subjects

8.3.1. Internal Electronic Library System of the University (IELSU)

№	*Name of the electronic resource*	*Brief description (content)*	*Access conditions*	*Number of users*
	Internal Electronic Library System (EBS)	The works of the academic staff of the Academy: textbooks and manuals, monographs, collections of scientific papers, scientific articles, dissertations, abstracts of dissertations, patents.	from any computer located on the Internet, using an individual login and password	Not limited

8.3.2. Electronic educational resources acquired by the University

№	*Name of the electronic resource*	*Brief description (content)*	*Access conditions*	*Number of users*
1.	*International scientometric database "Web of Science Core Collection"*	*Web of Science covers materials on natural, technical, social, and humanitarian sciences; takes into account the mutual citation of publications developed and provided by Thomson Reuters; has built-in capabilities for searching, analyzing, and managing bibliographic information.*	*Access is free from PIM computers [Electronic resource] – Access to the resource at: http://apps.webofknowledge.com*	*Access is free from PIMU computers*
2.	Electronic database "Student Consultant"	Educational literature + additional materials (audio, video, interactive materials, test tasks) for higher medical and pharmaceutical education. Publications are structured by specialties and disciplines in accordance with the current Federal State Educational Standard of Higher Education.	from any computer located on the Internet, using an individual login and password [Electronic resource] – Access mode: http://www.studmedlib.ru/	General PIMU subscription

8.3.3 Open access resources

№	*Name of the electronic resource*	*Brief description (content)*	*Access conditions*
1.	Federal Electronic Medical Library (FEMB)	Includes electronic analogues of printed publications and original electronic publications that have no analogues recorded on other media (dissertations, abstracts, books, journals, etc.). [Electronic resource] – Access mode: http://нэб.рф/	from any computer located on the Internet
2.	Scientific Electronic Library eLIBRARY.RU	The largest Russian information portal in the field of science, technology, medicine and education, containing abstracts and full texts of scientific articles and publications. [Electronic resource] – Access mode: https://elibrary.ru/	from any computer located on the Internet

9. Material and technical support for mastering an academic discipline

9.1. List of premises for classroom activities for the discipline

1. Lecture hall equipped with multimedia equipment and microphone.

2. Offices for laboratory workshops.

9.2. List of equipment for classroom activities for the discipline

1. Multimedia complex (computer and projection equipment)
2. Information stands.
3. Tables and reference books.
4. Slides and multimedia presentations of lectures.
5. Chemical tableware (burettes, pipettes, flasks, glasses, refrigerators, chemical reagents).
6. Chemical reagents.
7. Fume hood.
8. Alcohol lamps.
9. Electric stoves.
10. Analytical scales.
11. Water bath.
12. Tripods for test tubes.
13. Tripods with reagents.
14. Magnetic stirrers.

9.3. A set of licensed and freely distributed software, including domestic production

Item no.	Software	number of licenses	Type of software	Manufacturer	Number in the unified register of Russian software	Contract No. and date
1	Wtware	100	Thin Client Operating System	Kovalev Andrey Alexandrovich	1960	2471/05-18 from 28.05.2018
2	MyOffice is Standard. A corporate user license for educational organizations, with no expiration date, with the right to receive updates for 1 year.	220	Office Application	LLC "NEW CLOUD TECHNOLOGIES"	283	without limitation, with the right to receive updates for 1 year.
3	LibreOffice		Office Application	The Document Foundation	Freely distributed software	
4	Windows 10 Education	700	Operating systems	Microsoft	Azure Dev Tools for Teaching Subscription	
5	Yandex. Browser		Browser	«Yandex»	3722	
6	Subscription to MS Office Pro for 170 PCs for FGBOU VO "PIMU" of the Ministry of Health of Russia	170	Office Application	Microsoft		23618/HN10030 LLC "Softline Trade" from 04.12.2020

10. List of changes to the working program (to be filled out by the template)

Federal State Budgetary Educational Institution of Higher Education
"Privolzhsky Research Medical University"
Ministry of Health of the Russian Federation
(FSBEI HE "PRMU" of the Ministry of Health of Russia)

Department of
Name of the department

CHANGE REGISTRATION SHEET

working program for the academic discipline
General Chemistry

Field of study / specialty / scientific specialty: _____
(code, name)
Training profile: _____
(*name) - for master's degree programs*

Mode of study: _____
full-time/mixed attendance mode/extramural

Position	Number and name of the program section	Contents of the changes made	Effective date of the changes	Contributor's signature
1				

Approved at the department meeting
Protocol No. _____of _____20__

Head of the Department
_____ _____/_____
department name, academic title signature print name