

# **MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE**

## **CHEMISTRY**

**7–9<sup>th</sup> grades**

**Curriculum for comprehensive schools<sup>1</sup>**

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<sup>1</sup> Curriculum is approved by the Ministry of Education and Science of Ukraine No. 804 of June 7, 2017

7<sup>th</sup> grade

51 hours, 1,5 hours per week

Expected outcomes of students' learning and cognitive activity	Content of study materials	Practical part
<b>Introduction</b>		
<p><b>Student Knowledge component</b>  <i>names</i> the laboratory glassware and basic equipment of chemistry classroom;  <i>knows and understands</i> the rules of students' behavior in chemistry classroom and safety rules when working with laboratory glassware and equipment of chemistry classroom;  <i>explains</i> the purpose of laboratory glassware and equipment of chemistry classroom.</p> <p><b>Activity component</b>  <i>performs</i> the simplest laboratory operations using equipment of chemistry classroom as directed by teacher;  <i>complies with</i> the rules of students' behavior in chemistry classroom and safety rules when working with laboratory glassware and equipment of chemistry classroom.</p>	<p>Chemistry is a natural science. Substances and their transformations in the surrounding world. Brief history of chemistry. Rules of students' behavior in chemistry classroom. Studying of laboratory glassware and equipment of chemistry classroom, labeling of hazardous substances. Safety rules when working with laboratory glassware and equipment of chemistry classroom.</p>	<p><b>Demonstrations</b></p> <ol style="list-style-type: none"> <li>Interaction of bicarbonate of soda (sodium hydrogencarbonate) with vinegar (aqueous solution of acetic acid).</li> <li>Changing the color of natural indicators in the environment of household chemicals and food products.</li> </ol> <p><b>Laboratory experiments</b></p> <ol style="list-style-type: none"> <li>Study of the flame structure.</li> <li>Studying of labeling of hazardous substances (for example, household chemicals).</li> </ol> <p><b>Practical work</b></p> <ol style="list-style-type: none"> <li>Techniques for handling laboratory glassware, tripods and heating devices. Performance of the simplest laboratory operations.</li> </ol> <p><b>Class projects</b></p> <ol style="list-style-type: none"> <li>Chemicals around us.</li> <li>Historical importance of fire.</li> </ol>
<b>Topic 1. Initial chemical concepts</b>		
<p><b>Student Knowledge component</b>  <i>names</i> the chemical elements (at least 20) according to modern scientific Ukrainian nomenclature, writes down their symbols; the most abundant chemical elements in nature;  <i>give examples of</i> simple and complex substances, chemical phenomena in nature and everyday life;  <i>explains</i> the content of chemical formulas, essence of the Law of Conservation of Mass of substances, and chemical equations.</p>	<p>Physical objects. Materials. Substances. Molecules. Atoms. How substances are studied. Observation and experiment in chemistry. Physical properties of substances. Pure substances and mixtures (homogeneous, heterogeneous). Methods for separating mixtures. Chemical elements, their names and symbols. Abundance of chemical elements in nature. Studying of the periodic table of elements.</p>	<p><b>Calculations</b></p> <ol style="list-style-type: none"> <li>Calculation of the relative molecular mass of substance by its formula.</li> <li>Calculation of the mass fraction of element in a complex substance.</li> <li>Calculation of the mass of element in a complex substance by its mass fraction.</li> </ol> <p><b>Demonstrations</b></p> <ol style="list-style-type: none"> <li>Periodic table of elements.</li> <li>Samples of metals and non-metals.</li> </ol>

