INTERNATIONAL EUROPEAN UNIVERSITY

«APPROVED»

The Head of Admission committee

_____ SERGIY KURILO

«__» _____ 2020

PROGRAM
Chemistry
Admission exam for foreign citizens

Kyiv – 2020

The main purpose of the program is objective and unbiased assessment of the educational achievements of people who have completes a comprehensive educational institution and have expressed their desire to enter a private institution of higher education International European University.

The task of chemistry assessment is to assess the knowledge and skills of the participants, namely:

- The ability to use the names and symbols of chemical elements, the names of simple and complex substances;
- The ability to write chemical formulas and equations of chemical reactions, to solve experimental and numerical tasks;
- Understanding of the relationship between composition, structure, physical and chemical properties of substances, methods of their extraction, field of application;
- Understanding of the scientific foundations of certain chemical production;
- Awareness of some environmental problems, understanding of the role of chemistry in solving global problems of mankind.

The Program of entering assessment on chemistry is developed on the base of current chemistry curriculum for grades 7-9 and grades 10-11 of general education institutions, electronic version of which are available on the official website of the Ministry of Education and Science (*www.mon.gov.ua*).

The chemistry program is oriented on the state requirements for the general education level. It is important not only for the student to master the chemical concepts, laws, theories, but also the meaningful use of their knowledge and the formulation of evaluative judgment.

The material of the program is divided into four thematic blocks: **«General Chemistry», «Inorganic Chemistry», «Organic Chemistry» and «Calculations in Chemistry»**, which in turn are divided into relations and topics. Each thematic section lists the knowledge that the entrants need to possess. The requirements are listed in the column «*Subjects Skills and Learning Tools*» for each topic.

The results are drawn up by the protocol of the meeting of the working group for the admission of foreign citizens for study at International European University.

The names of the compounds correspond to the latest IUPAC recommendations. The abbreviation «STP» means standard conditions for temperature and pressure (temperature 0 °C, pressure 101.3 kPa or 760 mmHg) is used in the program. To indicate the thermal effect of the reaction, the symbol «ΔH» should be used. The reference tables: «Periodic Table of Chemical Elements of D.I. Mendeleev»,

«Solubility of acids, salts, bases and amphoteric hydroxides in water at 20-25 °C», «References» is recommended to use during the preparation to the test.

Program of an entering exam of Chemistry

№	Section and topics	Knowledge	Subjects and methods of educational activity
		1. General chemistry	
1.1	Basic chemical concepts. Substance	Matter, physical body, material, simple substance (metal, non-metal), complex substance, chemical element; the smallest particles of matter – atom, molecule, ion (cation, anion). Composition of the substance (qualitative, quantitative). Valence of the chemical element. Chemical and structural formulas. Physical phenomenon. Relative atomic and molecular masses, molar mass, amount of matter. Units of measurement of the amount of substances, molar mass, molar volume; values of temperature and pressure which correspond to normal conditions; molar volume of gas. Avogadro's Law; Avogadro's number; average relative molecular mass of gas mixture, air. The mass fraction of the element in the compound.	Write formulae of compounds based on valences of elements. Record structural chemical formulas of substances. To distinguish physical bodies and substances; simple and complex substances; elements and simple substances; metals and non-metals; atoms, molecules and ions (cations, anions); physical and chemical properties of the substance; physical phenomena and chemical reactions; the simplest and most accurate formula for the compound. Determine the valence of elements in binary compounds. Analyze the qualitative (elemental) and quantitative composition of matter according to its chemical formula.
1.2	Chemical reaction	Chemical reaction, reaction scheme, chemical equation. Laws of conservation of mass of substances during the chemical reaction, volume correlations of gases in the chemical reaction. Effects that accompany chemical reactions. The term oxidizer, reducing agent, oxidation, recovery. Types of chemical reactions. The rate of the chemical reaction. Catalyst.	Record reaction schemes, chemical equations. To distinguish types of reactions by the number of reagents and products (addition reaction, decomposition, exchange, substitutions), change in the degree of oxidation of the elements (reduction-oxidation and non-oxidation-reduction reactions), thermal effects (reactions exothermic, endothermic), direction of the reaction (reversible and irreversible reactions). Determine oxidizing and reducing agents oxidation-reduction reactions, oxidation and reduction processes. To analyze the influence of the concentration of reagents, temperature, catalyst on the rate of

			chemical reaction. Apply the las of preserving the mass of substances to convert the reaction scheme to the chemical equation.
1.3	Periodic law and periodic system of chemical elements of D.I. Mendeleev	Periodic law (modern formulation). Structure of short and long variants of the periodic system; periods, groups, subgroups (main, side). Sequential (atomic) element number, placement of metallic and non-metallic elements in the periodic system, periods and groups; alkaline, alkaline earth, inert elements, halogens.	To distinguish periods, groups, main and secondary subgroups; metallic and non-metallic elements according to their position in the periodic system. Use information contained in the periodic system to determine the type of elements (metallic or non-metallic elements), the maximum value of its valence, the type of simple substance (metal or non-metal), the chemical nature of oxides, hydroxides, and compounds of elements with Hydrogen. Analyze changes in the properties of simple substances depending on the position of elements in periods, subgroups, during the transition from one period to another.
1.4	Atomic structure	The composition of the atom (nucleus, electron shell). Nucleon, nuclide, isotopes, proton number, nucleon number, orbital, energy level and sublevel, coupled and unpaired electrons, radius of atom (simple ion); the main and excited stated of the atom. The essence of the phenomenon of radioactivity. Forms s- and p-orbitals, placement of p-orbitals in space. The sequence of electron filling of energy levels and sublevels in the atoms of elements number 1-20, electronic and graphic formulas of atoms and simple ions of elements No. 1-20.	To write electronic and graphic formulas of atoms and simple ions of elements No. 1-20, atoms of non-metallic elements of the 2^{nd} and 3^{rd} periods in the excited state. To determine the composition of the nuclei (the number of protons and neutrons in the nuclide) and the electron shell (energy levels and sublevels) of the atoms of elements 1-20. Compare radii of atoms and simple ions.
1.5	Chemical bond	The main types of chemical bonds (ionic, covalent, hydrogen, metallic). Characteristics of covalent bond – multiplicity, energy, polarity. Types of crystal lattices (atomic, molecular, ionic, metallic); dependence of physical properties of a substance on the type of crystal lattices. Electronegativity. The degree of oxidation of an element in a substance.	Compose electronic formulas of molecules, chemical formulas of compounds according to the stages of oxidation of elements, charges of ions. Distinguish the valence and the oxidation degree of the element. Calculate the oxidation degree of the element in the compound. Determine the multiplicity, polar or nonpolar covalent bond between atoms. To predict the type of chemical bond in the compound, the physical properties of the

