SYLLABUS
Academic Course “CHEMISTRY”

Speciality 192 Construction and Civil Engineering
EQL Bachelor
Faculty Design and Engineering

Syllabus compiled by: Senior Assistant Professor, PhD Kravchenko Olha,

<table>
<thead>
<tr>
<th>Course</th>
<th>Semester</th>
<th>Weeks</th>
<th>Credits</th>
<th>Lectures, hours</th>
<th>Lab works, hours</th>
<th>Self works, hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

Course - 1
Semester - 1
Weeks - 15
Credits - 3
Lectures, hours - 15
Lab works, hours - 30
Self works, hours - 45

Kyiv – 2019
1
### Field of knowledge, direction, specialty, education and qualification level

<table>
<thead>
<tr>
<th>Branch of knowledge</th>
<th>19 – Architecture and construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training direction</td>
<td></td>
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<tr>
<td>Specialty</td>
<td>192 – Construction and Civil Engineering</td>
</tr>
<tr>
<td>Education and qualification level</td>
<td>Bachelor</td>
</tr>
</tbody>
</table>

### Characteristics of training programme

<table>
<thead>
<tr>
<th>Type</th>
<th>Obligatory</th>
</tr>
</thead>
<tbody>
<tr>
<td>The total number of academic hours</td>
<td>90</td>
</tr>
<tr>
<td>Number of ECTS credits</td>
<td>3</td>
</tr>
<tr>
<td>Number of modules</td>
<td>3</td>
</tr>
<tr>
<td>Forms of control</td>
<td>Exam</td>
</tr>
</tbody>
</table>

### Indicators of academic discipline for full-time and part-time forms of training course

<table>
<thead>
<tr>
<th></th>
<th>Full-time</th>
<th>Part-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year (course)</td>
<td>2019</td>
<td>2019</td>
</tr>
<tr>
<td>Semester</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Lectures</td>
<td>15 hours</td>
<td>4</td>
</tr>
<tr>
<td>Laboratory sessions (activities)</td>
<td>30 hours</td>
<td>10</td>
</tr>
<tr>
<td>Self-study</td>
<td>45 hours</td>
<td>76</td>
</tr>
<tr>
<td>Independent study</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of hours a week</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-time leaning:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>auditorium</td>
<td>3 hours</td>
<td></td>
</tr>
<tr>
<td>own training –</td>
<td>3 hours</td>
<td></td>
</tr>
</tbody>
</table>
1. Goal and objectives of academic discipline

Chemistry is one-semester introductory course that examines matter and the changes it undergoes. Students explore the fundamental chemical principles and their applications to the properties and transformations of materials. The course provides an overview of the field of electrochemistry with a focus on the chemical aspects of the interfacial processes.

The main goals of the course are – to provide a solid foundation in the study of matter and its changes and to understand and apply basic chemistry concepts in branch engineering.

Learning outcomes of course is the student's ability as a future specialist:
- outlines the historical development of major principles, concepts and ideas in chemistry;
- describes applications of chemistry which affect society or the environment;
- explains trends and relationships between elements in terms of atomic structure, the periodic table and bonding;
- describes chemical changes in terms of energy inputs and outputs;
- compiles the different chemical reaction, describes factors that influence the type and rate of chemical reactions;
- relates the uses of carbon to the unique nature of carbon chemistry;
- applies simple electrochemical processes;

Upon completion of this course:

Students will develop knowledge and understanding of:
- the nature and practice of chemistry,
- the implications of chemistry for society and environment,
- atomic structure, the periodic table and bonding,
- chemical reactions, including acid/base reactions and chemical equilibrium,
- carbon chemistry,
- electrochemical applications.

Student will develop skill in:
- planning investigations,
- conducting simple analysis,
- working with laboratory equipment,
- working with different chemical compound.
2. Program and structure of the course

Module 1. The basics atomic-molecular theory of the matter structure.

Lecture 1. The main concepts and laws of chemistry.
The place of chemistry among the natural science subjects. The subject and tasks of general chemistry. The historical stages of chemistry development. Contribution of Ukrainian scientists in the development of chemical science. The role of chemistry in branch engineering. The main direction of chemicalization of mechanical engineering. Agroecological problem of chemicalization in Ukraine. Chemistry and environmental protection. The basic concepts of atomic-molecular theory: a molecule, atom, chemical element, simple and complex matter, relative atomic and molecular masses, mole, molar mass. The basic laws of chemistry: the law of conservation of mass and energy, the law of equivalents, the law of the constancy of the chemical compounds, Avogadro's law, their application in branch engineering. The modern principles of classification and nomenclature of inorganic compounds. The genetic link between the main classes of inorganic compounds.

Lecture 2. The atomic structure.
The main role of atomic structure in prediction of the physical and chemical properties of elements and their compounds. Modern ideas about the structure of the atom. The structure and dimensions of the nucleus, the electron. The wave nature of the electron. Quantum numbers. The concept of orbital, energy of levels, sublevels and their value. The principles of filling orbitals by electrons. Electron and graphic formulas.

Lecture 3. The periodic law and Mendeleev’s periodic table of chemical elements.
The modern formulation of periodic law. Mendeleev’s periodic system of elements. The concept of group, sub-group, period., s-, p-, d-elements. The main patterns of the periodic system: metal and non-metal, acid-basic, redox properties of elements. The concept of atom radius, ionization energy, electron affinity, electronegativity and their changes in periods and groups of the periodic system.

Lecture 4. The chemical bond and the structure of molecules.

The structure of molecules. The intermolecular interactions. The chemical bond and features of compounds.
Module 2. The main patterns of chemical reactions.

Lecture 1. Thermodynamic laws of chemical transformations.
The basic concepts of chemical kinetics. The rate of chemical reaction. The factors affecting to the rate of a chemical reaction. Law of mass action - basic law of chemical kinetics. The rate constant of a chemical reaction. The concept of activation energy, heat of reaction. Effect of temperature on the rate of reaction. Van't Hoff Rule. The concept of catalysis and its nature. Enzymes as catalysts of biochemical processes.

Lecture 2. The chemical equilibrium and conditions of its shift.
Reversible and irreversible reactions. The concept of chemical equilibrium. Constant of chemical equilibrium. The shift of chemical equilibrium. The influence of external factors on chemical equilibrium. Le Chatelier’s principle. The concepts of chemical kinetics and chemical equilibrium within the meaning of chemical processes for production and processing of branch engineering.

Lecture 3. The solutions of electrolytes
The general idea about dispersion systems. The concept of the solutions and their role in the nutrition of plants and animals. The physical and chemical nature of the solutions. Hydrates. The concept of the crystalline. The solubility. Ways of expressing concentration of solutions.
The concept of electrolytes and non-electrolytes solutions and their properties. The main positions of electrolytic dissociation theory.
The mechanism of electrolytic dissociation. The quantitative characteristics of the dissociation. Strong and weak electrolytes. The dissociation constant of weak electrolytes, it’s connection with the degree of dissociation. Amphoteric electrolytes. Reactions in solutions of electrolytes. Ionic reactions.