<p><b>Activity component</b>  <i>distinguishes between</i> physical objects, substances, materials, physical and chemical phenomena, physical and chemical properties of substances, pure substances and mixtures, simple and complex substances, metallic and non-metallic elements using the periodic table; metals and non-metals, atoms, molecules;  <i>observes</i> the chemical and physical phenomena;  <i>describes</i> the qualitative and quantitative composition of substances according to chemical formulas; phenomena that accompany chemical reactions;  <i>uses</i> the periodic table as reference to determine the relative atomic mass of elements;  <i>writes</i> formulas for binary compounds by valence of elements, plan for separating mixtures;  <i>determines</i> the valence of elements using binary compound formulas;  <i>calculates</i> the relative molecular mass of substance by its formula; mass fraction of element in a complex substance and mass of element in a complex substance by its mass fraction by choosing and justifying the method for solving;  <i>complies with</i> the rules of students' behavior in chemistry classroom and safety rules when working with laboratory glassware and equipment of chemistry classroom;  <i>performs</i> the simplest laboratory operations for heating substances, separating mixtures;</p>	<p>Mass of the atom. Atomic mass. Relative atomic masses of chemical elements.  Chemical formulas of substances. Simple and complex substances. Diversity of substances.  Metals and non-metals. Metallic and non-metallic elements.  Valence of chemical elements. Writing formulas for binary compounds by valence of elements. Determination of valence of elements by formulas for binary compounds. Relative molecular mass, its calculation by chemical formula.  Mass fraction of element in a complex substance. Physical and chemical phenomena. Chemical reactions and accompanying phenomena. Chemical properties of substances.  The Law of Conservation of Mass of substances during chemical reactions. Chemical reaction scheme. Chemical equations.</p>	<p>5. Experiment showing the Law of Conservation of Mass of substances (real or virtual).  <b>Laboratory experiments</b>  3. Studying of physical properties of substances. Description of observations. Formulation of conclusions.  4. Studying of samples of simple and complex substances.  5-9. Study of chemical reactions accompanied by release of gas, precipitation, color change, smell appearance, and thermal effect.  <b>Practical work</b>  2. Separation of mixtures.  3. Study of physical and chemical phenomena on examples of household chemicals and food products.  <b>Home experiment</b>  1. Interaction of bicarbonate of soda with sauerkraut juice, citric acid, kefir.  <b>Class projects</b>  3. Chemical phenomena in nature.  4. Chemical phenomena in everyday life.  5. Use of chemical phenomena in arts and folk crafts.  6. Substances and chemical phenomena in literary works and folk art.</p>
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### **Topic 2. Oxygen**

<p><b>Student Knowledge component</b>  <i>names</i> the composition of oxygen molecules, oxides, qualitative and quantitative composition of air;  <i>gives examples of</i> oxides, decomposition and combination reactions;</p>	<p>Air and its composition.  Abundance of oxygen in nature. Oxygen, composition of its molecule, and its abundance in nature. Physical properties of oxygen.  Obtaining oxygen in the laboratory (for example, hydrogen peroxide and water) and industry.  Decomposition reaction. Concept of catalyst.</p>	<p><b>Demonstrations</b>  6. Extraction of oxygen from hydrogen peroxide.  7. Oxygen collection by air displacement and water displacement.  8. Proof of presence of oxygen.  9. Combustion of simple and complex substances.</p>
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<p><i>explains</i> the essence of decomposition and combination reactions, oxidation processes, and oxygen cycle.</p> <p><b>Activity component</b>  <i>distinguishes between</i> combustion, slow oxidation, respiration, decomposition and combination reactions;  <i>describes</i> the abundance of oxygen in nature; its physical properties;  <i>characterizes</i> the chemical properties of oxygen;  <i>analyzes</i> the conditions for combustion and slow oxidation processes;  <i>writes</i> chemical equation: extraction of oxygen from hydrogen peroxide; oxygen with hydrogen, carbon, sulfur, magnesium, iron, copper, methane, hydrogen sulfide;  <i>uses</i> laboratory glassware to extract (from hydrogen peroxide) and collect oxygen;  <i>determines</i> experimentally the presence of oxygen;  <i>complies with</i> precautions during combustion processes; instructions for performing chemical experiments and safety rules when working in chemistry classroom.</p>	<p>Methods for collecting oxygen. Proof of presence of oxygen.</p> <p>Chemical properties of oxygen: interaction with simple substances (carbon, hydrogen, sulfur, magnesium, iron, copper). Combination reaction.</p> <p>Concept of oxides, oxidation (combustion, slow oxidation, respiration).</p> <p>Conditions for occurrence and cessation of combustion.</p> <p>Interaction of oxygen with complex substances (complete oxidation of methane, hydrogen sulfide).</p> <p>Oxygen cycle in nature. Ozone. Problem of air pollution. Application and biological role of oxygen.</p>	<p><b>Practical work</b></p> <p>4. Extraction of oxygen from hydrogen peroxide using various biological catalysts, proving its presence.</p> <p><b>Class projects</b></p> <p>7. Problem of air pollution and ways to solve it.  8. Improvement of air condition in the classroom during classes.</p>
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### Topic 3. Water