			substance, taking into account the type of crystalline lattice.
1.6	Mixture of substances. Solutions	Mixtures and homogeneous (solutions) and inhomogeneous (suspension, emulsion, foam, aerosol). Mass and volumetric (for gas) fraction of the substance in the mixture. Methods of separation of mixtures (settling, filtration, centrifugation, evaporation, distillation). Concept solution, solvent, dissolved substance, crystalline hydrate, electrolytic dissociation, electrolyte, non-electrolyte, degree of electrolytic dissociation, ion-molecular equation. Mass fraction of dissolved substance in solution. Structure of molecule of water; hydrogen bond in water. Coloring of indicators (universal, litmus, phenolphthalein, methylorange) in acidic, basic and neutral media. Exchange reactions between electrolytes in a solution	To draw up the schemes of electrolytic dissociation of bases, acids, salts; ion-molecular equations for molecular equations and molecular equations by ion-molecular equations. To distinguish homogeneous and heterogeneous mixtures of different types; dilute, concentrate, saturates, unsaturated solutions; electrolytes and non-electrolytes, strong and weak electrolytes. Determine the possibility of an exchange reaction between electrolytes in a solution. To analyze the influence of the structure of substances, temperature, pressure (for gases) on their solubility in water; mechanisms for the formation of ions in the dissolution of ion and molecular structure electrolytes in water. Apply knowledge to choose the method of separating a homogeneous or heterogeneous mixture of substances.
2. Inorganic Chemistry			
2.1 Main classes of inorganic compounds			
2.1.1	Oxides	Definition, nomenclature, classification of oxides, chemical properties of salt-forming oxides, methods of preparation of oxides	Write chemical formulas of oxides; equations of reactions that characterize the chemical properties of salt-forming oxides (interaction with water, oxides, acids, alkalis), methods of preparation of oxides (the interaction of simple and complex substances with oxygen, the decomposition of insoluble bases, some acids and salts during heating). Naming of oxides according to their chemical formulas. Determine the formulas of oxides among the formulas of compounds of other studied classes. Distinguish non-salt forming (CO, N_2O, NO, SiO) and salt-forming oxides (acidic, basic, amphoteric). Compare basic, acidic and amphoteric oxides by chemical properties of oxides on the type of

			element and the chemical bond in the compound.
2.1.2	Bases	Definition, nomenclature, classification, chemical properties, methods of preparation of bases	Write chemical formulas of bases; equations of reactions that characterize the chemical properties of alkalis (interaction with acidic oxides, acids and salts in solution) and insoluble bases (acid interaction, decomposition during heating), methods of obtaining alkalis (interaction of alkaline and alkaline earth metals with water, basic alkali, and alkaline earth elements with water) and insoluble bases (interaction of salts with alkalis in solution). Naming of the bases according to their chemical formulas. Define formulas of bases among formulas of compounds of other studied classes. Difference between soluble (alkali) and insoluble bases. Compare the chemical properties of soluble (alkali) and insoluble bases.
2.1.3	Acids	Definition, names, classification, chemical properties, methods of obtaining acids	Write chemical formulas of acids; equations of reactions that characterize the chemical properties of acids (interaction with metals, basic oxides, bases and salts in solution) and methods of their extraction (interaction of acid oxides with water, non-metals with hydrogen, salts with acids). Determine the formula of acids among the formulas of compounds of other classes, the valence of the acid residue by the acid formula. Classification of acids oxygen-containing, nonoxygenic, the ability to undergo the electrolytic dissociation (strong, weak) and basicity.
2.1.4	Salts	Definition (general and in terms of electrolytic dissociation), names, classification, chemical properties, methods of obtaining salts	Write chemical formulas of medium and acidic salts; chemical reactions that characterize the chemical properties of medium salts (interaction with metals, acids-hydrochloric, sulphuric, nitric, alkalis, salts in solution) and methods for their preparations (interaction of acids with metals,

			basic oxides with acids, acid oxides with alkali, alkali from acids, salts with alkali, acid oxides with basic oxides, salts with salts, salts with metals (reaction carried out in solution), metals from non-metals. Naming the formulas of medium and acidic salts among formulas of compounds of other studied classes.
2.1.5	Amphoteric compounds	The phenomenon of amphoteric (on examples of oxides and hydroxides); chemical properties, methods of obtaining amphoteric hydroxides	Write equations of chemical reactions that characterize the chemical properties of oxides and hydroxides of Aluminium and Zinc hydroxides (interaction of the salts of these elements with alkalis in solution, aluminates and zincates with acids).
2.1.6	Genetic links between classes of inorganic compounds		Write the equation of reactions between inorganic compounds of different classes. Compare the chemical properties of oxides, bases, acids, amphoteric hydroxides, salts. Estimate connections between the composition and chemical properties of oxides, acids, bases, amphoteric hydroxides, salts; genetic connections between simple substances, oxides, bases, acids, amphoteric hydroxides, salts.
2.2 Metallic elements and their compounds. Metalls			
2.2.1	General information about elements and metals	The position of metal elements in the periodic system; features of electronic structure of atoms of metal elements; features of the metal connection; general physical and chemical properties of metals, general methods of their extraction; series of activity of metals; the phenomenon or corrosion, methods of protecting metals from corrosion; Alloys based on iron (iron, steel).	Determine the position of metallic elements in the periodic system. To describe the metallic bond, metal crystalline lattices, physical properties of metals. To find the difference between metallic and nonmetallic elements according to the electronic structure of atoms. Write symbols of metallic elements – Lithium, Sodium, Magnesium, Aluminium, Potassium, Calcium, Ferum; the equations of reactions that characterize the chemical properties of metals (interaction with oxygen, halogens, sulfur, water, solution of acids, alkalis and salts) and methods of their extraction (reduction of oxides by coke, carbon (II) oxide, hydrogen,

