

МИНОБРНАУКИ РОССИИ

**Федеральное государственное автономное образовательное
учреждение высшего образования "Пермский
государственный национальный исследовательский
университет"**

**Кафедра неорганической химии, химической технологии и техносферной
безопасности**

Авторы-составители: **Васянин Александр Николаевич
Мокрушин Иван Геннадьевич
Красновских Марина Павловна**

Рабочая программа дисциплины

CHEMISTRY

Код УМК 95049

Утверждено
Протокол №3
от «25» мая 2021 г.

Пермь, 2021

1. Наименование дисциплины

Chemistry

2. Место дисциплины в структуре образовательной программы

Дисциплина входит в обязательную часть Блока « Б.1 » образовательной программы по направлениям подготовки (специальностям):

Направление: **05.03.06** Экология и природопользование
направленность Экологическая инженерия и новая энергетика

3. Планируемые результаты обучения по дисциплине

В результате освоения дисциплины **Chemistry** у обучающегося должны быть сформированы следующие компетенции:

05.03.06 Экология и природопользование (направленность : Экологическая инженерия и новая энергетика)

ОПК.1 Владеет базовыми знаниями о современной научной картине мира на основе положений, законов и методов математических и естественных наук

Индикаторы

ОПК.1.1 Имеет представление о научной картине мира на основе положений, законов и закономерностей естественных наук

4. Объем и содержание дисциплины

Направления подготовки	05.03.06 Экология и природопользование (направленность: Экологическая инженерия и новая энергетика)
форма обучения	очная
№№ триместров, выделенных для изучения дисциплины	1,2
Объем дисциплины (з.е.)	7
Объем дисциплины (ак.час.)	252
Контактная работа с преподавателем (ак.час.), в том числе:	112
Проведение лекционных занятий	42
Проведение практических занятий, семинаров	14
Проведение лабораторных работ, занятий по иностранному языку	56
Самостоятельная работа (ак.час.)	140
Формы текущего контроля	Итоговое контрольное мероприятие (2) Письменное контрольное мероприятие (10)
Формы промежуточной аттестации	Зачет (1 триместр) Экзамен (2 триместр)

5. Аннотированное описание содержания разделов и тем дисциплины

General Chemistry

Acquaintance with the main sections of the course of general chemistry, chemistry of elements and analytical chemistry. The knowledge and practical skills obtained in the course should help future bachelors to deeply understand the chemical processes underlying the chemical processing of mineral and plant raw materials, to assess the consequences of the effects of substances on the environment in the process of human activity.

Classes of inorganic compounds and chemical nomenclature

General information. Chemical elements - metals and non-metals.

Classes of inorganic compounds and chemical nomenclature.

Oxides, bases, acids, salts: classification, nomenclature. Prevalence in nature, obtaining.

Structure, physical and chemical properties. Application.

Regularities of the course of chemical processes

Types of chemical reactions. Thermodynamics of physical and chemical processes. Thermochemistry. Enthalpy of the system. Entropy. Gibbs free energy of the system.

Kinetics of chemical processes. Chemical reaction rate. Activation energy. Catalysis. LeChatelier's principle.

Basic concepts of chemical thermodynamics

Types of chemical reactions.

Thermodynamics of physical and chemical processes. System, its classification (isolated, closed, open).

Chemical processes, their classification (isothermal, isochoric, isobaric). Phase, classification of systems depending on the phase state of the components of the system (homogeneous, heterogeneous). Internal energy of the system, its change during the reaction. Work. Heat. The law of conservation of energy (the first law of thermodynamics).

Thermochemistry. Thermal effect of isobaric and isochoric processes. Enthalpy of the system, its change during the reaction, Standard enthalpies of formation, combustion of substances. Hess's law and its consequences for calculating the thermal effects of chemical reactions - changes in enthalpy during the reaction. Thermochemical equations. Energy diagrams of exo- and endothermic reactions. Fuel calorific value. Calorie content of food.

Macro and micro characteristics of the system. Entropy is the thermodynamic probability of the system.

Boltzmann equation. The second and third laws of thermodynamics. The change in the entropy of the system in the course of a chemical reaction, its determination based on the standard entropy of the formation of substances.

The criterion for the spontaneity of chemical processes is the Clausius criterion. Gibbs free energy of the system, its change in the course of a chemical reaction. Calculation of the change in Gibbs energy based on the standard Gibbs energies of the formation of substances or changes in enthalpies and entropies in the course of a chemical reaction.

The magnitude of the change in Gibbs free energy in chemical reactions is a measure of the reactivity of substances and the direction of the reaction. Enthalpy and entropy factors of processes.

Chemical reaction rate and chemical equilibrium

Kinetics of chemical processes. Mechanisms of chemical processes: radical, ionic. Radicals, ions: their structure, production, properties. Conditions for homolytic and heterolytic cleavage of covalent chemical bonds. Limiting stage.

The rate of a chemical reaction and the concentration of reactants in a homogeneous system. The law of the acting masses. Kinetic equations of reaction. Reaction rate constant. Molecularity, order of reaction by substance, general order of reaction.

Determination of the order of the reaction by substance. Heterogeneous systems and contact surfaces of substances. Kinetic and diffuse regions of the reaction.

Chemical reaction rate and temperature. Van't Hoff's rule, temperature coefficient. Arrhenius equation. Activation energy. Active particles, their change with temperature. Energy diagrams of reaction. Determination of the temperature coefficient, activation energy.

Reaction rate and presence of chemicals. Catalysis: positive, negative (inhibition), homogeneous and heterogeneous. Catalysis mechanism.