<p><b>Student Knowledge component</b>  <i>names</i> the composition of water molecule;  <i>gives examples of</i> the aqueous solutions; formulas of acids and bases.</p> <p><b>Activity component</b>  <i>describes</i> the abundance of water in nature, physical properties of water;  <i>distinguishes between</i> solvent and solute;  <i>writes</i> the equation of reactions of water with calcium oxide, sodium oxide, phosphorus(V) oxide, carbon(IV) oxide;</p>	<p>Water, composition of molecule, abundance in nature, physical properties. Water is a solvent.</p> <p>Solution and its components: solvent, solute.</p> <p>Quantitative composition of the solution. Mass fraction of solute. Preparation of the solution.</p> <p>Interaction of water with oxides. Concept of acids and bases. Concept of indicators.</p> <p>Importance of water and aqueous solutions in nature and human life. Acid rain. Problem of water pollution. Protection of bodies of water from pollution. Water purification at water treatment plants and at home.</p>	<p><b>Calculations</b></p> <p>4. Calculation of the mass fraction, mass of solute, mass and volume of water in solution.</p> <p><b>Demonstrations</b></p> <p>10. Preparation of solutions with a certain mass fraction of solute.  11. Interaction of calcium oxide with water. Testing the aqueous solution of the extracted substance with indicator.  12. Interaction of carbon(IV) oxide with water. Testing the aqueous solution of the extracted substance with indicator.</p>
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<p><i>calculates</i> the mass fraction and mass of the solute, mass and volume of water in the solution by choosing and justifying the method for solving;</p> <p><i>prepares</i> solutions with a certain mass fraction of solute;</p> <p><i>recognizes</i> experimentally acids and alkalis;</p> <p><i>uses</i> the acquired knowledge and skills in everyday life for rational use of water and environmental protection;</p> <p><i>has</i> basic skills of water purification at home.</p>		<p><b>Laboratory experiments</b></p> <p>10. Testing the aqueous solutions of acids and alkalis with indicators.</p> <p><b>Practical work</b></p> <p>5. Preparation of the aqueous solutions with specified mass fractions of solutes.</p> <p><b>Home experiment</b></p> <p>2. Purification of contaminated water with a hand-made filter.</p> <p><b>Class projects</b></p> <p>9. Study of water quality from various sources.</p> <p>10. Study of physical and chemical properties of water.</p> <p>11. Methods for water purification in everyday life.</p> <p>12. Keeping the bodies of water clean: solving the problem in native region.</p> <p>13. Ecological and economic project “Save the family budget by saving water”.</p>
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**Proposed excursion objects.** Chemical laboratories of industrial and agricultural enterprises, research institutes, and higher educational institutions. Fire station. Water treatment plant. Pharmacy. Local History Museum.

**8<sup>th</sup> grade**

68 hours, 2 hours per week

Expected outcomes of students' learning and cognitive activity	Content of study materials	Practical part
<b>Repetition of the most important questions of chemistry course for the 7<sup>th</sup> grade</b>		
<p><b>Student</b>  <b>Knowledge component</b>  <i>names</i> the chemical elements (at least 20) according to modern scientific Ukrainian nomenclature, writes down their symbols;  <i>gives examples of</i> formulas and names of simple (metals and non-metals) and complex (oxides, bases, acids) substances; chemical equations: extraction of oxygen from hydrogen peroxide and water; oxygen with hydrogen, carbon, sulfur, magnesium, iron, copper, methane, hydrogen sulfide, water with calcium oxide, sodium oxide, phosphorus(V) oxide, carbon(IV) oxide; decomposition and combination reactions.</p> <p><b>Activity component</b>  <i>calculates</i> the relative molecular mass of substance by its formula, mass fraction of element in a complex substance.</p>	<p>The most important chemical concepts.            Simple and complex substances (oxygen, water).            Decomposition and combination reactions.            Relative molecular mass, its calculation by chemical formula.            Mass fraction of element in a complex substance.</p>	
<b>Topic 1. Structure of the atom. Periodic Law and periodic table of elements</b>		
<p><b>Student</b>  <b>Knowledge component</b>  <i>formulates</i> Periodic Law;  <i>writes</i> electronic and graphical electronic formulas of atoms of 20 chemical elements;  <i>explains</i> the periodicity of changes in the properties of chemical elements (No. 1-20); dependence of the nature of elements and properties of their compounds on the electronic structure of atoms;  <i>gives examples of</i> alkaline, inert elements and halogens.</p>	<p>Brief historical information on the attempts to classify chemical elements. Concept of alkaline, inert elements and halogens.            Structure of the atom. Composition of atomic nuclei (protons and neutrons). Atomic number. Mass number. Structure of electron shells of atoms of chemical elements No. 1-20. State of electrons in the atom. Electronic orbitals. Energy levels and sublevels; their filling with electrons in the atoms of chemical elements No. 1-20. Electronic and graphical electronic formulas of atoms of chemical elements No. 1-20. Concept of atomic radius.</p>	<p><b>Demonstrations</b>            Periodic table of elements (long and short forms).            Models of atoms (virtual 3D).            3. Forms of electronic orbitals (virtual 3D).</p> <p><b>Class projects</b>            1. From the history of discovery of the periodic table of elements.            2. Forms of the periodic table of elements.            3. Chemical elements in literary works.            4. Interesting historical facts from discovery and origin of the names of chemical elements.</p>