			metallothermia (aluminothermia)); equations of reactions occurring during the production of pig iron and steel. Explain the dependence of the chemical activity of metals on the electronic structure of their atoms; the essence of corrosion of metals; chemical transformation during the production of pig iron and steel. To predict the possibility of chemical reactions of metals with water, solutions of acids, salts and alkalis.
2.2.2	Alkaline and alkaline earth elements	Chemical properties of sodium, potassium, magnesium, calcium; names and formulas of the most important compounds of alkaline and alkaline earth elements; the application of sodium, potassium, magnesium, calcium compounds; chemical formulas and names of the most important potassium fertilizer; hardness of water.	Characterize the position of sodium, potassium, magnesium, calcium in the periodic system, physical properties of sodium and potassium, magnesium and calcium, types of water hardness – temporary, or carbonate; permanent, general; the use of magnesium oxide and calcium, sodium hydroxide, potassium, magnesium and calcium. Write electronic formulas of atoms and ions of sodium, potassium, magnesium, calcium; equations of reactions that characterize the chemical properties of sodium, potassium, magnesium, calcium (interaction with oxygen, halogens, sulfur, water), oxides and hydroxides of sodium, potassium, magnesium, calcium; equations of reactions used to reduce or eliminate the hardness of water (boiling, adding soda or lime).
2.2.3	Aluminium	Chemical properties, producing and application of aluminium; names and formulas of the most important Aluminium compounds.	Characterize the position of aluminium in the periodic system, the physical properties of aluminium, Aluminium oxide and hydroxide, the use of aluminium. Write electronic configuration of the atom and ion of aluminium; the equations of reactions that characterize the chemical properties of aluminium (interaction with oxygen, halogens, Sulphur, acid solutions, alkalis and salts), amphotericity of the oxide and hydroxide Aluminium

			(interaction with the main and acid oxides, acids and alkalis).
2.2.4	Iron	Chemical properties and extraction of iron; names and formulas of the most important compounds of the iron; application of iron and iron compounds.	Characterize the position of the Iron in the periodic system, the physical properties of iron, oxides and hydroxides of the iron; application of iron and iron compounds; the physiological role of the ferromagnetic ions. To write the electronic formula of the iron atom; equations of reactions that characterize the chemical properties of iron (interaction with oxygen, chlorine, sulfur, water vapor, solutions of acids and salts, rust), oxides and hydroxides of the iron (interaction with acids), iron salts (interaction with solutions of alkalis, acids, salts), interconversion of the compounds of the iron (II) and of the iron (III).
2.3 Non-metallic elements and their compounds. Nonmetals			
2.3.1	Halogens	Chemical formulas of fluorine, chlorine, bromine, iodine; chemical formulas, names and physical properties of the most important compound of halogens (hydrogen chloride, halides of metallic elements); methods of obtaining in the laboratory and chemical properties of hydrogen chloride and hydrochloric acid; the most important branches of chlorine application, hydrogen chloride, chloride acid; qualitative reaction for the detection of chloride ions.	Write equations of characteristic reactions of chlorine (interaction with metals, non-metals, water), hydrogen chloride and hydrochloric acid (interaction with metals, basic oxides, bases, amphoteric compounds, salts); hydrogenation reactions of chloride. Compare the chemical activity of halogens. To characterize the most important applications of chlorine (as an oxidant, in the production of organic and inorganic substances), hydrogen chloride, hydrochloric acid (in the manufacture of plastics, for the production of chlorides), chlorides (sodium chloride 0 food condiments for the production of chlorine, sodium hydroxide, soda).
2.3.2	Oxygen and sulphur	Chemical formulas of oxygen, ozone, sulphur and the most important compounds of Oxygen and Sulfur; physical and chemical properties of oxygen, ozone, sulphur, sulphur oxides, sulphuric acid; sulphates; preparation of oxygen in the laboratory; application of oxygen, ozone, sulphur, sulphur-	Write the equation of reactions of oxygen with metals, non-metals, compounds of nonmetallic elements with Hydrogen, reactions of sulphur (interaction with metals, some nonmetals), sulphur oxides (interaction with water, basic oxides, bases), sulphuric acid

		containing compounds; qualitative reaction for the detection of sulphate ions.	(interaction with metals, basic oxides, bases, amphoteric compounds, salts); Compare composition and chemical activity of oxygen and ozone. To characterize he most important branches of oxygen use (as an oxidizer), ozone (disinfection of water), sulphur (preparation of sulphuric acid, production of rubber, matches, cosmetics), sulphuric acid (production of mineral fertilizers, fibers) and sulphates (gypsum in construction), medicine; copper sulphate – for the control of plant pests, etching of wood). Apply knowledge to choose how to detect oxygen and sulphate ions (in solution).
2.3.3	Nitrogen and Phosphorus	Chemical formulas of nitrogen, white and red phosphorus, the most important compounds of Nitrogen and Phosphorus; Physical and chemical properties of nitrogen, white and red phosphorus, nitrogen (II) oxide, nitrogen (IV) oxide, phosphorus (V) oxide, ammonia, ammonium salts, nitric acid, nitrates, orthophosphate acid, orthophosphates; methods for producing ammonia, nitrate and orthophosphate acids in the laboratory; the most important branches of nitrogen, ammonia, nitric acid, nitrates, orthophosphoric acid, orthophosphates; qualitative reactions for the detection of ammonium ions and orthophosphate ions.	Write the equations of reactions of nitrogen and phosphorus (interaction with metals, some nonmetals), ammonia (interaction with oxygen, water, acids), ammonium salts (interaction with alkalis, salts), nitric acid (interaction with metals, basic oxides, bases , amphoteric compounds, salts), nitrogen (IV) oxide and phosphorus (V) oxide (interaction with water, basic oxides, bases), orthophosphoric acid (interaction with metals, basic oxides, bases, salts); equation of thermal decomposition reactions of ammonium salts (chloride, nitrate, carbonate and hydrogen carbonate) and nitrates; the equation of the ammonia preparation reactions, nitric and orthophosphoric acids in the laboratory. Characterize the composition and structure of phosphorus substances
2.3.4	Carbon and silicon	Simple substances Carbon; adsorption, adsorption properties of activated carbon; chemical formulas of the most important compounds of Carbon and Silicon; physical and chemical properties of carbon, silicon, oxides of carbon, carbonates, silicates (IV) oxide, silicate acid, silicates; methods of	Write the equations of reactions of carbon and silicon (interaction with active metals and nonmetals, oxides of metallic elements), carbon (II) oxide (interaction with oxygen, metal oxide oxides), carbon (IV) oxide (interaction with water, basic oxides, alkali, carbon),