Initiation. Catalysts, inhibitors, initiators: their main characteristics.

Equilibrium, non-equilibrium reactions. Criteria for equilibrium, non-equilibrium of the reaction. Chemical equilibrium (true, metastable). Equilibrium constant, its relationship with the change in Gibbs free energy.

Equilibrium concentration of substances, equilibrium yield of reaction products. Balance shift - LeChatelier's principle.

Examination in chemical thermodynamics and kinetics

Student should know and operate in the following topics. Thermodynamics of physical and chemical processes. Thermochemistry. Enthalpy of the system. Entropy. Gibbs free energy of the system. Kinetics of chemical processes. Chemical reaction rate. Activation energy. Catalysis. LeChatelier's principle.

Solutions

Periodic table and the structure of the atoms of the elements; chemical bond (covalent bond, valence bond method, hybridization, molecular orbital method, ionic bond, chemical bond in complex compounds); the structure of a substance in a condensed state, solutions (ways of expressing concentrations, ideal and non-ideal solutions, activity); electrolyte solutions; equilibrium in solutions; redox reactions; protolytic equilibrium.

General properties of solutions

Homogeneous dispersed systems are true solutions: classification by the state of the solute in solution (solutions of electrolytes and non-electrolytes), by the state of equilibrium (saturated, unsaturated, supersaturated), mechanisms, dissolution thermodynamics. Solvation (hydration). Dissolution is a physicochemical process. Solubility, coefficient of solubility. Factors that determine the solubility of a substance. Henry's Law. Distribution law (distribution coefficient). Classification of substances by solubility. Extraction (from a mixture of solids, between two immiscible liquids) and crystallization from solutions (methods of salting out, precipitation, cooling) as methods of purification and separation of substances. Concentrations of solutions: mass (molality, mass fraction), volume (volume fraction, molar, equivalent, titer). Mutual transitions between different concentrations of solutions. Classification of solutions by concentration: concentrated, diluted.

Aqueous solutions of electrolytes

Ideal and imperfect electrolyte solutions. Equilibria in solutions. The theory of electrolytic dissociation. Quantitative characteristics of dissociation: degree, dissociation constant. Classification of substances by electrolytic strength. Factors determining the degree and constant of dissociation. Ionic strength of the solution. Activity. Activity coefficient. Debye-Hückel equations. Theories of acids and bases: electrolytic, protolytic, electronic. Protolytic equilibrium. Aqueous solutions of acids, bases, their properties. Ampholytes. The nature of the environment in aqueous solutions of acids, bases. Aqueous solutions of salts. Properties of salt solutions. Salt hydrolysis. Chemistry of hydrolysis processes. Reversible, irreversible hydrolysis. Factors determining the degree of hydrolysis. The nature of the environment in aqueous solutions of salts. Qualitative reactions to ions. Coloring of flame and solution with ions. Dissociation of water. Ionic product of water. Hydrogen exponent - pH. Methods for determining the pH value. Acid-base indicators, their nature and essence of action. pH meters. Reasons that determine the nature of the environment in aqueous solutions of electrolytes. Buffer solutions: composition, properties (pH, buffer capacity), value. Henderson-Hasselbach equations. Homogeneous and heterogeneous exchange reactions in aqueous solutions. The condition for the irreversibility of the exchange reaction. Equations of reactions exchanges. Condition for the formation and dissolution of the precipitate.

Solubility product and its factors. Precipitation is a method of separation and purification of substances.

Redox processes

The oxidation state of the element. Dependence of the oxidation states of elements on their position in the periodic system of D.I. Mendeleev. Atomic transfer reactions. Electron transfer reactions. Redox reactions. Oxidizing agent. Reducing agent. Disproportionation. Direction of redox reactions. Oxidation-reduction potentials.

The structure of the atom. Periodic Table of Chemical Elements. Chemical bond

Periodic law. Electronic structures of atoms. Orbital filling order. Pauli exclusion principle. Hund's rule. Effective charge of the nucleus. The structure of the periodic table. Periodicity of properties. Ionization energy. Electron affinity. Electronegativity. Orbital radii of atoms and ions. The nature of the chemical bond. Covalent, ionic, metallic bond. Polar and non-polar covalent bond. Molecular orbital theory. Order, length, bond energy. The theory of valence bonds. Donor-acceptor interaction. Oxidation state and coordination number of the central atom. Spatial configuration of molecules. Coordination number of the central atom of the molecule (complex). The main types of polyhedra. Repulsion model of valence localized electron pairs. Repulsion of electron pairs and the spatial configuration of the molecule. Valence angles. Simple and multiple links. The main types of interaction of molecules. Forces of intermolecular interaction. Hydrogen bond. Donor-acceptor mechanism of covalent bond formation. Aggregate state of matter. The chemical structure of a solid. Amorphous and crystalline state of matter. Crystals. Crystalline lattices. Metallic bond.

Control event

Final test on classes of compounds and laws of chemistry, kinetics and thermodynamics, solutions, RedOx.

Inorganic chemistry

General aspects of inorganic chemistry. Main classes and their reactivity.

Chemistry of non-metals

General characteristics of non-metals. Chemical elements - non-metals: position in the periodic table, electronic configurations, atomic radii, valence states. Change in the radii of atoms, non-metallic (oxidizing) and reducing properties, depending on the charge of the nucleus of the non-metal atom. Simple substances - non-metals: the nature and multiplicity of chemical bonds, the nature of the crystal lattice and the structure of matter (allotropy). Features of the physical and chemical properties of non-metals, depending on the composition, structure, thermal stability, nature and type of crystal lattice. The prevalence of non-metals in nature. Methods for obtaining non-metals. The value of non-metals. Complex substances of non-metals - hydrogen compounds, oxides, acid hydroxides, salts, their structure, properties and application.