<p><b>Activity component</b>  <i>distinguishes between</i> atomic nucleus, electrons, protons and neutrons; periods (large and small), main (A) and secondary (B) subgroups of the periodic table; metals and non-metals;  <i>characterizes</i> the composition of atomic nuclei (number of protons and neutrons), distribution of electrons (by energy levels and sublevels) in the atoms of the first 20 chemical elements; chemical element (No. 1-20) by its position in the periodic table, changes in atomic radii in periods and subgroups, metallic and non-metallic properties of elements; structure of the periodic table (periods: large and small, groups and subgroups (A and B));  <i>analyzes</i> information contained in the periodic table and uses it to characterize chemical element;  <i>uses</i> information contained in the periodic table to classify elements (metals or non-metals) and to determine their valence, and to classify simple substances (metal or non-metal).</p>	<p>Periodic Law of D.I. Mendeleev (modern formulation). Periodic table of elements, its structure.          Characteristics of chemical elements No. 1-20 by their place in the periodic table and structure of the atom.          Meaning of the Periodic Law</p>	
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### **Topic 2. Chemical bond and structure of substance**

<p><b>Student Knowledge component</b>  <i>names</i> the types of chemical bonds and types of crystal lattices;  <i>gives examples of</i> compounds with covalent (polar and nonpolar) and ionic chemical bonds, atomic, molecular and ionic crystal lattices;  <i>explains</i> the formation of ionic and covalent (polar and nonpolar) bonds.</p> <p><b>Activity component</b>  <i>writes</i> electronic formulas of molecules;  <i>characterizes</i> the features of covalent and ionic bonds, crystal structure of substances with different types of chemical bonds;  <i>determines</i> the type of chemical bond in standard cases, polarity of covalent bond;</p>	<p>Nature of chemical bond. Electronegativity of atoms of chemical elements. Covalent bond and its formation. Polar and nonpolar covalent bonds. Electronic formulas of molecules. Ions. Ion bond and its formation.          Crystal lattices. Atomic, molecular and ionic crystals. Dependence of physical properties of substances on the types of crystal lattices.</p>	<p><b>Demonstrations</b>          Models of different types of crystal lattices. Samples of substances of atomic, molecular and ionic structure.</p> <p><b>Laboratory experiments</b>          1. Studying of physical properties of substances of atomic, molecular and ionic structure.</p> <p><b>Practical work</b>          1. Study of physical properties of substances with different types of crystal lattices (for example: sugar, table salt, graphite).</p> <p><b>Class projects</b>          5. Use of crystals in engineering.          6. Crystals: beauty and benefits.</p>
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<p><i>predicts</i> the physical properties and practical use of substances depending on the type of chemical bond and type of crystal lattices; <i>uses</i> the concept of electronegativity to characterize chemical bonds.</p>		
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### **Topic 3. Amount of substance. Calculations by chemical formulas**

<p><b>Student</b> <b>Knowledge component</b> <i>names</i> the unit of measurement for the amount of substance, molar volume of gases under normal conditions, and Avogadro constant; <i>explains</i> the essence of the amount of substance.</p> <p><b>Activity component</b> <i>establishes</i> the relations between physical quantities (mass, molar mass, volume, molar volume, amount of substance); <i>calculates</i> the number of particles (atoms, molecules, ions) in a certain amount of substance, mass, volume; molar mass, mass and quantity of substance; volume of a given mass or amount of substance gas under normal conditions; relative density of gas by another gas by choosing and justifying the method for solving.</p>	<p>Amount of substance. Mole is a unit of the amount of substance. Avogadro constant. Molar mass. Avogadro's Law. Molar volume of gases. Relative density of gases.</p>	<p><b>Calculations</b> 5. Calculation of the molar mass of substance. 6. Calculation of the number of particles (atoms, molecules, ions) in a certain amount of substance, mass, volume. 7. Calculation of the mass of a given amount of substance and amount of substance by a known mass by chemical formula. 8. Calculation of the volume of a certain mass or amount of substance of a known gas under normal conditions. 9. Calculation using the relative density of gases.</p> <p><b>Demonstrations</b> 6. Samples of substances in the amount of 1 mol (or the same amount of substance).</p>
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### **Topic 4. Main classes of inorganic compounds**