		obtaining Carbon oxides in the laboratory; allotropy, diamond, graphite, activated carbon, carbon monoxide oxides, carbonates, hydrogen carbonates, silicates (IV) oxides, silicates; qualitative reactions for the detection of carbonate and silicate ions	silicon (IV) oxide (interaction with the basic oxides, alkalis); the thermal decomposition of carbonates and hydrocarbonates, and the preparation of Carbon oxides in the laboratory. Characterize the composition, structure and physical properties of Carbon modifications (graphite, diamond, carbine), application of carbon modifications (diamond - in cutting and grinding tools), graphite (in the manufacture of pencils, electrodes), activated charcoal (in medicine, in gas masks, for purification of water), Carbon oxides (CO as reducing agent, C02 - in the production of soda, sugar, carbonated drinks, filler of fire extinguishers), sodium hydrogen carbonate, calcium carbonate and sodium, silicon (IV) oxide (production of glass, building materials), silicates (porcelain, liquid glass). Apply knowledge to select a method for detecting carbon (IV) oxide, carbonate and silicate ions (in solution).
3. Organic chemistry			
3.1	Theoretical bases of organic chemistry	The most important elements are organogens, organic compounds; natural and synthetic organic compounds.	Determine the most important elemental organogens (C, H, 0, N, S, P). Characteristic features of inorganic and organic compounds, natural and synthetic organic compounds.
		Molecular structure of organic compounds. Chemical bond in organic molecules: energy, length, spatial orientation, polarity, a-bond and ***n***-bond. Single, multiple (double, triple), aromatic bonds.	To characterize the multiplicity, polarity or nonpolarity of covalent bond in molecules of organic compounds, a- and тс-bonds. Compare single, double, triple and aromatic bonds by energy and length and spatial orientation. Analyze the reactivity of organic compounds with different types of bonds.
		Hybridization of the electron orbitals of the Carbon atom; sp^3-, sp^2-, sp-hybridization.	Determine the types of hybridization and spatial orientation of hybrid electronic orbitals of Carbon atoms in organic molecules.

		Classification of organic compounds according to the structure of the carbon chain and the presence of characteristic (functional) groups.	Classify organic compounds according to the structure of the carbon chain to saturated hydrocarbons acyclic structure - alkanes, unsaturated hydrocarbons of acyclic structure - alkenes, alkynes; cyclic hydrocarbons - cycloalkanes and arenes; by the presence of characteristic (functional) groups on alcohols, phenol, halogenoalkanes, aldehydes, carboxylic acids, esters, amines, amino acids.
		The phenomenon of homology; homologues, homologous series, homologous difference. Classes of organic compounds. General formulas of homologous series and classes of organic compounds.	Determine homologues of hydrocarbons and their derivatives. Separate homologous series and classes of organic compounds. Establish correspondences between representatives of homologous series and their general formulas, classes of organic compounds and their characteristic (functional) groups.
		The primary (secondary, tertiary, quaternary) Carbon atom.	Determine in organic molecules of different structure the primary, secondary, tertiary, and quaternary atoms of Carbon.
		Nomenclature of organic compounds	To give names of organic compounds according to the structural formulas, using the nomenclature of IUPAC. Write organic formulas of organic compounds by the name in accordance with the nomenclature IUPAC.
		The phenomenon of isomerism, isomers, structural and spatial (geometric, or cis-trans-) isomerism.	Determine isomers by structural formulas. To distinguish between structural and spatial (geometric, or cis- and trans-) isomers. To distinguish between isomers and homologues for: qualitative and quantitative composition, structure of molecules.
		Mutual influence of atoms or groups of atoms in organic molecules.	Establish a connection between the structure and properties of organic compounds, taking into account the redistribution of electron density on examples of proven (joining of halogens and water in accordance with V. Markovnikov's rule);

			Alcohols (similar to acids); phenol (acidic properties, ability to substitute reactions in the benzene ring); saturated monobasic carboxylic acids (acidic properties), amines (basic properties, aniline's ability to substitution reactions in the benzene ring). Analyze the chemical structure of organic compounds, using the main provisions of the theory of A. Butlerov. To predict the reactivity of organic compounds using the notion of the mutual influence of atoms or groups of atoms in molecules.
		Classification of chemical reactions in organic chemistry (reactions of joining, substitution, isomerization).	Classify reactions involving organic compounds (substitution, addition, splitting, isomerization). Establish connections between the structure of molecules of organic compounds and their ability to react in a certain type.
		3.2 Hydrocarbons	
3.2.1	Alkanes	General formula of alkanes, their nomenclature, isomerism, structure of molecules, physical and chemical properties, methods of extraction, application	To name the first 10 representatives of the homologous series of alkanes in the nomenclature IUPAC. Formulate molecular and structural formulas of alkanes; equations of reactions characterizing the chemical properties of alkanes (substitution reaction on the example of chlorination of methane, complete oxidation of alkanes or partial oxidation of methane, thermal decomposition of methane, cracking, isomerization of alkanes), laboratory method for methane extraction. Explain the phenomenon of sp3-hybridization of the electron orbitals of Carbon atoms in alkanes molecules. Compare the physical properties of alkanes by their boiling and melting temperatures. To substantiate the dependence between the aggregate state under normal conditions, the melting and boiling points of alkanes and their

			relative molecular mass; the ability of alkanes to substitution reactions by the electronic structure of molecules, the use of alkanes (fuel, fuel, solvents, soot, hydrogen, halogenoalkanes) by their properties. Establish connections between the structure of molecules and the properties of alkanes.
3.2.2	Alkenes	General formula of alkenes, their nomenclature, isomerism, structure of molecules, chemical properties, methods of extraction, application; qualitative reactions to double bond.	Determine structural isomers of alkenes according to the structure of the carbon chain, the location of the double bond; intergroup (alkenes and cycloalkanes) and spatial (geometric or cis-trans) isomers. Name the alkenes according to the IUPAC nomenclature. Form molecular, structural alkene formulas; equations of reactions characterizing the chemical properties of ethane and propane (reactions of hydrogen, halogens, halogens, water, polymerization, partial oxidation of ethane and total oxidation of alkenes), industrial and laboratory methods for the extraction of alkenes (thermal cracking of alkenes, dehydrogenation of alkenes, dehydration of saturated monoatomic alcohols, interaction of halogenoalkenes with alcoholic solution of alkali, reactions of alkyns with hydrogen), the production of ethane in the laboratory. Explain the phenomenon of sp2-hybridization of the electron orbitals of Carbon atoms in alkene molecules. Apply knowledge to choose a method for detecting ethene (interaction with bromine water, aqueous solution of potassium permanganate), alkenes (interaction with bromine water). To substantiate the use of alkenes (production of polyethylene,