Lecture 4. The solution of non-electrolytes.
The concept of heterogeneous systems. Colligative properties of solutions of non-electrolytes and their application in engineering. The disperse state of matter. The general idea of heterogeneous solutions (disperse systems, colloid solutions) and features of their properties. Surface phenomena at the interface. Sorption processes. Disperse systems in nature.

Lecture 5. The redox processes and their conditions.


Lecture 8. Corrosion processes and materials protection against corrosion.


Module 3. Chemical elements and compounds of elements as the basis of inorganic and organic structural materials

Lecture 1. Properties of non-metals and their compounds in materials and excipients engineering.

General characteristics of non-metals and their position in the Periodic System D.I.Mendelyeyeva. The dependence of the properties of the electronic structure of atoms of non-metals. The use of non-metal compounds for the production of polymers, CFCs and preservatives, wood, glass, fire-resistant paint, fiberglass, chemical power sources, corrosion inhibitors, detergents, and in welding work in lighting technology, the vulcanization of rubber, and others.

Lecture 2. Chemistry of metals.

Regulation metals in the Periodic System D.I.Mendelyeyeva, general characteristics of metals. Features of the electronic structure of atoms. The physical properties of metals, electrical conductivity, thermal conductivity, ductility. Methods of obtaining metals and alloys, special alloys properties, heat resistance, lightness, corrosion resistance, hardness etc. Properties metals side subgroups ability to form complexes. Water hardness. Application of metals and their compounds in batteries, for the manufacture of mirrors, white, glass, glaze, decoration, electrical wires, tubes, semiconductors. Environmental problems of heavy metals.


## Structure of the course “Chemistry”

<table>
<thead>
<tr>
<th>Modules and topics</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full time included</td>
</tr>
<tr>
<td></td>
<td>total L P Lab Ind Self work</td>
</tr>
<tr>
<td>Module 1. The basics atomic-molecular theory of the matter structure</td>
<td></td>
</tr>
<tr>
<td>Topic 1. The main concepts and laws of chemistry</td>
<td>6 2 2 2 2 5.5 0.5 5</td>
</tr>
<tr>
<td>Topic 2. Atomic structure</td>
<td>6 2 2 2 6.5 0.5 1 5</td>
</tr>
<tr>
<td>Topic 3. The periodic law and Mendeleev’s periodic table of chemical elements</td>
<td>5 1 2 2 5</td>
</tr>
<tr>
<td>Topic 4. The chemical bond and the structure of molecules.</td>
<td>6 1 2 3 6.5 0.5 1 5</td>
</tr>
<tr>
<td>Total</td>
<td>23 6 8 9 23.5 1.5 2 20</td>
</tr>
<tr>
<td>Module 2. The main patterns of chemical reactions</td>
<td></td>
</tr>
<tr>
<td>Topic 1. Thermodynamic laws of chemical transformations.</td>
<td>6 - 2 4 5</td>
</tr>
<tr>
<td>Topic 2. The chemical equilibrium and conditions of its shift.</td>
<td>6 - 2 4 5</td>
</tr>
<tr>
<td>Topic 3. The solutions of electrolytes.</td>
<td>6 1 2 2 6.5 0.5 1 5</td>
</tr>
<tr>
<td>Topic 4. The solution of non-electrolytes.</td>
<td>6 1 2 3 5</td>
</tr>
<tr>
<td>Topic 5. The redox processes and their conditions.</td>
<td>6 1 2 3 5</td>
</tr>
<tr>
<td>Topic 6. Bases of electrochemistry.</td>
<td>6 1 2 3 5,5 0.5 1 4</td>
</tr>
<tr>
<td>Topic 7. Electrolysis of melts and solutions of electrolytes as oxidation - reduction process.</td>
<td>6 1 2 3 5,5 0.5 1 4</td>
</tr>
<tr>
<td>Topic 8. Corrosion processes and materials protection against corrosion.</td>
<td>5 1 2 2 5</td>
</tr>
<tr>
<td>Total</td>
<td>47 6 16 24 42.5 1.5 5 36</td>
</tr>
</tbody>
</table>
Module 3. Chemical elements and compounds of elements as the basis of inorganic and organic structural materials

| Topic 1. Properties of non-metals and their compounds in materials and excipients engineering | 6 | 1 | 2 | 4 | 6 | 0,5 | 1 | 5 |
| Topic 2. Chemistry of metals. | 6 | 1 | 2 | 4 | 6,5 | 0,5 | 1 | 5 |
| Topic 3. Bases of organic chemical compounds. | 4 | 1 | 1 | 2 | 5 | | | 5 |
| Topic 4. Polymeric materials and their applications in engineering | 4 | 1 | 1 | 2 | 6,5 | 0,5 | 1 | 5 |
| Total | 20 | 3 | 6 | 12 | 24 | 1 | 3 | 20 |
| Total hours of the course | 90 | 15 | 30 | 45 | 90 | 4 | 10 | 76 |

4. Topics of seminars

<table>
<thead>
<tr>
<th>№</th>
<th>Topic</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td></td>
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<tr>
<td>2</td>
<td></td>
<td></td>
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<tr>
<td>...</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Topics of practical works

<table>
<thead>
<tr>
<th>№</th>
<th>Topic</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Topics of laboratory works

<table>
<thead>
<tr>
<th>№</th>
<th>Topic</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction. Equipment and safety in chemical laboratory. Methods of chemical experiments.</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Bases of modern nomenclature and classification of inorganic compounds.</td>
<td>2(1)</td>
</tr>
<tr>
<td>3</td>
<td>The structure of the atom and Mendeleev’s periodic law</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Determination of the types of chemical bonds between atoms in compounds. The relative electronegativity of atoms.</td>
<td>2(1)</td>
</tr>
<tr>
<td>5</td>
<td>Determination of the thermal effect of the neutralization and dissolution of anhydrous salts.</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>Calculation of kinetic parameters of the reaction according to the experiment.</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Topic</td>
<td>Duration</td>
</tr>
<tr>
<td>---</td>
<td>----------------------------------------------------------------------</td>
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</tr>
<tr>
<td>7</td>
<td>Determination of the conductivity of electrolyte solutions. Indicator method of pH solutions calculation.</td>
<td>2(1)</td>
</tr>
<tr>
<td>8</td>
<td>The preparation of solutions given concentration</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>The properties of metals in redox reactions.</td>
<td>2(1)</td>
</tr>
<tr>
<td>10</td>
<td>The dependence of electromotive force from galvanic cells of metals.</td>
<td>2(1)</td>
</tr>
<tr>
<td>11</td>
<td>Investigation of electrolysis of aqueous solutions of electrolytes. The calculations of the amount of substances using Faraday’s law.</td>
<td>2(1)</td>
</tr>
<tr>
<td>12</td>
<td>Determination of corrosion mass index rate.</td>
<td>2(1)</td>
</tr>
<tr>
<td>13</td>
<td>The chemical properties of non-metals and their compounds/</td>
<td>2(1)</td>
</tr>
<tr>
<td>14</td>
<td>The chemical properties of metals and their compounds.</td>
<td>2(1)</td>
</tr>
<tr>
<td>15</td>
<td>The genetic link between the classes of organic compounds, the methods of detection of organic compounds.</td>
<td>1</td>
</tr>
<tr>
<td>16</td>
<td>The properties of polymers. Introduction to methods of determining the quality of fuels.</td>
<td>2(1)</td>
</tr>
</tbody>
</table>