<p><b>Student</b> <b>Knowledge component</b> <i>names</i> oxides, bases, acids, amphoteric hydroxides, and medium salts according to modern scientific Ukrainian nomenclature; <i>gives examples of</i> basic, acidic and amphoteric oxides, oxygen-containing and oxygen-free, mono-, di- and tribasic acids, soluble and insoluble bases, amphoteric hydroxides, and medium salts.</p>	<p>Classification of inorganic compounds, their composition and nomenclature. Physical properties of oxides. Chemical properties of basic, acidic, and amphoteric oxides: interaction with water, acids, alkalis, and other oxides. Physical properties of acids. Chemical properties of acids: effect on indicators, interaction with metals, basic oxides, bases, and salts. Neutralization reaction. Reactivity series. Substitution and exchange reactions. Safety precautions when working with acids.</p>	<p><b>Calculations</b> 10. Calculations of mass, volume, amount of substance of reagents and reaction products by chemical equations.</p> <p><b>Demonstrations</b> 7. Samples of oxides. 8. Interaction of acidic and basic oxides with water. 9. Samples of acids. 10. Chemical properties of acids. 11. Samples of bases.</p>
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<p><b>Activity component</b>  <i>distinguishes between</i> non-salt-forming and salt-forming (acidic, basic, amphoteric) oxides, soluble and insoluble bases, acids by composition (oxygen-containing, oxygen-free) and basicity (mono-, di-, tribasic), and medium salts; substitution, exchange and neutralization reactions;  <i>describes</i> the abundance of representatives of the main classes of inorganic compounds in nature;  <i>writes</i> chemical formulas of oxides, bases, amphoteric hydroxides (aluminum, zinc), acids, and medium salts; chemical equations characterizing the chemical properties of basic, acidic and amphoteric oxides; acids, alkalis, insoluble bases, amphoteric hydroxides, and medium salts;  <i>compares</i> the chemical properties of basic, acidic and amphoteric oxides, alkalis, and insoluble bases;  <i>classifies</i> inorganic compounds by class;  <i>characterizes</i> the concept of amphoteric nature, physical and chemical properties of oxides, bases, acids, salts, and amphoteric hydroxides;  <i>establishes</i> genetic links between simple and complex substances, main classes of inorganic compounds;  <i>calculates</i> the mass, amount of substance and volume of gas (normal conditions) by chemical equations based on the known mass, amount of substance, volume of one of the reagents or reaction products by choosing and justifying the method for solving;  <i>uses</i> modern Ukrainian nomenclature of the main classes of inorganic compounds; chart of solubility of acids, bases and salts for writing chemical equations; indicators for detecting acids and alkalis;  <i>plans</i> experiment, conducts it, describes observations, and makes conclusions;</p>	<p>Physical properties of bases. Chemical properties of alkalis: effect on indicators, interaction with acids, acid oxides, and salts. Chemical properties of insoluble bases: interaction with acids and decomposition due to heating. Safety precautions when working with alkalis.  Chemical properties of amphoteric hydroxides: interaction with acids and alkalis (in solution, during fusion).  Physical properties of medium salts. Chemical properties of medium salts: interaction with metals, acids, alkalis, and other salts.  Genetic links between the main classes of inorganic compounds.  Abundance in nature and use of oxides, acids, bases and medium salts. Impact on the environment and human health.</p>	<p>12. Chemical properties of alkalis.  13. Extraction and chemical properties of insoluble bases.  14. Proof of amphoteric nature of zinc hydroxide.  15. Chart of solubility of acids, bases, amphoteric hydroxides and salts.  16. Samples of salts.  17. Chemical properties of salts.  18. Interaction of calcium oxide with water, study of the extracted solution with indicator, passing of carbon dioxide into the solution obtained.</p> <p><b>Laboratory experiments</b>  Interaction of alkalis with acids in solution.  Interaction of hydrochloric acid with metals.  Interaction of metals with salts in the aqueous solution.  Interaction of salts with alkalis in the aqueous solution.  Exchange reaction between salts in solution.  Solving the experimental problem on the example of the exchange reaction.</p> <p><b>Practical work</b>  2. Study of properties of the main classes of inorganic compounds.  3. Solving experimental problems.</p> <p><b>Home experiment</b>  1. Effect of lemon juice, vinegar, baking soda solution and soap solution on beet or red cabbage juice.</p> <p><b>Class projects</b>  7. Inorganic substances are representatives of the main classes in construction and everyday life.  8. Chemical composition and use of minerals.  9. Impact of chemical compounds on the environment and human health.</p>
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<p><i>predicts</i> the course of chemical reactions of salts and acids with metals, using the reactivity series; <i>observes</i> safety precautions when working with acids and alkalis <i>solves</i> experimental problems by choosing and justifying the method for solving.</p>		
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**Proposed excursion objects.** Local History and Mineralogical Museums.