			polypropylene, ethanol, 1,2-dichloroethane) by their properties. Establish connections between the structure and the ability of alkenes to join reactions. Analyze the addition of halohydrides and water to propene according to the redistribution of electron density in a molecule (V. Markovnikov's rule).
3.2.3	Alkyne	General formula of alkynes, their nomenclature, isomerism, structure of molecules; chemical properties and methods of obtaining ethyne, application; qualitative reactions to the triple bond.	Determine the structural isomers of alkynes in the structure of the carbon chain, the location of the triple bond. Call alkynes by the IUPAC nomenclature. Formulate molecular and structural alkynes; the reaction equation of the reactions characterizing the chemical properties of acetylene (the reaction of the addition of hydrogen, halogens, halogens, water (Kucherov's reaction), the substitution reaction - the interaction with sodium, ammonium solution of silver (I) oxide, acetylene trimerization, complete oxidation of alkenes and partial oxidation of acetylene), industrial and laboratory methods of acetylene extraction (thermal decomposition of methane, interaction of calcium acetylenide with water, reaction of 1,2-dichloroethane with alcoholic solution of alkali). To substantiate the application of acetylene (gas cutting and welding of metals; extraction of vinyl chloride, polyvinyl chloride, acetic aldehyde) due to its properties. Explain the phenomenon of sp-hybridization of the electron orbitals of the Carbon atoms in the molecules of alkenes. Apply knowledge to select the method of detecting acetylene (interaction with bromine water, aqueous solution of potassium permanganate, ammonium solution of silver (I) oxide), alkynes which

			contain C-H bond molecules (interaction with bromine water, ammonium solution of silver (I) oxide).
3.2.4	Aromatic hydrocarbons. Benzene	The general formulas of the arenes of the homologous series of benzene. Structure, properties, methods of obtaining benzene; the naming of aromatics, 6% -electronic system.	Write the molecular and structural formulas of benzene; the equations of reactions characterizing the chemical properties of benzene (the reaction of substitution with halogens, the reaction of joining - hydrogenation and chlorination (hv), oxidation), the production of benzene in the industry (catalytic dehydrogenation of hexane, cyclohexane, acetylene trimerization). To distinguish unsaturated and aromatic hydrocarbons. Explain the phenomenon of sp2 hybridization of the electron orbitals of the Carbon atoms in the benzene molecule, the stability of benzene to the action of oxidants and its ability to substitution reactions. Compare the connections between Carbon atoms in benzene, alkanes and alkenes, reactivity of benzene, alkanes and alkenes in the reactions of substitution and oxidation.
3.2.5	Natural sources of hydrocarbons and their processing	Oil, natural and associated petroleum gases, coal, their composition; cracking and flavoring of oil and petroleum products, detonating stability of gasoline, octane number; coal processing; problems of extraction of liquid fuel from coal and alternative sources	To name products of processing of oil and coal. To give examples of the use of natural hydrocarbon raw materials as sources of organic compounds. Formulate the equations of reactions occurring during the combustion of natural gas. To distinguish between reactions occurring during the cracking and aromatization of hydrocarbons. Compare detonation stability of gasoline based on their octane numbers.
3.3 Oxygen-containing organic compounds			
3.3.1	Alcohol	Characteristic (functional) group of alcohols. Classification of alcohols. The general formula of monoatomic saturated alcohols. Structure, nomenclature, isomerism, properties,	Determine the structural isomers of monoatomic saturated alcohols based on the structure of the carbon chain, the location of the hydroxyl

		methods of extraction and application. Hydrogen bond.	group, and interclass isomers (ethers). To name monoatomic saturated alcohols, as well as ethylene glycol and glycerol in the nomenclature IUPAC. Classify alcohols according to the structure of the carbon chain - saturated, unsaturated, the number of hydro- groups - mono- and polyatomic, the nature of the Carbon atoms with which the hydroxo- group is combined, - primary, secondary, tertiary alcohols. Write molecular, structural alcohols; equations of reactions reflecting the chemical properties of saturated monoatomic alcohols and glycerol (substitution reactions - interaction with active metals, halogen, esterification, intermolecular dehydration, intramolecular dehydration, partial and complete oxidation), industrial methods of producing methanol (synthesis gas), ethanol (hydration of the ethen, enzymatic fermentation of glucose, ethanal recovery) and laboratory methods for obtaining alcohols (hydrolysis of halogenoalkanes). Characterize the composition and structure of molecules of monatomic saturated alcohols. To substantiate the use of ethanol (production of acetic acid, diethyl ether) and methanol (extraction of formaldehyde) by their properties. Compare physical properties (boiling point, solubility in water) of monoatomic saturated alcohols and corresponding alkanes, methanol, ethanol, ethylene glycol and glycerol; Activity of monatomic saturated alcohols, water and inorganic acids in reactions with alkali metals. To establish connections between the electronic structure of molecules of monatomic saturated

			alcohols and their physical and chemical properties.
		Ethylene glycol and glycerol as representatives of polyhydric alcohols; qualitative reaction to polyhydric alcohols	Write reaction equations reflecting the chemical properties of ethylene glycol and glycerol (interaction with sodium, cuprum (II) hydroxide; glycerol (interaction with nitric acid, higher saturated and unsaturated carboxylic acids); extraction of glycerol (rubbing of fats). Establish connections between the structure of molecules of polyhydric alcohols and their properties. Apply knowledge to choose a method for detecting polyhydric alcohols (interaction with cuprum (II) hydroxide).
3.3.2	Phenol	Formula of phenol. The structure of the phenol molecule, the characteristic (functional) group in it; properties, extraction, application; qualitative reactions on phenol	Write molecular, structural formulas of phenol; equations of reactions reflecting the chemical properties of phenol (reactions involving the hydroxyl group - interaction with sodium, sodium hydroxide, reactions involving the benzene ring - interaction with bromine water, nitric acid), its extraction in industry (hydrolysis chlorobenzene). To substantiate the mutual influence of the hydroxyl group and the benzene ring in the phenol molecule. Compare the acidic properties of alcohols, phenol and carbonate acid; the ability of benzene and phenol to the substitution reactions. Establish connections between the structure of the phenol molecule and its properties. Apply knowledge to choose a method for detecting phenol (interaction with iron (III) chloride, bromine water).
3.3.3	Aldehyde	General formula of aldehydes. Structure of aldehyde molecules, characteristic (functional) group, nomenclature, isomerism, properties, extraction, application; qualitative reactions to the aldehyde group.	Determine the structural isomers of aldehydes in the structure of the carbon chain. To name aldehydes with the nomenclature IUPAC. Give examples of the use of ethanal (production of acetic acid,