Chemistry of metals

General characteristics of metals. Chemical elements - metals: position in the periodic system, electronic configurations, atomic radii, valence states. Change in the radii of atoms and metallic (reducing) properties depending on the charge of the nucleus of the metal atom (effects of compression, shielding and penetration). Simple substances - metals: the nature of the chemical bond, the nature of the crystal lattice (polymorphism), features of the physical and chemical properties of s-, p-, d- and f-elements. Features of changes in metallic (reducing) properties in solid, gas phases and in solutions (voltage series). The prevalence of metals in nature. Methods for obtaining and purifying metals. Metal alloys. The value of metals and their alloys. Compounds of metals - oxides, hydroxides (basic, amphoteric), salts, their structure, properties and application.

Complex compounds

The theory of the formation of complex compounds. Classification and nomenclature of complex compounds. Atoms and ions as complexing agents. Instability constants of complexes. Various types of ligands in complex compounds. Complex anion compounds. Compounds of complex cations and neutral complexes. Application of the method of complexation in chemical analysis. Dissociation of complex compounds.

Laboratory work report

Report on laboratory work on inorganic compounds.

Final control

Final control on classes of inorganic compounds.

Analytical Chemistry

Analytical chemistry studies and uses instruments and methods used to separate, identify, and quantify matter. In practice, separation, identification or quantification may constitute the entire analysis or be combined with another method. Separation isolates analytes. Qualitative analysis identifies analytes, while quantitative analysis determines the numerical amount or concentration.

Introduction to Analytical Chemistry

Subject, tasks and methods of analytical chemistry. Classification of methods of analysis. Advantages and shortcomings of chemical and physicochemical methods of analysis.

Measurements and Their Characteristics. Analytical Signal

Subject, tasks and methods of analytical chemistry. Classification of methods of analysis. Advantages and shortcomings of chemical and physicochemical methods of analysis.

Quantitative And Qualitative Analysis

Quantitative data analysis includes information about quantities and numbers, as far as qualitative data applies to things which can be observed but not measured.

Analytical Techniques, Methods, Protocols

Macroanalysis, semi-microanalysis, microanalysis, submicroanalysis, ultramicroanalysis. Systematic and fractional analysis methods. Analytical reactions: group, specific and selective reactions. Test tube, drip, demonstration methods of qualitative reactions.

Sampling and Sample Preparation

Sampling and Sample Preparation in Analytical chemistry

Theoretical Foundations of Analytical Chemistry. Chemical Equilibrium

Physicochemical laws and basic provisions of general chemistry applied to Analytical Chemistry. Application of the law of mass action in analytical chemistry

Equilibrium in a homogeneous system. The Law of the Acting Masses. Protolytic theory of acids and bases

Application of the law of mass action (MWA) in analytical chemistry. Equilibrium in homogeneous systems - in solutions of acids and bases, protolytic theory of Bronsted-Lowry. The influence of solvents on acid-base interactions.

Dissociation degree. Dissociation constant. Ionic strength of the solution. Ion activity. Solubility constant (product)

The degree of electrolytic dissociation, its calculation. Ostwald's dilution law. Strong and weak electrolytes.

Application of the law of mass action to the dissociation process. Dissociation (ionization) constant of acids and bases. The concept of thermodynamic activity. The law of mass action in heterogeneous systems. Solubility constant, its calculation.

Electrolytic dissociation of water. Hydrogen exponent. Buffer solutions

Dissociation of water, derivation of the formula for the ionic product of water. Hydrogen and hydroxyl indicators. Methods for measuring the pH of a solution during analysis. Examples of calculating pH in solutions of strong acids and bases. Buffer solutions and their use in analytical chemistry.

Theoretical foundations of analytical chemistry (test)

Performing a test on the studied topic "Theoretical Foundations of Analytical Chemistry"

Classical Chemical Methods of Analysis

Goals and objectives of quantitative chemical analysis. Its importance in industry, science, medicine, ecology and other fields. Classification of analytical chemistry methods.

Methods for expressing the concentration of solutions in analytical chemistry. Quantitative analysis methods

Various ways of expressing the concentration of solutions: mass, molar, molar, volumetric, titer, substance titer, mole fraction. Classification of the main methods of quantitative chemical analysis: gravimetry and titrimetry, their application.

Test Work on Solving Problems

Solution of a qualitative problem containing a mixture of the studied cations and anions.

Methods Based on the Mass Measuring: Gravimetry

Gravimetric analysis describes a set of methods used in analytical chemistry for the quantitative determination of an analyte (the ion being analyzed) based on its mass. The principle of this type of analysis is that once an ion's mass has been determined as a unique compound, that known measurement can then be used to determine the same analyte's mass in a mixture, as long as the relative quantities of the other constituents are known.

Test Work on Solving Problems

Solution of a qualitative problem containing a mixture of the studied cations and anions.

Methods Based on the Volume Measuring: Titrimetry

Titrimetric method of analysis. Analytical signal. The use of indicators when performing the quantitative determination of a substance. Alkalimetry, acidimetry.

Acid-base Titration

Acid-base Titration. The main provisions of the protolytic theory of acids and bases, the theory of electrolytic dissociation.

Complexometric Titrations

Complexometric titration. Basics of the method. Direct and back titration. Calculation of mass content, percentage. The law of equivalents.