30 hours (10 hours)
### 7. Example of module tests

**Module №1**

**«Atomic structure and chemical bond»**

**Variant № 1**

1. The possible values of main(principal) quantum number are:

<table>
<thead>
<tr>
<th>A.</th>
<th>integers from 0 to n-1;</th>
<th>B.</th>
<th>+½, -½;</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.</td>
<td>integers from 1 to ∞;</td>
<td>D.</td>
<td>integers from + l to - l.</td>
</tr>
</tbody>
</table>

2. The total number of orbitals in an s-subshell is?...... :

(Write right answer to the answer sheet)

3. Which electron configuration represents an atom Sb in the ground state:

<table>
<thead>
<tr>
<th>A.</th>
<th>1s²2s²2p⁶3s²3p⁶3d¹⁰⁴s²4p⁶4d¹⁰⁵s²5p³;</th>
<th>B.</th>
<th>1s²2s²2p⁶3s²3p⁶3d¹⁰⁴s²4p⁶5s²⁵p⁶⁵d¹⁰;</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.</td>
<td>1s²2s²2p⁶3s²3p⁶3d¹⁰⁴s²5p⁶⁵s²⁵p⁶⁵d¹⁰⁵p⁴;</td>
<td>D.</td>
<td>1s²2s²2p⁶3s²3p⁶3d¹⁰⁴s²4p⁶⁵d¹⁰⁵s⁵p⁴</td>
</tr>
</tbody>
</table>

4. To give the characteristics of elements:

**№ 17, № 50**

**Scheme of answer:**

- To determine (according to the placement of element in the periodic system):
  - element properties - metal or non-metal;
  - the total number of electrons, the total number of shells, the total number of valence electrons;
- To compile electronic and graphic structure of atom of elements.
- To determine the possible valence and oxidation number of element.
- To give an examples of compounds (oxides, bases, acids, salts) with all of possible oxidation numbers.
- To confirm chemical properties with the proper chemical equations.

5. To compile equation between simple substances formed by elements with atomic number 30 and 8, specify the type of chemical bond of obtained compound

6. Determine the types of chemical bonds for the following compounds:

- Manganese; potassium carbonate; phosphate acid; calcium hydroxide; ferrum (III) sulfate

**Variant № 2**

1. What’s formula determine value of secondary(azimuthal) quantum number:

<table>
<thead>
<tr>
<th>A.</th>
<th>2l + 1;</th>
<th>B.</th>
<th>2n²;</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.</td>
<td>2(2l + 1);</td>
<td>D.</td>
<td>0 ÷ n-1.</td>
</tr>
</tbody>
</table>

2. Electronic structure of atom Manganese ..... :

(Write right answer to the answer sheet)

3. The total number of shells (levels) of atom is equal to the number of:...

<table>
<thead>
<tr>
<th>A.</th>
<th>Group ;</th>
<th>B.</th>
<th>Element;</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.</td>
<td>Period;</td>
<td>D.</td>
<td>Series.</td>
</tr>
</tbody>
</table>

4. To give the characteristics of elements:

**№ 15, № 40**

**Scheme of answer:**

- To determine (according to the placement of element in the periodic system):
  - element properties - metal or non-metal;
  - the total number of electrons, the total number of shells, the total number of valence electrons;
- To compile electronic and graphic structure of atom of element.
- To determine the possible valence and oxidation number of element.
- To give an examples of compounds (oxides, bases, acids, salts) with all of possible oxidation numbers.
- To confirm chemical properties with the proper chemical equations.

5. To compile equation between simple substances formed by elements with atomic number 16 and 19, specify the type of chemical bond of obtained compound

6. Determine the types of chemical bonds for the following compounds:

- steel; chrome (III) nitrate; silicate acid; carbon (IV) oxide; chlorine
Variant № 3
1. The total number of orbitals in an f-subshell is:

| A. 7 | B. 3 | C. 5 | D. 1 |

2. The orientation of an orbital in space is specified by ……. quantum number:

(Write only one word to the answer sheet)

3. Which electron configuration represents an atom Zr in the ground state:

A. 1s²2s²2p⁶3s²3p⁶3d¹⁰4s²4p⁴5s²5p⁴;  
B. 1s²2s²2p⁶3s²3p⁶3d¹⁰4s²4p⁴5s²5p⁴;  
Γ 1s²2s²2p⁶3s²3p⁶3d¹⁰4s²4p⁴5s²5p⁴⁴

4. To give the characteristics of elements:

№ 7, № 23

Scheme of answer:
➢ To determine (according to the placement of element in the periodic system):
• element properties - metal or non-metal;
• the total number of electrons, the total number of shells, the total number of valence electrons;
➢ To compile electronic and graphic structure of atom of element.
➢ To determine the possible valence and oxidation number of element.
➢ To give an examples of compounds (oxides, bases, acids, salts) with all of possible oxidation numbers.
➢ To confirm chemical properties with the proper chemical equations.

5. To compile equation between simple substances formed by elements with atomic number 7 and 8, specify the type of chemical bond of obtained compound

6. Determine the types of chemical bonds for the following compounds:
   - barium chlorate;
   - potassium carbonate;
   - 2 molecule of fluoride acid;
   - zinc hydroxide;
   - scandium

Variant № 4

1. Which electron configuration represents an atom Ga in the ground state:

A. 1s²2s²2p⁶3s²3p⁶3d¹⁰4s²4p⁴;  
B. 1s²2s²2p⁶3s²3p⁶3d¹⁰4s²4p⁴;  
Γ 1s²2s²2p⁶3s²3p⁶3d¹⁰4s²4p⁴

2. The maximum number of electron in a d-subshell is?

(Write right answer to the answer sheet)

3. The possible values of spin quantum number are:

<table>
<thead>
<tr>
<th>A. integers from 0 до N-1</th>
<th>B. +½, - ½</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. integers from 0 до ∞</td>
<td>Γ integers from + l до - l</td>
</tr>
</tbody>
</table>

4. To give the characteristics of elements:

№ 9, № 49

Scheme of answer:
➢ To determine (according to the placement of element in the periodic system):
• element properties - metal or non-metal;
• the total number of electrons, the total number of shells, the total number of valence electrons;
➢ To compile electronic and graphic structure of atom of element.
➢ To determine the possible valence and oxidation number of element.
➢ To give an examples of compounds (oxides, bases, acids, salts) with all of possible oxidation numbers.
➢ To confirm chemical properties with the proper chemical equations.

5. To compile equation between simple substances formed by elements with atomic number 19 and 53, specify the type of chemical bond of obtained compound

6. Determine the types of chemical bonds for the following compounds:
   - plumbum (II) nitrate;
   - stibium;
   - 2 molecule of ammoniac;
   - zinc chlorate;
   - nitrogen (V) oxide
Variant № 5

1. The common electronic structures of halogens are:
   A. \((n-1)p^5ns^2\);       B. \((n-1)d^1\);       C. \(ns^2np^5\);       D. \(ns^2(n-1)d\).