			ethyl alcohol) and methanal (extraction of formalin, urotropin) by their properties. Formulate the structural formulas of the aldehyde molecules and their structural isomers; equations of reactions reflecting the chemical properties of aldehydes (reduction, partial oxidation), ethanal production in industry (acetylenic hydration by M. Kucherov's reaction) and laboratory (by oxidation of ethanol). Apply knowledge to select a method for detecting aldehydes by quality reactions - interaction with an ammonium solution of silver (I) oxide, copper (II) hydroxide
3.3.4	Carboxylic acid	Characteristic (functional) group of carboxylic acids. Classification of carboxylic acids. The general formula of saturated monobasic carboxylic acids. Structure, nomenclature, isomerism of monobasic carboxylic acids, properties, extraction, application.	Determine structural isomers of saturated monobasic carboxylic acids based on the structure of the carbon chain, interclass isomers (esters). Name the IUPAC range of saturated monobasic carboxylic acids; give trivial names to the first three monobasic carboxylic acids. Classify carboxylic acids in the structure of the carbon chain (saturated, unsaturated), the number of carboxyl groups (one-, two-base) and the number of carbon atoms in their molecules (lower, higher). Formulas of structural isomers of saturated monobasic carboxylic acids; equations of reactions reflecting the chemical properties of carboxylic acids (interaction with active metals, basic oxides, bases, salts of acetic acid, alcohols); methane oxidation reaction (methane oxidation, carbon (II) oxide interaction with sodium hydroxide with subsequent action of chloride acid) and ethanoic acid (oxidation of butane, ethanol, ethanal). To substantiate the ability of lower carboxylic acids to electrolytic dissociation, and their solutions - to

			change the color of the indicators; special chemical properties of methane acid (the ability to oxidation - the interaction with the ammonia solution of the silver (I) oxide, cuprum (II) hydroxide). Compare physical properties (boiling temperature, water solubility) of saturated monobasic carboxylic acids and monoatomic saturated alcohols; acidic properties of carboxylic acids within the homologous range, as well as with alcohols, phenol and inorganic acids. Establish connections between the electronic structure of molecules and the physical and chemical properties of carboxylic acids.
3.3.5	Esters, fats	General formula of carboxylic esters. Structure, nomenclature, isomerism, properties, extraction, application. Fats - esters of glycerol and higher carboxylic acids. Classification of fats, properties, extraction, application. Soaps and synthetic detergents.	Determine the structural isomers of the carboxylic ester by the structure of the carbon chain, interclass isomers (carboxylic acids); structural formulas of fats - trioleine, tristearina; Formulas of salts of palmitic and stearic acids. Name esters in the IUPAC nomenclature. Classify fats on animal and vegetable; solid and liquid. Formulate equations of formation of esters (esterification) and their hydrolysis; equations of reactions that reflect the properties of fats (sapling, hydrogenation). Establish connections between composition, structure of molecules, properties and application of fats. Apply knowledge to choose a way to detect unsaturated liquid fats (interaction with bromine water).
3.3.6	Carbohydrates	Classification of carbohydrates; composition, molecular formulas of glucose, fructose, sucrose, starch and cellulose; structural formula of the open form of the glucose molecule; properties of glucose, sucrose, starch and cellulose; extraction of glucose, production of sucrose and starch; qualitative reactions for determination	Distinguish between mono-, di- and polysaccharides. Provide examples of the use of glucose, starch (ethanol production) and cellulose (the production of artificial acetate silk) by their properties. Formulate reaction equations reflecting the chemical properties

		of glucose and starch; application of glucose, starch, cellulose.	of glucose (complete and partial oxidation, reduction, alcoholic and lactic acid fermentation, esterification, interaction with cuprum (II) without the heating of the hydroxide (without recording the equation of reaction) and with heating), sucrose (complete oxidation, hydrolysis , formation of saccharates), starch (acid and enzymatic hydrolysis) and cellulose (complete oxidation, hydrolysis, esterification - formation of triacetate and trinitrate of cellulose), photosynthesis. To establish the similarity and difference of starch and cellulose in composition, structure of molecules and properties. Apply knowledge to choose a method for detecting glucose (interaction with ammonium solution of argentum (I) oxide, reaction with cuprum (II) hydroxide) and starch (interaction with iodine).
3.4 Nitrogen-containing organic compounds			
3.4.1	Amines	Characteristic (functional) group of amines. Classification of amines. Nomenclature, isomerism, structure, properties, methods of extraction and application.	Determine the structural formulas of isomeric amines in the structure of the carbon chain, the position of the amino group and interspecific isomers (primary, secondary, tertiary amines). Name amines in the IUPAC nomenclature. Classify amines as ammonia derivatives (primary, secondary and tertiary) and in the structure of the carbon chain (saturated, aromatic). Formulate equations of reactions reflecting the chemical properties of saturated amines as organic bases (interaction with water, inorganic acids, combustion); aniline (interaction with inorganic acids, bromine water); Extraction of aniline (reduction of nitrobenzene - reaction of M. Zinin).