Redox Titrations

Redox titration. Its purpose and objectives by the example of methods for the determination of iron in solutions and ores by various methods (permanganometry, dichromatometry). Mohr's method, Zimmermann-Reingard method. Indicators in redox titration.

Precipitation Titrations

Precipitation titration is a way to precisely determine the end point of a titration. Instead of trying to visually determine when a precipitate stops forming, an indicator is added to the solution and forms a precipitate of its own with excess molecules from the titrant that is added gradually.

Calculations in Titrimetry

Calculation of mass content, percentage. The law of equivalents.

Test Work on Solving Problems

Solution of a qualitative problem containing a mixture of the studied cations and anions.

Quantitative Analysis Laboratory Workshop

Quantitative Analysis Laboratory Workshop. Solution of a qualitative problem containing a mixture of the studied cations and anions.

Instrumental methods of analysis

The fundamentals of physical and chemical methods of analysis, their classification, advantages and disadvantages are considered. Modern instrumental methods of analysis and their practical application in analytical chemistry.

Laboratory Practice Report

Preparation and submission of a report on the laboratory work performed on the qualitative, quantitative and physicochemical methods of analysis. Brief physical and chemical analysis of a real object. Determination of pH, electrical conductivity of a water sample. Comparison of the obtained indicators with regulatory documents (State and industry standards).

Final control

Final control of qualitative, quantitative and physicochemical methods of analysis.

6. Методические указания для обучающихся по освоению дисциплины

Освоение дисциплины требует систематического изучения всех тем в той последовательности, в какой они указаны в рабочей программе.

Основными видами учебной работы являются аудиторские занятия. Их цель - расширить базовые знания обучающихся по осваиваемой дисциплине и систему теоретических ориентиров для последующего более глубокого освоения программного материала в ходе самостоятельной работы. Обучающемуся важно помнить, что контактная работа с преподавателем эффективно помогает ему овладеть программным материалом благодаря расстановке необходимых акцентов и удержанию внимания интонационными модуляциями голоса, а также подключением аудио-визуального механизма восприятия информации.

Самостоятельная работа преследует следующие цели:

- закрепление и совершенствование теоретических знаний, полученных на лекционных занятиях;
- формирование навыков подготовки текстовой составляющей информации учебного и научного назначения для размещения в различных информационных системах;
- совершенствование навыков поиска научных публикаций и образовательных ресурсов, размещенных в сети Интернет;
- самоконтроль освоения программного материала.

Обучающемуся необходимо помнить, что результаты самостоятельной работы контролируются преподавателем во время проведения мероприятий текущего контроля и учитываются при промежуточной аттестации.

Обучающимся с ОВЗ и инвалидов предоставляется возможность выбора форм проведения мероприятий текущего контроля, альтернативных формам, предусмотренным рабочей программой дисциплины. Предусматривается возможность увеличения в пределах 1 академического часа времени, отводимого на выполнение контрольных мероприятий.

Процедура оценивания результатов обучения инвалидов и лиц с ограниченными возможностями здоровья по дисциплине предусматривает предоставление информации в формах, адаптированных к ограничениям их здоровья и восприятия информации.

При проведении текущего контроля применяются оценочные средства, обеспечивающие передачу информации, от обучающегося к преподавателю, с учетом психофизиологических особенностей здоровья обучающихся.

7. Перечень учебно-методического обеспечения для самостоятельной работы обучающихся по дисциплине

При самостоятельной работе обучающимся следует использовать:

- конспекты лекций;
- литературу из перечня основной и дополнительной учебной литературы, необходимой для освоения дисциплины (модуля);
- текст лекций на электронных носителях;
- ресурсы информационно-телекоммуникационной сети "Интернет", необходимые для освоения дисциплины;
- лицензионное и свободно распространяемое программное обеспечение из перечня информационных технологий, используемых при осуществлении образовательного процесса по дисциплине;
- методические указания для обучающихся по освоению дисциплины.

8. Перечень основной и дополнительной учебной литературы

Основная:

1. Fundamentals of analytical chemistry/Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch.-9-е изд.-Belmont:Brooks/Cole, Cengage Learning,2014, ISBN 978-0-495-55828-6.-958471824.- Указ.: с. I - 1
2. McMahon P. E.,McMahon R. F.,Khomtchouk B. B. Survival guide to general chemistry/P. E. McMahon, R. F. McMahon, B. B. Khomtchouk.-Boca Raton:CRC Press,2019, ISBN 9781138333628.-532.
<http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=2029923>
3. K. Danzer Analytical Chemistry. Theoretical and Metrological Fundamentals. Springer-Verlag Berlin Heidelberg, 2007. Online ISBN 978-3-540-35990-6. Текст: электронный//
<https://link.springer.com/book/10.1007/978-3-540-35990-6#toc> <https://link.springer.com/book/10.1007/978-3-540-35990-6>

Дополнительная:

1. Nataliya Turova Inorganic Chemistry in Tables. Springer-Verlag Berlin Heidelberg, 2011. Online ISBN978-3-642-20487-6. <https://link.springer.com/book/10.1007/978-3-642-20487-6#toc>
<https://link.springer.com/book/10.1007/978-3-642-20487-6>
2. Birdi K. S. Surface and colloid chemistry:principles and applications/K. S. Birdi.-Boca Raton:CRC Press,2010, ISBN 9781420095036.-244.
<http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=295669>

9. Перечень ресурсов сети Интернет, необходимых для освоения дисциплины

При освоении дисциплины использование ресурсов сети Интернет не предусмотрено.