2. The general rules for electron formulas compilation are …… :
   (write right answer to the answer sheet)

3. Which electron configuration represents an atom Br in the ground state:
   A. \(1s^22s^22p^63s^23p^63d^104s^24p^5\);   B. \(1s^22s^22p^63s^23p^63d^{10}4s^24p^6\);
   C. \(1s^22s^22p^63s^23p^64s^24p^6\);   D. \(1s^22s^22p^63s^23p^63d^{10}4s^44p^6\);

To give the characteristics of elements:

 № 14, № 38

Scheme of answer:

- To determine (according to the placement of element in the periodic system):
  - element properties - metal or non-metal;
  - the total number of electrons, the total number of shells, the total number of valence electrons;
- To compile electronic and graphic structure of atom of element.
- To determine the possible valence and oxidation number of element.
- To give an examples of compounds (oxides, bases, acids, salts) with all of possible oxidation numbers.
- To confirm chemical properties with the proper chemical equations.

5. To compile equation between simple substances formed by elements with atomic number 11 and 35, specify the type of chemical bond of obtained compound

6. Determine the types of chemical bonds for the following compounds:
   ferrum (III) oxide; silumin; radium phosphate; borate acid; 2 molecule of sulfide acid

Variant № 6

1. The total number of orbitals in an p-subshell is:
   A. 6;       B. 3;       C. 5;       D. 1.

2. The possible values of spin quantum number for electrons in s-subshell are:
   (write right answer to the answer sheet)

3. Which electron configuration represents an atom Mn in the ground state:
   A. \(1s^22s^22p^63s^23p^64s^24p^3\);   B. \(1s^22s^22p^63s^23p^63d^{4}4s^2\);
   C. \(1s^22s^22p^63s^23p^64s^24d^4\);   D. \(1s^22s^22p^63s^23p^63d^{6}4s^4\);

To give the characteristics of elements:

 № 11, № 53

Scheme of answer:

- To determine (according to the placement of element in the periodic system):
  - element properties - metal or non-metal;
  - the total number of electrons, the total number of shells, the total number of valence electrons;
- To compile electronic and graphic structure of atom of element.
- To determine the possible valence and oxidation number of element.
- To give an examples of compounds (oxides, bases, acids, salts) with all of possible oxidation numbers.
- To confirm chemical properties with the proper chemical equations.

5. To compile equation between simple substances formed by elements with atomic number 15 and 8, specify the type of chemical bond of obtained compound

6. Determine the types of chemical bonds for the following compounds:
   phosphorus(V) oxide; hydrogen; aluminium sulfite; chlorate acid; 3 molecules of water
Variant № 7

1. The total number of orbitals in an d-subshell is:
   - A. 1;
   - B. 3;
   - C. 5;
   - D. 10

2. The spin quantum number is specified ….. :
   (write right answer to the answer sheet)

3. Which electron configuration represents an atom I in the ground state:
   - A. 1s²2s²2p⁶3s²3p⁶3d¹⁰4s²⁴p⁶4d⁶⁵s⁵p⁶
   - B. 1s²2s²2p⁶3s²3p⁶3d¹⁰4s²⁴p⁶4d⁶⁵s⁵p⁶
   - C. 1s²2s²2p⁶3s²3p⁶4s²4p⁶⁴d¹⁰⁵s⁵p⁶
   - D. 1s²2s²2p⁶3s²3p⁶3d¹⁰4s²⁴p⁶4d⁶⁵s⁵p⁶

To give the characteristics of elements:

№ 34, № 40

Scheme of answer:
- To determine (according to the placement of element in the periodic system):
  - element properties - metal or non-metal;
  - the total number of electrons, the total number of shells, the total number of valence electrons;
- To compile electronic and graphic structure of atom of element.
- To determine the possible valence and oxidation number of element.
- To give an examples of compounds (oxides, bases, acids, salts) with all of possible oxidation numbers.
- To confirm chemical properties with the proper chemical equations.

5. To compile equation between simple substances formed by elements with atomic number 15 and 8, specify the type of chemical bond of obtained compound

6. Determine the types of chemical bonds for the following compounds:
   - stannum hydroxide; brass; ferrum(III) sulfate; phosphate acid; nitrogen

Variant № 8

1. The magnetic quantum number is specified:
   - A. The energy of an electron in shell and the size of the orbital;
   - B. The energy of an electron in subshell and the shape of an orbital
   - C. The energy of an electron in shell and the size of the orbital;
   - D. The energy of an electron in subshell and the shape of an orbital

2. What is formula determine maximum quantity of electrons on the energy level :
   (write right answer to the answer sheet)

3. Which electron configuration represents an atom Mn in the ground state:
   - A. 1s²2s²2p⁶3s²3p⁶4s²⁴p²;
   - B. 1s²2s²2p⁶3s²3p⁶3d⁴⁴s²;
   - C. 1s²2s²2p⁶3s²3p⁶4s²⁴p²;
   - D. 1s²2s²2p⁶3s²3p⁶3d⁴⁴s²

To give the characteristics of elements:

№ 15, № 48

Scheme of answer:
- To determine (according to the placement of element in the periodic system):
  - element properties - metal or non-metal;
  - the total number of electrons, the total number of shells, the total number of valence electrons;
- To compile electronic and graphic structure of atom of element.
- To determine the possible valence and oxidation number of element.
- To give an examples of compounds (oxides, bases, acids, salts) with all of possible oxidation numbers.
- To confirm chemical properties with the proper chemical equations.

5. To compile equation between simple substances obtained by elements with atomic number 7 and 8, specify the type of chemical bond of obtained compound

6. Determine the types of chemical bonds for the following compounds:
   - barium nitrate; iodine; cadmium phosphate; chlorate acid; 2 molecules of flouride acid
Variant № 9

1. The possible values of main (principal) quantum number are:
   A. integers from 0 до n-1;
   B. integers from 1 до ∞;
   Г. integers from + l до - l.

2. How many valence electrons are found in an atom Cl….. :
   (write right answer to the answer sheet)

3. Which electron configuration represents an atom Sb in the ground state:
   A. 1s²2s²2p⁶3s²3p⁶3d¹⁰4s²4p⁶4d¹⁰5s²5p³;
   Б. 1s²2s²2p⁶3s²3p⁶3d¹⁰4s²4p⁶4d¹⁰5s²5p⁶;
   Г. 1s²2s²2p⁶3s²3p⁶3d¹⁰4s²4p⁶4d¹⁰5s²5p⁶5s⁴.

4. To give the characteristics of elements:
   № 8, № 50

   Scheme of answer:
   ➢ To determine (according to the placement of element in the periodic system):
     • element properties - metal or non-metal;
     • the total number of electrons, the total number of shells, the total number of valence electrons;
   ➢ To compile electronic and graphic structure of atom of element.
   ➢ To determine the possible valence and oxidation number of element.
   ➢ To give an examples of compounds (oxides, bases, acids, salts) with all of possible oxidation numbers.
   ➢ To confirm chemical properties with the proper chemical equations.