			To substantiate the basic properties of saturated amines and aniline; reduction of the basic properties and increase of the reactivity of aniline in the substitution reactions. Compare the basic properties of ammonia, primary, secondary, tertiary saturated amines and aniline.
3.4.2	Amino acids	Composition and structure of molecules, nomenclature, properties, extraction, application of amino acids. The notion of amphoteric amino acids, bipolar ion; di-, tri-, polypeptides, peptide bond (peptide group of atoms)	Name the amino acids in the nomenclature IUPAC. Formulate the structural formulas of the simplest amino acids - glycine (aminothian), alanine (2-aminopropane); equations of reactions reflecting the chemical properties of amino acids by the example of the interaction of aminothic acid and 2-aminopropanoic acid with inorganic acids, bases; the formation of di-, tri-, polypeptides. To substantiate the amphotericity of amino acids, the formation of bipolar ions. Compare the structure of molecules and the chemical properties of amino acids with carboxylic acids and amines.
3.4.3	Proteins	The structure of proteins, their properties, application, color reactions to proteins.	Characterize the processes of hydrolysis, denaturation of proteins. Apply knowledge to choose a way to detect proteins (xanthoprotein and biuret reactions).
3.5 Synthetic high molecular substances and polymeric materials on their basis			
	Synthetic high molecular compounds and polymeric materials based on them	The concept of polymer, monomer, degree of polymerization. Classification of macromolecular substances; methods of synthesis of macromolecular substances; structure and properties of polymers; thermoplastic polymers and plastics on their basis; natural and synthetic rubbers, synthetic fibers; the importance of polymers in the social economy and everyday life.	Classify polymers by the way of obtaining (natural, artificial, synthetic); relation to heating (thermoplastic, thermosetting); structure (linear, branched, mesh). Write the equation of polymerization reactions to the formation of the most important polymers (polyethylene, polypropylene, polystyrene, polyvinylchloride, teflon, phenol formaldehyde resins, polyisoprene, polybutadiene). To distinguish between methods for the formation of

			macromolecular compounds (polymerization and polycondensation). Compare the properties of natural (cotton, flax, silk, wool), artificial (artificial acetate and viscose silk) and synthetic fibers (Capron, lavsan).
3.6 Generalization of knowledge about organic compounds			
	Establishing genetic links between different classes of organic compounds, between organic and inorganic compounds		Compare the chemical properties of organic compounds of different classes. Establish connections between the composition and chemical properties of organic compounds of different classes, between organic and inorganic compounds; genetic links between organic and inorganic compounds. Formulate reaction equations - transformations of organic compounds of different classes.
4. Calculations in chemistry			
4.1	Problem solving by using of chemical formulas, the mass fraction of the element in the compound	Formulas for calculating of the amount of substance, the amount of particles in a certain amount of substance, the mass fraction of the element in the compound, the relative density of gas, the mass (volume) of the component in the mixture, the derivation of the formula of the compound in terms of the mass fraction of elements	Calculate the relative molecular and molar mass of matter; number of particles in a certain amount of substance, mass of matter, volume of gas; the volume of this mass or amount of gas; relative gas density for another gas; mass and volumetric (for gas) particles of substances in the mixture; average molar mass of gas mixture; the mass fraction of the element in the compound according to its formula.
4.2	Expression of the quantitative composition of the solution (mixture)	Mass fraction of the dissolved substance	Calculate the mass fraction of the dissolved substance in the solution, the mass (volume) of the solution and the solvent, the mass of the dissolved substance. Perform calculations to prepare solutions from crystalline hydrates.
4.3	Solving problems by reaction equations	Algorithms for solving problems by the equation of reaction; relative yield of the reaction product	Calculate the chemical reaction of the mass, the volume (for gas) or the amount of substance of the reagent or product by known mass, volume (for gas) or the amount of substance of another reagent or product; relative yield of the reaction product.

			To establish the chemical formula of a substance on the quantitative data on reagents and reaction products. Perform calculations if the substances contain impurities or are present in excess. Solve combined tasks (combining no more than two algorithms).

S = soluble in water
A = soluble in acids, insoluble in water
P = partially soluble in water, soluble in dilute acids (if *reactant*, soluble in water, if *product*, insoluble in
I = insoluble in dilute acids and insoluble in water
a = slightly soluble in acids but insoluble in water
d = decomposes in water

ION	Acetate	Bromide	Carbonate	Chlorate	Chloride	Chromate	Hydroxide	Iodide	Nitrate	Oxide
Aluminum	S	S	-	S	S	-	A	S	S	a
Ammonium	S	S	S	S	S	S	-	S	S	-
Barium	S	S	P	S	S	A	S	S	S	S
Calcium	S	S	P	S	S	S	P	S	S	P
Copper (II)	S	S	-	S	S	-	A	-	S	A
Hydrogen	S	S	-	S	S	-	-	S	S	-
Iron (II)	S	S	P	S	S	-	A	S	S	A
Iron (III)	S	S	-	S	S	A	A	S	S	A
Lead (II)	S	S	A	S	S	A	P	P	S	P
Magnesium	S	S	P	S	S	S	A	S	S	A
Manganese (II)	S	S	P	S	S	-	A	S	S	A
Mercury (I)	P	A	A	S	a	P	-	A	S	A
Mercury (II)	S	S	-	S	S	P	A	P	S	P
Potassium	S	S	S	S	S	S	S	S	S	S
Silver	P	a	A	S	a	P	-	I	S	P
Sodium	S	S	S	S	S	S	S	S	S	S
Strontium	S	S	P	S	S	P	S	S	S	S
Tin (II)	d	S	-	S	S	A	A	S	d	A
Tin (IV)	S	S	-	-	S	S	P	d	-	A
Zinc	S	S	P	S	S	P	A	S	S	P