10. Перечень информационных технологий, используемых при осуществлении образовательного процесса по дисциплине

Образовательный процесс по дисциплине **Chemistry** предполагает использование следующего программного обеспечения и информационных справочных систем:

1. Presentation materials (slides on the topics of lectures and practical classes);
2. Online access to the Electronic Library System (ELS)
3. Access to the electronic information and educational environment of the university.
4. An application that allows you to view and play media content of PDF-files "Adobe Acrobat Reader DC".
5. Programs, demonstration of video materials (player) "WindowsMediaPlayer".
6. Program for viewing Internet content (browser) "Google Chrome".

При освоении материала и выполнения заданий по дисциплине рекомендуется использование материалов, размещенных в Личных кабинетах обучающихся ЕТИС ПГНИУ (**student.psu.ru**).

При организации дистанционной работы и проведении занятий в режиме онлайн могут использоваться:

- система видеоконференцсвязи на основе платформы BigBlueButton (<https://bigbluebutton.org/>).
- система LMS Moodle (<http://e-learn.psu.ru/>), которая поддерживает возможность использования текстовых материалов и презентаций, аудио- и видеоконтент, а так же тесты, проверяемые задания, задания для совместной работы.
- система тестирования Indigo (<https://indigotech.ru/>).

11. Описание материально-технической базы, необходимой для осуществления образовательного процесса по дисциплине

To conduct lectures and seminar-type classes, an audience is required that is equipped with presentation equipment (projector, screen, computer / laptop) with the appropriate software, chalk (s) or marker board. Laboratory classes are held in the Laboratory of General and Inorganic Chemistry and the Laboratory of Qualitative and Quantitative Analysis, which are equipped with specialized equipment. The composition of the equipment is specified in the Laboratory Passport.

To conduct group, individual consultations, you need an audience equipped with presentation equipment (projector, screen, computer / laptop) with appropriate software, chalk (s) or marker board.

The current control is carried out in an auditorium equipped with a chalkboard (s) or marker board.

To carry out independent work, you need an audience equipped with computer equipment with the ability to connect to the Internet, provided with access to the electronic information and educational environment of the university.

Помещения научной библиотеки ПГНИУ для обеспечения самостоятельной работы обучающихся:

1. Научно-библиографический отдел, корп.1, ауд. 142. Оборудован 3 персональными компьютера с доступом к локальной и глобальной компьютерным сетям.
2. Читальный зал гуманитарной литературы, корп. 2, ауд. 418. Оборудован 7 персональными компьютерами с доступом к локальной и глобальной компьютерным сетям.
3. Читальный зал естественной литературы, корп.6, ауд. 107а. Оборудован 5 персональными компьютерами с доступом к локальной и глобальной компьютерным сетям.
4. Отдел иностранной литературы, корп.2 ауд. 207. Оборудован 1 персональным компьютером с

доступом к локальной и глобальной компьютерным сетям.

5. Библиотека юридического факультета, корп.9, ауд. 4. Оборудована 11 персональными компьютерами с доступом к локальной и глобальной компьютерным сетям.

6. Читальный зал географического факультета, корп.8, ауд. 419. Оборудован 6 персональными компьютерами с доступом к локальной и глобальной компьютерным сетям.

Все компьютеры, установленные в помещениях научной библиотеки, оснащены следующим программным обеспечением:

Операционная система ALT Linux;

Офисный пакет Libreoffice.

Справочно-правовая система «КонсультантПлюс»

**Фонды оценочных средств для аттестации по дисциплине
Chemistry**

**Планируемые результаты обучения по дисциплине для формирования компетенции.
Индикаторы и критерии их оценивания**

ОПК.1

Владеет базовыми знаниями о современной научной картине мира на основе положений, законов и методов математических и естественных наук

Компетенция (индикатор)	Планируемые результаты обучения	Критерии оценивания результатов обучения
<p>ОПК.1.1 Имеет представление о научной картине мира на основе положений, законов и закономерностей естественных наук</p>	<p>Know: - basic laws of chemistry; have an idea of the modern structure of the atom, the structure of matter; chemical properties of the main classes of inorganic compounds; have an idea of the direction of the chemical reaction, the state of chemical equilibrium and the conditions for its displacement. - theoretical foundations of analytical chemistry; the law of action of the masses; Ostwald's dilution law; mathematical expression of hydrogen and hydroxyl indicators, ionic strength of a solution; balance between liquid and solid phases; solubility product; ways of expressing the concentration of solutions; calculations in titrimetric methods of analysis.</p> <p>Be able to: - draw up equations for exchange chemical reactions, redox reactions and complexation reactions; carry out calculations according to the equations of chemical reactions (calculate the mass of a substance, the mass of a solution, the concentration of a solute in a solution, the pH of a solution), problems with an excess or deficiency of a substance, using gas laws.</p>	<p align="center">Неудовлетворител</p> <p>Student has no idea of the chemical nature of material objects and is not able to apply them in solving practical problems in their professional activities in the field of biology, geology, geography and related sciences.</p> <p align="center">Удовлетворительн</p> <p>Know: - basic laws of chemistry; have an idea of the modern structure of the atom, the structure of matter; chemical properties of the main classes of inorganic compounds; have an idea of the direction of the chemical reaction, the state of chemical equilibrium and the conditions for its displacement. - theoretical foundations of analytical chemistry; the law of action of the masses; Ostwald's dilution law; mathematical expression of hydrogen and hydroxyl indicators, ionic strength of a solution; balance between liquid and solid phases; solubility product; ways of expressing the concentration of solutions; calculations in titrimetric methods of analysis.</p> <p align="center">Хорошо</p> <p>Know: - basic laws of chemistry; have an idea of the modern structure of the atom, the structure of matter; chemical properties of the main classes of inorganic compounds; have an idea of the direction of the chemical reaction, the state of chemical equilibrium and the conditions for its displacement. - theoretical foundations of analytical chemistry; the law of action of the masses; Ostwald's dilution law; mathematical expression of hydrogen and hydroxyl indicators, ionic strength</p>