5. To compile equation between simple substances obtained by elements with atomic number 16 и 8, specify the type of chemical bond of obtained compound

6. Determine the types of chemical bonds for the following compounds:
   molibden; nitrogen; phosphate acid; aluminium sulfite; cobalt (III) nitrate

Variant № 10

1. Metallic properties across a period tend to
   A. decrease;
   B. don’t change
   В. increase;
   D. first increase and then decrease

2. Electronic structure of atom Sr ….. :
   (write right answer to the answer sheet)

3. The total number of shells (levels) of atom is equal to the number of :
   A. Group;
   B. Element;
   Г. Period;
   D. Series.

4. To give the characteristics of elements:
   № 35, № 49

   Scheme of answer:
   ➢ To determine (according to the placement of element in the periodic system):
     • element properties - metal or non-metal;
     • the total number of electrons, the total number of shells, the total number of valence electrons;
   ➢ To compile electronic and graphic structure of atom of element.
   ➢ To determine the possible valence and oxidation number of element.
   ➢ To give an examples of compounds (oxides, bases, acids, salts) with all of possible oxidation numbers.
   ➢ To confirm chemical properties with the proper chemical equations.

5. To compile equation between simple substances obtained by elements with atomic number 16 и 1, specify the type of chemical bond of obtained compound

6. Determine the types of chemical bonds for the following compounds:
   silumin; ferrum (III) nitrate; sodium phosphate; sulfur (VI) oxide; borate acid
1. The total number of orbitals in an d-subshell is:

A. 7;  B. 3;  C. 5;  D. 10.

2. The orientation of an orbital in space is specified by ….quantum number:

(write only one word to the answer sheet)

3. Which electron configuration represents an atom Ca in the ground state:

A. $1s^22s^22p^63s^23p^63d^{10};$  
B. $1s^22s^22p^63s^23p^63d^{10}4s^1;$  

4. To give the characteristics of elements:

№ 30, № 33

Scheme of answer:

➢ To determine (according to the placement of element in the periodic system):
• element properties - metal or non-metal;
• the total number of electrons, the total number of shells, the total number of valence electrons;
➢ To compile electronic and graphic structure of atom of element.
➢ To determine the possible valence and oxidation number of element.
➢ To give an examples of compounds (oxides, bases, acids, salts) with all of possible oxidation numbers.
➢ To confirm chemical properties with the proper chemical equations.

5. To compile equation between simple substances obtained by elements with atomic number 13 i 16, specify the type of chemical bond of obtained compound

6.Determine the types of chemical bonds for the following compounds:

- cobalt chloride;  
- magnesium phosphate;  
- 2 molecules of ammoniac;  
- sulfite acid;  
- bromine

Variant № 12

1. Which electron configuration represents an atom Rb in the ground state:

A. $1s^22s^22p^63s^23p^63d^{10}4s^24p^5s^1;$  
B. $1s^22s^22p^63s^23p^63d^{10}4s^24p^64d^1;$  

2. The spin quantum number determines….. :

(write right answer to the answer sheet)

3. The possible values of main(principal) quantum number are

A. integers from 0 до n-1;  
B. $+\frac{1}{2}$, $-\frac{1}{2};$

B. integers from 1 до $\infty$;  

4. To give the characteristics of elements:

№ 52, № 19

Scheme of answer:

➢ To determine (according to the placement of element in the periodic system):
• element properties - metal or non-metal;
• the total number of electrons, the total number of shells, the total number of valence electrons;
➢ To compile electronic and graphic structure of atom of element.
➢ To determine the possible valence and oxidation number of element.
➢ To give an examples of compounds (oxides, bases, acids, salts) with all of possible oxidation numbers.
➢ To confirm chemical properties with the proper chemical equations.

5. To compile equation between simple substances obtained by elements with atomic number 15 i 8, specify the type of chemical bond of obtained compound

6.Determine the types of chemical bonds for the following compounds:

- ferrum (III) sulfate;  
- stannum hydroxide;  
- silicate acid;  
- zinc chloride;  
- brass
Module №2

«The bases of electrochemistry»

Variant № 1

1. Specify the number of lost or attached electrons according to the scheme
   \( \text{HNO}_3 \rightarrow \text{NH}_3\):

2. Balance Redox reactions using method of electron balance. Point out oxidizing and reducing agents:
   \( \text{Ba} + \text{H}_2\text{SO}_4\text{conc.} \rightarrow \) Mn + HNO\(_3\)\text{dil.} \rightarrow
   Cu + HCl\(-\) → Na + H\(_2\)O →
   Al + NaOH → Zn(CH\(_3\)COO)\(_2\) + Mg \rightarrow

3. To calculate EMF for the Fe-Cu galvanic cell:
   A. 1,92 V, B. -1,92 V, C. 2,8 V, D. -2,8 V

4. Make the circuit electrode processes that occur on. cathode and anode during the electrolysis of aqueous solutions of potassium sulfate and melt sodium chloride?

5. Calculate amount of Copper on the cathode during electrolysis of aqueous solution of nickel sulfate for 30 minutes at a current 2A??
   A. 71,6 g, B. 4,12 g, C. 2,38 g, D. 1,19 g.

Variant № 2

1. Specify the number of lost or attached electrons according to the scheme
   \( \text{HNO}_3 \rightarrow \text{HNO}_2\):
   A. +2, B. -2, C. +1, D. +8.

2. Balance Redox reactions using method of electron balance. Point out oxidizing and reducing agents:
   \( \text{Ca} + \text{H}_2\text{SO}_4\text{conc.} \rightarrow \) Cu + HNO\(_3\)\text{dil.} \rightarrow
   Au + HCl\(-\) → Ba + H\(_2\)O →
   Cr + NaOH → Cu(CH\(_3\)COO)\(_2\) + Zn \rightarrow

3. To calculate EMF for the Zn-Cu galvanic cell:
   A. 0,1 V, B. -0,78 V, C. 0,78 V, D. 1,1 V

4. Make the circuit electrode processes that occur on. cathode and anode during the electrolysis of aqueous solutions of plumbum nitrate and melt of potassium chloride?

5. Calculate amount of Nickel on the cathode during electrolysis of aqueous solution of nickel sulfate for 80 minutes at a current 5A?
   A. 1,83g, B. 14,7 g, C. 7,3 g, D. 2,23 g.

Variant № 3

1. Specify the number of lost or attached electrons according to the scheme
   \( \text{H}_2\text{SO}_4 \rightarrow \text{S}^0\):
   A. +2, B. +6, C. -6, D. +8.