Recommended Reading List

1. Textbook "Chemistry. Class 7" /auth. Popel P.P., Kryklia L.S./ K: Academy, 2007.
2. Textbook "Chemistry. Class 7" /auth. Yaroshenko O.H./ K: Stanitsa, 2008.
3. Textbook "Chemistry. Class 7" /auth. Burynska N.M./ K: Perun, 2007.
4. Textbook "Chemistry. Class 7" /auth. Lashevska H.A./ K: Heneza, 2007
5. Textbook "Chemistry. Class 8" /auth. Popel P.P., Kryklia L.S./ K: Academy, 2008.
6. Textbook "Chemistry. Class 8" /auth. Yaroshenko O.H./ K: Stanitsa, 2008.
7. Textbook "Chemistry. Class 8" /auth. Burynska N.M./ K: Perun, 2008.
8. Textbook "Chemistry. Class 9" /auth. Burynska N.M., Velychko L.P./ K: Perun, 2009.
9. Textbook "Chemistry. Class 9" /auth. Lashevska H.A./ K: Heneza, 2009.
10. Textbook "Chemistry. Class 9" /auth. Popel P.P., Kryklia L.S./ K: Academy, 2009.
11. Textbook "Chemistry. Class 9" /auth. Yaroshenko O.H./ K: Osvita, 2009.
12. Textbook "Chemistry. Class 10 (standard level, academic level)" /auth. Yaroshenko O.H./ K: Gramota, 2010.
13. Textbook "Chemistry. Class 10 (standard level, academic level)" /auth. Popel P.P., Kryklia L.S./ K: Academy, 2010.
14. Textbook "Chemistry. Class 10 (specialized level)" /auth. Burynska N.M. and others/ K: Pedahohichna dumka, 2010.
15. Textbook "Chemistry. Class 11 (standard level)" /auth. Lashevska H.A., Lashevska A.A./ K: Heneza, 2011.
16. Textbook "Chemistry. Class 11 (standard level)" /auth. Yaroshenko O.H./ K: Gramota, 2011.
17. Textbook "Chemistry. Class 11 (academic level)" /auth. Popel P.P., Kryklia L.S./ K: Academy, 2011.
18. Textbook "Chemistry. Class 11 (academic level)" /auth. Velychko L.P./ K: Osvita, 2011.
19. Modern terminology and nomenclature of organic compounds /auth. Tolmachova V.S., Kovtun O.M., Kornilov M.Y., Hordiienko, Vasylenko S.V./ Ternopil: Navchalna Knyha – Bohdan, 2008.
20. Nomenclature of organic compounds /auth. Tolmachova V.S., Kovtun O.M., Dubovyk O.A., Fitsailo S.S./ Ternopil: Mandrivets, 2011.
21. Collection of tasks for the state final certification in chemistry. Class 9 /auth. Lashevska H.A., Tytarenko N.V./ K: Center of educational materials, 2011.
22. Collection of tasks for the state final certification in chemistry. Class 11 /auth. Dubovyk O.A./ K: Center of educational materials, 2011.
23. Chemistry. Full course. Universal reference for graduate students and applicants /auth. Tytarenko N.V./ K: Letter LTD, 2011.

Knowledge Assessment Criteria

For entering exam of «Chemistry» for foreign citizens

The tasks of the entrance exam in chemistry include issues compiled in accordance with the Chemistry Examination Program for admittance to higher education institutions of Ukraine, approved by the Ministry of Education and Science of Ukraine. At the same time, test tasks are selected so as to cover all sections of the program as fully as possible.

The assessment is conducted using a 200-point scale, based on the fact that the final score consists of an assessment of each individual task (**Table 1**).

According to the structure, the test consists of typical tasks, which are distributed as follows:

1. Task of type I.

22 tasks **(from 1st till 22nd task)** are multi-option tasks with one correct answer from the 4 listed. **Questions 23 and 24** represent a chain of transformation. They are related to general theoretical and practical knowledge of general chemistry, inorganic and organic chemistry.

In the test: from questions 1 to 22 the correct answer is estimated as 6 points, wrong – 0 points; task 23 and 24 (a chain of transformation) the correct answer is estimated as 14 points, wrong – 0 points.

2. Task of type II «*Applying the theoretical knowledge to solve numerical problems*».

Questions such as «*Writing of reduction-oxidation reactions*» (**Task 25**) show the ability to apply the theoretical aspects of reduction-oxidation processes to record the provided reactions. The task offers to the entrant to complete the given equation of the reduction-oxidation reaction and to put the required coefficients using the electronic balance method. Each correct answer is estimated as 20 points. For a significant error, 10 points are removed, and for the insignificant – 5 points. Incorrect answer or its absence – 0 points.

Question «*Solve a numerical problem*» (**Task 26**).

This is a task that contains a calculation task and requires the ability to solve typical and combined tasks from the main sections of chemistry. The task is estimated as follows:

20 points – the chemical reaction is recorded correctly, the problem is solved correctly, and the correct numerical response is given.

15 points – the chemical reaction is recorded correctly, the course of the solution of the problem is correct, but not brought to a numerical value or a mathematical error is assumed.

10 points – the products of the chemical reaction are recorded correctly, but not properly set coefficients, the course of the solution of the problem is correct, but the answer is not correct.

5 points – the task is nor solved to the end, there are one or two correct fragments of the solution (the reaction equitation, he number of substances for the reaction is calculated). No answer – 0 points.

Significant errors (those that affect the quality and value of the response and can significantly reduce its assessment):

- Incorrect application of the basic laws and concepts for the analysis of specific processes: the shift of chemical equilibrium, changes in the rate of reactions;
- Incorrect interpretation of changes in the properties of substances depending on reactions, changes in properties in periods and groups of the periodic system in a series of standard electrode potentials, and others;
- The conditions of the course of chemical reactions that lead to incorrect reproduction of its end products are not specified;
- The corresponding coefficients of reaction are not set out in freely written products;
- Reaction products are incorrectly indicated;
- Incorrect formulation of substances (ignorance of valence or oxidation degree);
- Incorrect compilation of electronic or electron-ion balance in oxidative-reduction reactions;
- Incorrect attribution of substances to certain classes;
- There are no equations of the corresponding chemical transformations in solving typical and combined settlement problems.

Sensitive errors (those that do not affect the quality of the answer, but are able to change the assessment of the answer):

- mistakes in the names of substances (incorrect application of the chemical nomenclature);

- the physical state of the final products in chemical reactions are not marked by the corresponding marks (special symbols);

- the dimension of physical quantities in solving tasks is not specified;

- careless, timidly written response to the task.

Taking into account the mentioned, as well as guided by the requirements of the chemistry program for admittance to higher educational institutions of Ukraine, the general assessment of the knowledge of applicants is based on the answer to all questions posed in the test task.

Table 1. The structure of exam test assignments and the evaluation of each section's answers

№	**Structure and content test task**	**Criteria for assessment of answer**	**Maximal scores**
1	Test questions from 1 to 22 with one correct answer from general chemistry, inorganic and organic chemistry;	6 – correct answer 0 – incorrect answer	22×6=132
	test 23 and 24 «*chain of transformations*».	14 – correct answer 0 – incorrect answer	2×14=28
2	Task 25 «*Reduction-Oxidation reactions*»	20 – correct answer	20×1=20
	Task 26 «*Numerical Problem*»	20 – correct answer	20×1=20

The maximum sum of points is 200.

The minimal sum of points with which the entrant is allowed to take part in the competitive selection is 120 points.