Компетенция (индикатор)	Планируемые результаты обучения	Критерии оценивания результатов обучения
	<p>- to carry out basic operations to conduct a qualitative analysis using a semi-micro method; calculate the amount of substance required to prepare a solution with a given concentration; carry out calculations related to the transition from one concentration to another; use measuring utensils; prepare and fill in the burette correctly; choose a suitable indicator; correctly count the titrant volume; calculate the results of titrimetric determinations.</p> <p>Acquire skills: in the implementation of a qualitative analysis of an unknown substance; in determining the alkalinity and total hardness of water; in calculating the results of quantitative determinations; in solving computational problems; in the presentation of the analysis results and in the correct maintenance of the work log.</p>	<p>Хорошо of a solution; balance between liquid and solid phases; solubility product; ways of expressing the concentration of solutions; calculations in titrimetric methods of analysis.</p> <p>Be able to: - draw up equations for exchange chemical reactions, redox reactions and complexation reactions; carry out calculations according to the equations of chemical reactions (calculate the mass of a substance, the mass of a solution, the concentration of a solute in a solution, the pH of a solution), problems with an excess or deficiency of a substance, using gas laws.</p> <p>- to carry out basic operations to conduct a qualitative analysis using a semi-micro method; calculate the amount of substance required to prepare a solution with a given concentration; carry out calculations related to the transition from one concentration to another; use measuring utensils; prepare and fill in the burette correctly; choose a suitable indicator; correctly count the titrant volume; calculate the results of titrimetric determinations.</p> <p>Отлично Know: - basic laws of chemistry; have an idea of the modern structure of the atom, the structure of matter; chemical properties of the main classes of inorganic compounds; have an idea of the direction of the chemical reaction, the state of chemical equilibrium and the conditions for its displacement. - theoretical foundations of analytical chemistry; the law of action of the masses; Ostwald's dilution law; mathematical expression of hydrogen and hydroxyl indicators, ionic strength of a solution; balance between liquid and solid phases; solubility product; ways of expressing the concentration of solutions; calculations in titrimetric methods of analysis.</p> <p>Be able to: - draw up equations for exchange chemical</p>

Компетенция (индикатор)	Планируемые результаты обучения	Критерии оценивания результатов обучения
		<p style="text-align: center;">Отлично</p> <p>reactions, redox reactions and complexation reactions; carry out calculations according to the equations of chemical reactions (calculate the mass of a substance, the mass of a solution, the concentration of a solute in a solution, the pH of a solution), problems with an excess or deficiency of a substance, using gas laws.</p> <p>- to carry out basic operations to conduct a qualitative analysis using a semi-micro method; calculate the amount of substance required to prepare a solution with a given concentration; carry out calculations related to the transition from one concentration to another; use measuring utensils; prepare and fill in the burette correctly; choose a suitable indicator; correctly count the titrant volume; calculate the results of titrimetric determinations.</p> <p>Acquire skills: in the implementation of a qualitative analysis of an unknown substance; in determining the alkalinity and total hardness of water; in calculating the results of quantitative determinations; in solving computational problems; in the presentation of the analysis results and in the correct maintenance of the work log.</p>

Оценочные средства текущего контроля и промежуточной аттестации

Схема доставки : Базовая

Вид мероприятия промежуточной аттестации : Зачет

Способ проведения мероприятия промежуточной аттестации : Оценка по дисциплине в рамках промежуточной аттестации определяется на основе баллов, набранных обучающимся на контрольных мероприятиях, проводимых в течение учебного периода.

Максимальное количество баллов : 100

Конвертация баллов в отметки

«отлично» - от 81 до 100

«хорошо» - от 61 до 80

«удовлетворительно» - от 48 до 60

«неудовлетворительно» / «незачтено» менее 48 балла

Компетенция (индикатор)	Мероприятие текущего контроля	Контролируемые элементы результатов обучения
ОПК.1.1 Имеет представление о научной картине мира на основе положений, законов и закономерностей естественных наук	Examination in chemical thermodynamics and kinetics Письменное контрольное мероприятие	Types of chemical reactions. Thermodynamics of physical and chemical processes. Thermochemistry. Enthalpy of the system. Entropy. Gibbs free energy of the system. Kinetics of chemical processes. Chemical reaction rate. Activation energy. Catalysis. LeChatelier's principle.