2. Balance Redox reactions using method of electron balance. Point out oxidizing and reducing agents:
   \( \text{Cu} + \text{H}_2\text{SO}_4\text{conc.} \rightarrow \) Fe + HNO\(_3\)\text{dil.} \rightarrow
   Fe + HCl\(-\) → Li + H\(_2\)O →
   Sn + NaOH → CaCl\(_2\) + Zn \rightarrow

3. To calculate EMF for the Cd-Mn galvanic cell:
   A. 1,96 V, B. -1,96 V, C. 1,92 V, D. 2,76 V

4. Make the circuit electrode processes that occur on. cathode and anode during the electrolysis of aqueous solutions of cobalt sulfate and melt of calcium bromide?
5. Calculate amount of Mercury on the cathode during electrolysis of aqueous solution of nickel sulfate for 120 minutes at a current 10A?
   A. 59.7 g  B. 74.6 g,  C. 149.3 g,  D. 29.9 g.

**Variant № 4**

1. Specify the number of lost or attached electrons according to the scheme
   HNO$_3$ → NH$_3$:
   A. +9,  B. -2,  C. -8,  D. +8.

2. Balance Redox reactions using method of electron balance. Point out oxidizing and reducing agents:
   - K + H$_2$SO$_4$ conc. → Zn + HNO$_3$ dil.
   - Ca + H$_2$SO$_4$ dil. → Cr + H$_2$O
   - Al + NaOH → Zn(NO$_3$)$_2$ + Ag

3. To calculate EMF for the Fe-Ca galvanic cell:
   A. 3.31 V  B. -1.96 V,  C. 2.43 v,  D. -3.31 V

4. Make the circuit electrode processes that occur on cathode and anode during the electrolysis of aqueous solutions of sodium carbonate and melt of sodium sulfide?

5. Calculate amount of Copper on the cathode during electrolysis of aqueous solution of nickel sulfate for 150 minutes at a current 1.5A?
   A. 0.06 g  B. 74.6 g,  C. 3.58 g,  D. 214.9 g.

**Variant № 5**

1. Specify the number of lost or attached electrons according to the scheme
   H$_2$MnO$_4$ → Mn$^{2+}$:

2. Balance Redox reactions using method of electron balance. Point out oxidizing and reducing agents:
   - Zn + H$_2$SO$_4$ conc. → Sn + HNO$_3$ dil.
   - Pb + H$_3$PO$_4$ → Co + H$_2$O
   - Sb + LiOH → CuSO$_4$ + Fe

3. To calculate EMF for the Zn-Cu galvanic cell:
   A. 0.32 V  B. -1.2 V,  C. 1.2 V,  D. 2.8 V

4. Make the circuit electrode processes that occur on cathode and anode during the electrolysis of aqueous solutions of manganese sulfate and melt of aluminium chloride?

5. Calculate amount of Nickel on the cathode during electrolysis of aqueous solution of nickel sulfate for 45 minutes at a current 5A?
   A. 7.49 g  B. 15 g,  C. 149.7 g,  D. 29.9 g.

**Variant № 6**

1. Specify the number of lost or attached electrons according to the scheme
   Fe$^0$ → Fe$^{3+}$:

2. Balance Redox reactions using method of electron balance. Point out oxidizing and reducing agents:
   - Ba + H$_2$SO$_4$ conc. → Zn + HNO$_3$ dil.
   - Ca + HCl → Na + H$_2$O
   - K + NaOH → Zn(CH$_3$COO)$_2$ + Sr

3. To calculate EMF for the Fe-Cd galvanic cell:
A. 0.74 V       B. -0.74 V,       C. 0.06 V,       D. 2.53 V
4. Make the circuit electrode processes that occur on cathode and anode during the electrolysis of aqueous solutions of zinc sulfate and melt of lithium iodide?
5. Calculate amount of aurum on the cathode during electrolysis of aqueous solution of nickel sulfate for 200 minutes at a current 10A?
A. 183 g       B. 367.5 g,       C. 49.1 g       D. 122.5 g.

**Variant № 7**

1. Specify the number of lost or attached electrons according to the scheme
   \( \text{H}_2\text{MnO}_4 \rightarrow \text{H}_2\text{MnO}_4 \):
   A. +2,       B. -2,       C. +1,       D. -1.

2. Balance Redox reactions using method of electron balance. Point out oxidizing and reducing agents:
   \( \text{Cu} + \text{H}_2\text{SO}_4 \text{conc.} \rightarrow \text{Ba} + \text{HNO}_3 \text{dil.} \rightarrow \)
   \( \text{Al} + \text{HCl} \rightarrow \text{Au} + \text{H}_2\text{O} \rightarrow \)
   \( \text{Pb} + \text{NaOH} \rightarrow \text{FeCl}_2 + \text{Zn} \rightarrow \)

3. To calculate EMF for the Fe-Al galvanic cell:
   A. 1.22 V       B. -1.22 V,       C. 1.5 V,       D. 2.1 V

4. Make the circuit electrode processes that occur on cathode and anode during the electrolysis of aqueous solutions of stannum nitrate and melt of cobalt bromide?
5. Calculate how much time should pass through the electrolyte solution electric current 5A power to 1050 g of copper?
A. 83.75 h       B. 23.5 h,       C. 41.8 h,       D. 120 h.

**Variant № 8**

1. Specify the number of lost or attached electrons according to the scheme
   \( \text{H}_2\text{SO}_4 \rightarrow \text{S}_0 \):

2. Balance Redox reactions using method of electron balance. Point out oxidizing and reducing agents:
   \( \text{Ag} + \text{H}_2\text{SO}_4 \text{conc.} \rightarrow \text{Zn} + \text{HNO}_3 \text{dil.} \rightarrow \)
   \( \text{Co} + \text{HCl} \rightarrow \text{Al} + \text{H}_2\text{O} \rightarrow \)
   \( \text{Be} + \text{NaOH} \rightarrow \text{Mg(CH}_3\text{COO)}_2 + \text{Ca} \rightarrow \)

3. To calculate EMF for the Fe-Cu galvanic cell:
   A. 0.47 V       B. -0.47 V,       C. 0.21 V,       D. 2.1 V

4. Make the circuit electrode processes that occur on cathode and anode during the electrolysis of aqueous solutions of potassium sulfate and melt of sodium chloride?
5. Calculate amount of copper on the cathode during electrolysis of aqueous solution of nickel sulfate for 40 minutes at a current 2A?
A. 51.6 g       B. 23.8 g,       C. 0.86 g,       D. 12 g.

**Variant № 9**

1. Specify the number of lost or attached electrons according to the scheme
   \( \text{H}_2\text{S} \rightarrow \text{SO}_2 \):

2. Balance Redox reactions using method of electron balance. Point out oxidizing and reducing agents:
   \( \text{Cu} + \text{H}_2\text{SO}_4 \text{conc.} \rightarrow \text{Fe} + \text{HNO}_3 \text{dil.} \rightarrow \)
Mg + HCl → Ba + H₂O →
Ca + LiOH → Cu(CH₃COO)₂ + Fe →

3. To calculate EMF for the Ag-Cu galvanic cell:
   A. 1.24 V   B. -0.36 V,   C. 0.36 V,   D. 2.1 V

4. Make the circuit electrode processes that occur on cathode and anode during the electrolysis of aqueous solutions of aluminium sulfate and melt of sodium bromide?

5. Calculate how much time should pass through the electrolyte solution electric current 1-10A power to receive 3 kg of Aurum?
   A. 51.6 h   B. 122.2 h,   C. 40 h,   D. 0.12 h.