**9<sup>th</sup> grade**  
68 hours, 2 hours per week

Expected outcomes of students' learning and cognitive activity	Content of study materials	Practical part
<b>Repetition of the most important questions of chemistry course for the 8th grade</b>		
<p><b>Student</b> <b>Knowledge component</b> <i>gives examples of</i> the names and formulas of substances belonging to the main classes of inorganic compounds.</p> <p><b>Activity component</b> <i>classifies</i> inorganic compounds; <i>compares</i> the composition and properties of inorganic compounds of different classes; properties of substances of atomic, molecular and ionic structure; <i>characterizes</i> ionic and covalent chemical bonds; chemical properties of the main classes of inorganic compounds.</p>	<p>Composition and properties of the main classes of inorganic compounds. Chemical bond and structure of substance.</p>	
<b>Topic 1. Solutions</b>		
<p><b>Student</b> <b>Knowledge component</b> <i>give examples of</i> colloidal and true solutions, solutions, suspensions, emulsions, aerosols, electrolytes and nonelectrolytes, strong and weak electrolytes, and crystalline hydrates; <i>explains</i> the impact of various factors on the solubility of substances; formation of hydrogen bond; essence of the electrolytic dissociation.</p> <p><b>Activity component</b> <i>distinguishes between</i> solution components, saturated and unsaturated solutions, cations and anions, electrolytes and nonelectrolytes, strong and weak electrolytes; pH of alkaline, acidic and neutral environment;</p>	<p>Concept of dispersion. Colloidal and true solutions. Suspensions, emulsions and aerosols. Structure of the water molecule, concept of hydrogen bond. Solubility of substances, its dependence on various factors. Saturated and unsaturated, concentrated and dilute solutions. Thermal phenomena accompanying the dissolution of substances. Dissolution as physical and chemical process. Concept of crystalline hydrates. Electrolytic dissociation. Electrolytes and nonelectrolytes. Electrolytic dissociation of acids, bases, and salts in the aqueous solutions. Degree of electrolytic dissociation. Strong and weak electrolytes. Concept of pH of the solution (without mathematical calculations). PH value for</p>	<p><b>Calculations</b> 1. Solving problems by chemical equations using solutions with a certain mass fraction of solute.</p> <p><b>Demonstrations</b> Thermal phenomena during dissolution (dissolution of ammonium nitrate and anhydrous calcium chloride in water). Study of substances and their aqueous solutions for electrical conductivity (crystalline sodium chloride, distilled water, sodium chloride solution, crystalline sugar, sugar solution, hydrochloric acid). Exchange reactions between electrolytes in the aqueous solutions.</p>

<p><i>describes</i> dissolution of substances in water as physical and chemical phenomenon; qualitative analysis for chloride ions; detection of hydroxide ions and hydrogen ions in solution;</p> <p><i>writes</i> equations of electrolytic dissociation of alkalis, acids and salts; equations of exchange reactions in full and abbreviated ionic forms; equations of qualitative analysis for chloride ions in molecular and ionic forms;</p> <p><i>solves</i> experimental problems by choosing and justifying the method for solving;</p> <p><i>calculates</i> the mass, volume and amount of substance by chemical equations using solutions with a certain mass fraction of solute by choosing and justifying the method for solving;</p> <p><i>characterizes</i> electrolytes by the degree of dissociation;</p> <p><i>determines</i> the nature of environment by its pH value;</p> <p><i>carries out</i> reactions between electrolyte solutions, taking into account the conditions of their behavior; qualitative analysis for carbonate, sulfate and chloride ions;</p> <p><i>detects</i> hydroxide ions and hydrogen ions in solution;</p> <p><i>uses</i> the pH value to characterize acidic or alkaline environment.</p>	<p>characterizing acidic or alkaline environment. Exchange reactions between electrolyte solutions, conditions of their behavior. Ion and molecular chemical equations.</p> <p>Detection of hydroxide ions and hydrogen ions in solution. Qualitative analysis for some ions. Use of qualitative analysis.</p>	<p><b>Laboratory experiments</b></p> <ol style="list-style-type: none"> <li>1. Detection of hydrogen ions and hydroxide ions in solutions.</li> <li>2. Determination of the approximate pH value of water, alkaline and acidic solutions (sodium hydroxide, hydrochloric acid) using universal indicator.</li> <li>3. Study of pH of food and cosmetic products.</li> <li>4. Exchange reactions between electrolytes in the aqueous solutions that are accompanied by precipitation.</li> <li>5. Exchange reactions between electrolytes in the aqueous solutions that are accompanied by release of gas.</li> <li>6. Exchange reactions between electrolytes in the aqueous solutions that are accompanied by formation of water.</li> <li>7. Detection of chloride ions in solution.</li> <li>8. Detection of sulfate ions in solution.</li> <li>9. Detection of carbonate ions in solution.</li> </ol> <p><b>Practical work</b></p> <ol style="list-style-type: none"> <li>1. Ion exchange reactions between electrolytes in the aqueous solutions.</li> <li>2. Solving experimental problems.</li> </ol> <p><b>Home experiment</b></p> <ol style="list-style-type: none"> <li>1. Preparation of colloidal solutions (jelly, etc.).</li> </ol> <p><b>Class projects</b></p> <ol style="list-style-type: none"> <li>1. Electrolytes in modern batteries.</li> <li>2. Growing salt crystals.</li> <li>3. Preparation of solutions for providing pre-medical care.</li> <li>4. Study of soil pH of native region.</li> <li>5. Study of impact of soil acidity and alkalinity on plant development.</li> <li>6. Study of pH of atmospheric precipitation and its impact on various materials in the environment.</li> </ol>
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7. Study of natural objects as acid-base indicators.  
8. Study of pH of mineral water environment in Ukraine.