Компетенция (индикатор)	Мероприятие текущего контроля	Контролируемые элементы результатов обучения
<p>ОПК.1.1 Имеет представление о научной картине мира на основе положений, законов и закономерностей естественных наук</p>	<p>Aqueous solutions of electrolytes Письменное контрольное мероприятие</p>	<p>Knowledge of the general properties of solutions; concepts of strengths and weaknesses electrolytes, solubility; degrees and constants of dissociation of weak electrolytes; Ostwald's law; fundamentals theories of dilute strong electrolytes, activity and activity coefficient; ionic product of water and hydrogen index (pH); solubility products; hydrolysis of salts; dissociation constants of complex ions; ion exchange; oxidation state. Ability to write equations for the processes of ion hydration and electrolytic dissociation of electrolytes; calculate the degree of dissociation of a weak electrolyte and the concentration of ions in this electrolyte; calculate the ionic strength of the solution and the activity of ions in a strong electrolyte solution; calculate the pH of solutions of weak acids and bases, strong acids and alkalis; determine the pH of the solution using indicators; calculate the solubility and solubility product of poorly soluble compounds; write the equation for the hydrolysis of a particular salt; calculate the degree of hydrolysis and concentration of hydrogen and hydroxide ions; write the equations of the stepwise dissociation of complex ions and the dissociation constant.</p>
<p>ОПК.1.1 Имеет представление о научной картине мира на основе положений, законов и закономерностей естественных наук</p>	<p>Redox processes Письменное контрольное мероприятие</p>	<p>The oxidation state of the element. Dependence of the oxidation states of elements on their position in the periodic system of D.I. Mendeleev. Atomic transfer reactions. Electron transfer reactions. Redox reactions. Oxidizing agent. Reducing agent. Disproportionation. Direction of redox reactions. Oxidation-reduction potentials.</p>

Компетенция (индикатор)	Мероприятие текущего контроля	Контролируемые элементы результатов обучения
<p>ОПК.1.1 Имеет представление о научной картине мира на основе положений, законов и закономерностей естественных наук</p>	<p>The structure of the atom. Periodic Table of Chemical Elements. Chemical bond Письменное контрольное мероприятие</p>	<p>Periodic law. Electronic structures of atoms. Orbital filling order. Pauli exclusion principle. Gund's rule. Effective charge of the nucleus. The structure of the periodic table. Periodicity of properties. Ionization energy. Electron affinity. Electronegativity. Orbital radii of atoms and ions. The nature of the chemical bond. Covalent, ionic, metallic bond. Polar and non-polar covalent bond. Molecular orbital theory. Order, length, bond energy. The theory of valence bonds. Donor-acceptor interaction. Oxidation state and coordination number of the central atom. Spatial configuration of molecules. Coordination number of the central atom of the molecule (complex). The main types of polyhedra. Repulsion model of valence localized electron pairs. Repulsion of electron pairs and the spatial configuration of the molecule. Valence angles. Simple and multiple links. The main types of interaction of molecules. Forces of intermolecular interaction. Hydrogen bond. Donor-acceptor mechanism of covalent bond formation. Aggregate state of matter. The chemical structure of a solid. Amorphous and crystalline state of matter. Crystals. Crystalline lattices. Metallic bond.</p>
<p>ОПК.1.1 Имеет представление о научной картине мира на основе положений, законов и закономерностей естественных наук</p>	<p>Control event Письменное контрольное мероприятие</p>	<p>Laws of chemistry. Classes of compounds and laws of chemistry, kinetics and thermodynamics, solutions, RedOx.</p>
<p>ОПК.1.1 Имеет представление о научной картине мира на основе положений, законов и закономерностей естественных наук</p>	<p>Complex compounds Письменное контрольное мероприятие</p>	<p>Understanding of chemistry laws and general aspects of inorganic chemistry. Main classes and their reactivity. Properties of elements, compounds, mixtures and solutions.</p>

Компетенция (индикатор)	Мероприятие текущего контроля	Контролируемые элементы результатов обучения
ОПК.1.1 Имеет представление о научной картине мира на основе положений, законов и закономерностей естественных наук	Laboratory work report Итоговое контрольное мероприятие	Understanding of chemistry laws. Properties of elements, compounds, mixtures and solutions.
ОПК.1.1 Имеет представление о научной картине мира на основе положений, законов и закономерностей естественных наук	Final control Итоговое контрольное мероприятие	Possession of the skills of conducting a chemical experiment, elementary calculations. Ability to analyze and summarize results.

Спецификация мероприятий текущего контроля

Examination in chemical thermodynamics and kinetics

Продолжительность проведения мероприятия промежуточной аттестации: **2 часа**

Условия проведения мероприятия: **в часы самостоятельной работы**

Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **20**

Проходной балл: **9**

Показатели оценивания	Баллы
The correct answer to question number 4	9
The correct answer to question number 3	6
The correct answer to question number 2	3
The correct answer to question number 1	2

Aqueous solutions of electrolytes

Продолжительность проведения мероприятия промежуточной аттестации: **2 часа**

Условия проведения мероприятия: **в часы аудиторной работы**

Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **10**

Проходной балл: **5**

Показатели оценивания	Баллы
The correct answer to question number 2	5
The correct answer to question number 1	5

Redox processes

Продолжительность проведения мероприятия промежуточной аттестации: **2 часа**

Условия проведения мероприятия: **в часы аудиторной работы**

Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **10**

Проходной балл: **5**

Показатели оценивания	Баллы
-----------------------	-------

The correct answer to question number 2	5
The correct answer to question number 1	5

The structure of the atom. Periodic Table of Chemical Elements. Chemical bond

Продолжительность проведения мероприятия промежуточной аттестации: **1 часа**

Условия проведения мероприятия: **в часы аудиторной работы**

Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **10**

Проходной балл: **5**

Показатели оценивания	Баллы
The correct answer to question number 2	5
The correct answer to question number 1	5

Control event

Продолжительность проведения мероприятия промежуточной аттестации: **4 часа**

Условия проведения мероприятия: **в часы самостоятельной работы**

Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **10**

Проходной балл: **5**

Показатели оценивания	Баллы
Solving practical problem	5
Theoretical question answer	5

Complex compounds

Продолжительность проведения мероприятия промежуточной аттестации: **2 часа**

Условия проведения мероприятия: **в часы самостоятельной работы**

Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **10**

Проходной балл: **5**

Показатели оценивания	Баллы
Theoretical question answer	5
Solving practical problem	5