Variant № 10

1. Specify the number of lost or attached electrons according to the scheme
   H₂SO₄ → SO₂:
   A. +2,   B. -2,   C. +1,   D. +4.

2. Balance Redox reactions using method of electron balance. Point out oxidizing and reducing agents:
   Ca + H₂SO₄ conc. → Fe + HNO₃ dil. →
   Ag + HCl → Ba + H₂O →
   Sb + NaOH → ZnCl₂ + Ca →

3. To calculate EMF for the Fe-Co galvanic cell:
   A. 0.62 V   B. -0.47 V,   C. 0.06 V,   D. 0.74 V

4. Make the circuit electrode processes that occur on. cathode and anode during the electrolysis of aqueous solutions of aluminium sulfate and melt of lithium sulfide?

5. Calculate amount of Copper on the cathode during electrolysis of aqueous solution of nickel sulfate for 30 minutes at a current 2A?
   A. 0.05 g   B. 3.18 g,   C. 0.86 g,   D. 191 g.
Module №3

«Electrolytic dissociation. Chemistry of the elements»

Variant № 1

1. Ions \( \text{Al}^{3+} \) are formed during dissociation in an aqueous solution of:
   A. \( \text{Al(NO}_3\text{)}_3 \), B. \( \text{Al(OH)}_3 \), C. \( \text{Na}_3\text{AlO}_3 \), D. \( \text{Al}_2\text{O}_3 \).

2. The main points of theory of electrolytic dissociation are:
   A. electrolytic dissociation occurs during melting or dissolving of electrolyte;
   B. substance with ionic or covalent non-polar bonds undergo dissociation;
   C. dissociation – is an equilibrium process;
   D. ions are surrounded by hydration shell in aqueous solution.

3. To write molecular, complete and net ionic equations:
   - \( \text{ZnCl}_2 + K_3\text{PO}_4 \rightarrow \text{Ba(NO}_3\text{)}_2 + H_2\text{SO}_4 \rightarrow \)
   - \( K_2\text{SiO}_3 + HCl \rightarrow \text{Fe}_2\text{O}_3 + HNO_3 \rightarrow \)
   - \( \text{Zn(OH)}_2 + \text{Ca(OH)}_2 \rightarrow (\text{NH}_4)_2\text{SO}_4 + \text{NaOH} \rightarrow \)

4. To write the dissociation equation for the ions of the following compounds:
   - ferrum (III) carbonate, itric acid, potassium hydroxide.

5. Specify the number of lost or attached electrons according to the scheme
   \( \text{NO}_3^- \rightarrow \text{NH}_3 \):

6. Balance Redox reactions using method of electron balance. Point out oxidizing and reducing agents:
   - \( \text{Ba} + H_2\text{SO}_4 \text{ conc.} \rightarrow \text{Mn} + HNO_3 \text{ dil.} \rightarrow \)
   - \( \text{Cu} + \text{HCl} \rightarrow \text{Na} + H_2O \rightarrow \)
   - \( \text{Al} + \text{NaOH} \rightarrow \text{Zn(CH}_3\text{COO)}_2 + \text{Mg} \rightarrow \)

Variant № 2

1. Ions \( \text{Pb}^{2+} \) are formed during dissociation in an aqueous solution of:
   A. \( \text{PbCl}_2 \), B. \( \text{Pb(OH)}_2 \), C. \( \text{Na}_2\text{PbO}_2 \), D. \( \text{Pb(CH}_3\text{COO)}_2 \).

2. Determinate strong electrolytes:
   A. \( \text{CaCO}_3, \text{Na}_2\text{CO}_3, \text{Al}_2\text{(SO}_4\text{)}_3 \), B. \( \text{BaO, Mn(CH}_3\text{COO)}_2, \text{HBr} \),
   C. \( \text{Na}_3\text{AlO}_3, (\text{NH}_4)_2\text{PO}_4, \text{HClO}_4 \),
   D. \( \text{CuCl}_2, \text{HNO}_2, \text{Ca(NO}_3\text{)}_2 \).

3. To write molecular, complete and net ionic equations:
   - \( \text{CoCl}_2 + \text{Na}_3\text{PO}_4 \rightarrow \text{BaCl}_2 + H_2\text{SO}_4 \rightarrow \)
   - \( K_2\text{SO}_3 + HNO_3 \rightarrow \text{NH}_4\text{NO}_3 + \text{NaOH} \rightarrow \)
   - \( \text{Al(OH)}_3 + \text{NaOH} \rightarrow \text{Cr}_2\text{O}_3 + \text{HClO}_4 \rightarrow \)

4. To write the dissociation equation for the ions of the following compounds:
   - Aluminium hydroxide, mangane (II) chloride, sulfate acid.

5. Specify the number of lost or attached electrons according to the scheme
   \( \text{NO}_3^- \rightarrow \text{NO}_2 \):
   A. +2, B. -2, C. +1, D. +8.

6. Balance Redox reactions using method of electron balance. Point out oxidizing and reducing agents:
   - \( \text{Ca} + H_2\text{SO}_4 \text{ conc.} \rightarrow \text{Cu} + HNO_3 \text{ dil.} \rightarrow \)
   - \( \text{Au} + \text{HCl} \rightarrow \text{Ba} + H_2O \rightarrow \)
   - \( \text{Cr} + \text{NaOH} \rightarrow \text{Cu(CH}_3\text{COO)}_2 + \text{Zn} \rightarrow \)

Variant № 3

1. Ions \( \text{Ca}^{2+} \) are formed during dissociation in an aqueous solution of:
   A. \( \text{Ca(NO}_3\text{)}_2 \), B. \( \text{CaCO}_3 \), C. \( \text{Ca}_3(\text{AlO}_3)_2 \), D. \( \text{CaO} \).

2. The main points of theory of electrolytic dissociation are:
A. electrolytic dissociation occurs during melting or dissolving of electrolyte;
B. substance with ionic or covalent non-polar bonds undergo dissociation;
C. dissociation – is an equilibrium process;
D. ions are surrounded by hydration shell in aqueous solution.

3. To write molecular, complete and net ionic equations:
   \[ \text{MgBr}_2 + \text{Na}_3\text{PO}_4 \rightarrow \]
   \[ \text{Pb(NO}_3\text{)}_2 + \text{H}_2\text{SO}_4 \rightarrow \]
   \[ \text{Cu(CH}_3\text{COO})_2 + \text{HNO}_3 \rightarrow \]
   \[ \text{AgNO}_3 + \text{NH}_4\text{Cl} \rightarrow \]
   \[ \text{Be(OH)}_2 + \text{Ba(OH)}_2 \rightarrow \]
   \[ \text{Fe}_2\text{O}_3 + \text{HJ} \rightarrow \]

4. To write the dissociation equation for the ions of the following compounds:
   manganese phosphate, chlorate acid, cobalt hydroxide.

5. Specify the number of lost or attached electrons according to the scheme
   \[ \text{SO}_4^{2-} \rightarrow \text{S}^0; \]
   A. +2, \hspace{1cm} B. +6, \hspace{1cm} В. -6, \hspace{1cm} Г. +8.