### *Topic 2. Chemical reactions*

<p><b>Student</b> <b>Knowledge component</b> <i>knows and understands</i> the essence of concepts: chemical reaction, oxidation state, oxidizing agent, reducing agent, oxidation and reduction processes, thermal effect of reaction, reaction rate; <i>provides examples of</i> the main types of chemical reactions; reducing agents and oxidizing agents.</p> <p><b>Activity component</b> <i>determines</i> the oxidation states of elements in compounds by their formulas; <i>distinguishes between</i> conjugation, substitution, exchange and decomposition reactions; redox reactions and reactions without changing the oxidation state; exo- and endothermic, reversible and irreversible reactions; oxidizing and reducing agents; valence and oxidation state of element; <i>writes</i> chemical formulas of binary compounds by the oxidation state of elements; equations of the simplest redox reactions based on electronic balance, thermochemical equations; equations of reversible and irreversible reactions; <i>classifies</i> reactions by various characteristics; <i>characterizes</i> the processes of oxidation, reduction, combination, decomposition, substitution and exchange; impact of various factors on reaction rate; role of redox processes in the environment; <i>complies with</i> the rules of use of household chemicals.</p>	<p>Classification of chemical reactions by the number and composition of reagents and reaction products: combination, decomposition, substitution and exchange reactions. Oxidation state. Determination of the oxidation state of element by chemical formula of the compound. Writing compound formula by the known oxidation state of elements. Redox reactions. Processes of oxidation and reduction, oxidizing agents and reducing agents. Writing equations of redox reactions. Importance of redox processes in human life, nature and technology. Exothermic and endothermic reactions. Thermochemical equation. Reversible and irreversible reactions. Reaction rate, dependence of reaction rate on various factors.</p>	<p><b>Demonstrations</b> Decomposition, combination, substitution, exchange, exo- and endothermic reactions. Dependence of rate of reaction of metals (zinc, magnesium, iron) with hydrochloric acid on the activity of metal.</p> <p><b>Laboratory experiments</b> 10. Impact of concentration and temperature on the rate of reaction of zinc with hydrochloric acid.</p> <p><b>Practical work</b> 3. Impact of various factors on reaction rate.</p> <p><b>Class projects</b> 9. Endothermic reactions in the service of humans. 10. Exothermic reactions in the life of living organisms.</p>
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### Topic 3. Basic concepts of organic compounds

#### Student

#### Knowledge component

*knows and understands* the essence of concepts of homologue, homology; division of organic substances by qualitative composition into hydrocarbons, oxygen-containing and nitrogen-containing compounds;

*names* the elements-organogens, the most important organic compounds (methane and its first ten homologues, ethylene, acetylene, methanol, ethanol, glycerol, ethanoic acid, glucose, sucrose, starch, cellulose, stearic, palmitic, oleic and aminoethanoic acids), main products of oil refining;

*gives examples of* methane homologues; natural and synthetic substances, alcohols, carboxylic acids, fats, carbohydrates;

*explains* the reactions of combustion of organic substances, substitution of methane, addition for ethylene and acetylene; some chemical properties of ethanoic acid; essence of oil refining process.

#### Activity component

*writes* molecular and structural formulas of methane and its first ten homologues, ethylene, acetylene, methanol, ethanol, glycerol, ethane and aminoethanoic acids; molecular formulas of glucose, sucrose, starch, cellulose; equations of combustion reactions (methane, ethylene and acetylene, methanol, ethanol), substitution of methane (chlorination), addition of ethylene and acetylene (halogenation, hydrogenation), ethanoic acid (electrolytic dissociation, interaction with metals, alkalis and salts); general scheme of ethylene polymerization;

*distinguishes between* methane, ethylene, acetylene, methanol, ethanol, glycerol, acetic acid, higher carboxylic acids, glucose, sucrose, starch, cellulose, soap, natural and hydrogenated,

Features of organic compounds (compared to inorganic ones). Elements-organogens.

Hydrocarbons.

Methane as a representative of saturated hydrocarbons. Homology. Methane homologues (the first ten), their molecular and structural formulas and names.

Physical properties. Substitution reaction of methane.

Ethylene (ethene) and acetylene (ethine) as representatives of unsaturated hydrocarbons.