Laboratory work report

Продолжительность проведения мероприятия промежуточной аттестации: **2 часа**

Условия проведения мероприятия: **в часы аудиторной работы**

Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **10**

Проходной балл: **5**

Показатели оценивания	Баллы
A report on laboratory work is written and protected	5
Successfully completed laboratory work	5

Final control

Продолжительность проведения мероприятия промежуточной аттестации: **8 часа**

Условия проведения мероприятия: **в часы самостоятельной работы**

Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **20**

Проходной балл: **9**

Показатели оценивания	Баллы
The correct answer to question number 4	9
The correct answer to question number 3	6
The correct answer to question number 2	3
The correct answer to question number 1	2

Вид мероприятия промежуточной аттестации : Экзамен

Способ проведения мероприятия промежуточной аттестации : Оценка по дисциплине в рамках промежуточной аттестации определяется на основе баллов, набранных обучающимся на контрольных мероприятиях, проводимых в течение учебного периода.

Максимальное количество баллов : 100

Конвертация баллов в отметки

«отлично» - от 81 до 100

«хорошо» - от 61 до 80

«удовлетворительно» - от 44 до 60

«неудовлетворительно» / «незачтено» менее 44 балла

Компетенция (индикатор)	Мероприятие текущего контроля	Контролируемые элементы результатов обучения
------------------------------------	--	---

Компетенция (индикатор)	Мероприятие текущего контроля	Контролируемые элементы результатов обучения
<p>ОПК.1.1 Имеет представление о научной картине мира на основе положений, законов и закономерностей естественных наук</p>	<p>Test Work on Solving Problems Письменное контрольное мероприятие</p>	<p>Knowledge of the general properties of solutions; concepts of strengths and weaknesses electrolytes, solubility; degrees and constants of dissociation of weak electrolytes; Ostwald's law; fundamentals theories of dilute strong electrolytes, activity and activity coefficient; ionic product of water and hydrogen index (pH); solubility products; hydrolysis of salts; dissociation constants of complex ions; ion exchange; oxidation state. Ability to write equations for the processes of ion hydration and electrolytic dissociation of electrolytes; calculate the degree of dissociation of a weak electrolyte and the concentration of ions in this electrolyte; calculate the ionic strength of the solution and the activity of ions in a strong electrolyte solution; calculate the pH of solutions of weak acids and bases, strong acids and alkalis; determine the pH of the solution using indicators; calculate the solubility and solubility product of poorly soluble compounds; write the equation for the hydrolysis of a particular salt; calculate the degree of hydrolysis and concentration of hydrogen and hydroxide ions; write the equations of the stepwise dissociation of complex ions and the dissociation constant.</p>
<p>ОПК.1.1 Имеет представление о научной картине мира на основе положений, законов и закономерностей естественных наук</p>	<p>Test Work on Solving Problems Письменное контрольное мероприятие</p>	<p>Determination of cations and anions. Basics of Gravimetric analysis. Applications and laws.</p>
<p>ОПК.1.1 Имеет представление о научной картине мира на основе положений, законов и закономерностей естественных наук</p>	<p>Test Work on Solving Problems Письменное контрольное мероприятие</p>	<p>Titrimetric method of analysis. Analytical signal. The use of indicators when performing the quantitative determination of a substance. Alkalimetry, acidimetry. Acid-base Titration, Complexometric Titrations, Redox Titration, Precipitation Titrations, Calculations in Titrimetry.</p>

Компетенция (индикатор)	Мероприятие текущего контроля	Контролируемые элементы результатов обучения
ОПК.1.1 Имеет представление о научной картине мира на основе положений, законов и закономерностей естественных наук	Final control Письменное контрольное мероприятие	Possession of the skills of conducting a chemical experiment, elementary calculations. Ability to analyze and summarize results.

Спецификация мероприятий текущего контроля

Test Work on Solving Problems

Продолжительность проведения мероприятия промежуточной аттестации: **2 часа**

Условия проведения мероприятия: **в часы самостоятельной работы**

Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **20**

Проходной балл: **9**

Показатели оценивания	Баллы
The correct answer to question number 4	9
The correct answer to question number 3	6
The correct answer to question number 2	3
The correct answer to question number 1	2

Test Work on Solving Problems

Продолжительность проведения мероприятия промежуточной аттестации: **2 часа**

Условия проведения мероприятия: **в часы самостоятельной работы**

Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **20**

Проходной балл: **9**

Показатели оценивания	Баллы
The correct answer to question number 4	9
The correct answer to question number 3	6
The correct answer to question number 2	3
The correct answer to question number 1	2

Test Work on Solving Problems

Продолжительность проведения мероприятия промежуточной аттестации: **2 часа**

Условия проведения мероприятия: **в часы самостоятельной работы**

Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **40**

Проходной балл: **17**

Показатели оценивания	Баллы
The correct answer to question number 5	10
The correct answer to question number 4	10
The correct answer to question number 3	7

The correct answer to question number 6	6
The correct answer to question number 2	4
The correct answer to question number 1	3

Final control

Продолжительность проведения мероприятия промежуточной аттестации: **2 часа**

Условия проведения мероприятия: **в часы самостоятельной работы**

Максимальный балл, выставляемый за мероприятие промежуточной аттестации: **20**

Проходной балл: **9**

Показатели оценивания	Баллы
Correct solution of second practical problem	9
Correct solution of first practical problem	6
Correct answer to second theoretical question	3
Correct answer to first theoretical question	2