Molecular and structural formulas. Physical properties. Addition reaction of ethylene and acetylene (halogenation, hydrogenation).

Combustion of hydrocarbons.

Concept of polymers on the example of polyethylene. Use of polyethylene.

Distribution of hydrocarbons in nature. Natural gas, oil, and coal are natural sources of hydrocarbons. Oil refining. Hydrocarbon raw materials and environmental protection. Use of hydrocarbons.

Oxygen-containing organic substances.

Concept of alcohols, carboxylic acids, fats and carbohydrates.

Methanol, ethanol, glycerol: molecular and structural formulas, physical properties. Combustion of ethanol. Qualitative analysis of glycerol.

Toxicity of methanol and ethanol. Harmful effects of alcohol on the human body.

Acetic acid, its molecular and structural formulas, physical properties. Chemical properties of acetic acid: electrolytic dissociation, effect on indicators, interaction with metals, alkalis and salts. Use of acetic acid. Higher carboxylic acids: stearic, palmitic and oleic. Soap, its composition, washing effect.

#### Calculations

2. Calculation of volume ratios of gases by chemical equations.

#### Demonstrations

Models of hydrocarbon molecules (including 3D design).

Combustion of paraffin, determination of its qualitative composition by combustion products.

8. Study of samples of polyethylene products. Identification of properties of polyethylene: relation to heating, solutions of acids, alkalis.

9. Effect of acetic acid on indicators.

10. Interaction of acetic acid with metals and alkalis.

#### Laboratory experiments

11. Interaction of glycerol with copper(II) hydroxide.

12. Interaction of glucose with copper(II) hydroxide.

13. Ratio of starch to water (solubility, paste formation).

14. Interaction of starch with iodine.

#### Practical work

Properties of acetic acid.

Detection of organic compounds in food.

#### Home experiment

2. Comparison of washing effect of soap and washing powder of domestic manufacturer.

3. Detection of starch in food.

#### Class projects

11. Use of polymers: ecological and economic aspect.

12. Alternative energy sources.

<p>animal and vegetable, solid and liquid fats, proteins, polyethylene, natural and artificial fats;  <b>compares</b> the organic and inorganic substances, starch and cellulose, composition of methane homologues, saturated and unsaturated hydrocarbons;  <b>characterizes</b> composition and physical properties of methane and its homologues, ethylene, acetylene, ethanol, glycerol, acetic acid, fats, glucose, sucrose, starch, cellulose, proteins, polyethylene;  <b>determines</b> experimentally glycerol, ethanoic acid, glucose and starch;  <b>solves</b> problems for calculating the volume ratios of gases by chemical equations and other previously studied types on the example of organic compounds;  <b>complies with</b> the rules of safe handling of flammable substances and household chemicals.</p>	<p>Fats. Fat composition, physical properties. Natural and hydrogenated fats. Biological role of fats.  Carbohydrates: glucose, sucrose, starch and cellulose. Molecular formulas, physical properties, distribution and formation in nature. Starch and cellulose are natural polymers. Qualitative analysis of glucose and starch. Use of carbohydrates, their biological role.  Nitrogen-containing organic substances. Concept of amino acids. Proteins as biological polymers. Protein denaturation. Biological role of amino acids and proteins. Importance of natural and synthetic organic compounds.  Protection of the environment from persistent organic pollutants.</p>	<p>13. Ecotrophology is a science of eco-friendly nutrition.  14. Making soap from a soap base.  15. Study of chemical composition of food.  16. Chemical composition of chewing gum.  17. Chemical composition of dental care products.  18. Second life of paper.  19. Sources of organic pollution of the territory of community (microdistrict).</p>
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#### **Topic 4. Role of chemistry in society**

<p><b>Student Knowledge component</b>  <b>names</b> famous domestic chemists; the most important chemical production facilities in Ukraine;  <b>gives examples of</b> relations between substances; use of chemical compounds in various industries and in everyday life.</p> <p><b>Activity component</b>  <b>characterizes</b> the importance of chemistry in society, preserving the environment, and for human health.</p>	<p>Diversity of substances and chemical reactions. Relations between substances and their interconversion.  Place of chemistry among the natural sciences, its importance for understanding the scientific picture of the world.  Role of chemistry to ensure sustainable human development.  Chemistry and production in Ukraine. Famous domestic chemists.</p>	<p><b>Class projects</b>  20. Famous domestic chemists as scientists and personalities.  21. Environmental situation in my region: I feel, think and act.  22. Survey of students regarding their participation in solving environmental problems of native region.  23. Study of advertising credibility from the point of view of chemistry.</p>
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**Proposed excursion objects.** Water treatment plant. Plastic manufacturing enterprises, sugar refinery, confectionery, bakery.