6. Balance Redox reactions using method of electron balance. Point out oxidizing and
   reducing agents:
   \[ \text{Cu} + \text{H}_2\text{SO}_4\text{conc.} \rightarrow \]
   \[ \text{Fe} + \text{HCl} \rightarrow \]
   \[ \text{Sn} + \text{NaOH} \rightarrow \]
   \[ \text{CaCl}_2 + \text{Zn} \rightarrow \]

**Variant № 4**
1. Ions Mn$^{2+}$ are formed during dissociation in an aqueous solution of:
   A. MnBr$_2$, \hspace{1cm} Б. Mn(OH)$_2$, \hspace{1cm} В. MnCO$_3$, \hspace{1cm} Г. Mn(CH$_3$COO)$_2$.

2. Determinate strong electrolytes:
   A. H$_2$CO$_3$, Na$_2$SO$_3$, Al$_2$(SO$_4$)$_3$, \hspace{1cm} Б. Ba(OH)$_2$, Mn(CH$_3$COO)$_2$, HBr,
   B. Na$_3$AlO$_3$, NH$_4$OH, LiOH, \hspace{1cm} Г. HF, HNO$_2$, Ca(NO$_3$)$_2$.

3. To write molecular, complete and net ionic equations:
   \[ \text{Mn(CH}_3\text{COO})_2 + \text{HJ} \rightarrow \]
   \[ \text{Fe}_2\text{O}_3 + \text{H}_2\text{SO}_4 \rightarrow \]
   \[ \text{K}_2\text{S} + \text{Cu(NO}_3\text{)}_2 \rightarrow \]
   \[ \text{K}_2\text{SO}_4 + \text{Ca(OH)}_2 \rightarrow \]
   \[ \text{Na}_3\text{PO}_4 + \text{H}_2\text{SO}_3 \rightarrow \]

4. To write the dissociation equation for the ions of the following compounds:
   zinc hydroxide, copper (II) silicate, sulfide acid.

5. Specify the number of lost or attached electrons according to the scheme
   \[ \text{NO}_3^- \rightarrow \text{NH}_4^+; \]
   A. +9, \hspace{1cm} Б. -2, \hspace{1cm} В. -8, \hspace{1cm} Г. +8.

6. Balance Redox reactions using method of electron balance. Point out oxidizing and
   reducing agents:
   \[ \text{K} + \text{H}_2\text{SO}_4\text{conc.} \rightarrow \]
   \[ \text{Ca} + \text{H}_2\text{SO}_4\text{dil} \rightarrow \]
   \[ \text{Al} + \text{NaOH} \rightarrow \]
   \[ \text{Zn(NO}_3\text{)}_2 + \text{Ag} \rightarrow \]

**Variant № 5**
1. Ions Fe$^2$ are formed during dissociation in an aqueous solution of:
   A. Fe(OH)$_2$, \hspace{1cm} Б. FeCO$_3$, \hspace{1cm} В. Fe$_3$(AlO)$_2$, \hspace{1cm} Г. FeCl$_2$.

2. Acids are dissociated with forming of:
   A. metal atoms (or ion NH$_4^+$) \hspace{1cm} Б. acid residue
   Б. hydroxyl group – OH. \hspace{1cm} Г. Hydrogen atom

3. To write molecular, complete and net ionic equations:
   \[ \text{Fe(NO}_3\text{)}_2 + \text{H}_2\text{PO}_4 \rightarrow \]
   \[ \text{Zn(CH}_3\text{COO})_2 + \text{HNO}_3 \rightarrow \]
   \[ \text{KOH} + \text{Cr(OH)}_3 \rightarrow \]
   \[ \text{NH}_4\text{Cl} + \text{Ba(OH)}_2 \rightarrow \]
   \[ \text{ZnO} + \text{HJ} \rightarrow \]
   \[ \text{Na}_2\text{CO}_3 + \text{CaCl}_2 \rightarrow \]
4. To write the dissociation equation for the ions of the following compounds: calcium hydroxide, ferrum (III) nitrate, phosphate acid.

5. Specify the number of lost or attached electrons according to the scheme

\[ \text{MnO}_4^- \rightarrow \text{Mn}^{3+} \]

A. +3, \quad \text{B.} -3, \quad \text{B.} -5, \quad \Gamma. +5.

6. Balance Redox reactions using method of electron balance. Point out oxidizing and reducing agents:

\[ \text{Zn} + \text{H}_2\text{SO}_4 \text{conc.} \rightarrow \quad \text{Sn} + \text{HNO}_3 \text{dil.} \rightarrow \]
\[ \text{Pb} + \text{H}_3\text{PO}_4 \rightarrow \quad \text{Co} + \text{H}_2\text{O} \rightarrow \]
\[ \text{Sb} + \text{LiOH} \rightarrow \quad \text{CuSO}_4 + \text{Fe} \rightarrow \]

**Variant № 6**

1. Ions \( \text{PO}_4^{3-} \) are formed during dissociation in an aqueous solution of:

A. \( \text{H}_3\text{PO}_4 \), \quad \text{B.} \text{Na}_3\text{PO}_4, \quad \text{В.} \text{Mn}_3(\text{PO}_4)_2, \quad \Gamma. \text{Zn}_3(\text{PO}_4)_2.

2. Determine strong electrolytes:

A. \( \text{H}_2\text{SO}_4, \text{H}_2\text{SiO}_3, \text{Al}_2(\text{SO}_4)_3 \), \quad \text{Б.} \text{Ba(OH)}_2, \text{BaSO}_4, \text{HJ},

B. \( \text{NaCl}, (\text{NH}_4)_2\text{SO}_4, \text{LiOH} \), \quad \Gamma. \text{HF}, \text{HNO}_2, \text{Ca(NO}_3)_2.

3. To write molecular, complete and net ionic equations:

\[ \text{NaOH} + (\text{NH}_4)_3\text{PO}_4 \rightarrow \quad \text{CuS} + \text{H}_2\text{SO}_4 \rightarrow \]
\[ \text{FeSO}_4 + \text{Na}_3\text{PO}_4 \rightarrow \quad \text{NH}_3\text{NO}_3 + \text{Ca(OH)}_2 \rightarrow \]
\[ \text{Al(OH)}_3 + \text{NaOH} \rightarrow \quad \text{ZnO} + \text{HNO}_3 \rightarrow \]

4. To write the dissociation equation for the ions of the following compounds: copper (II) phosphate, stibium hydroxide, carbonate acid.

5. Specify the number of lost or attached electrons according to the scheme

\[ \text{Fe}^{0} \rightarrow \text{Fe}^{3+} \]

A. +3, \quad \text{B.} -3, \quad \text{В.} +6, \quad \Gamma. -1.

6. Balance Redox reactions using method of electron balance. Point out oxidizing and reducing agents:

\[ \text{Ba} + \text{H}_2\text{SO}_4 \text{conc.} \rightarrow \quad \text{Zn} + \text{HNO}_3 \text{dil.} \rightarrow \]
\[ \text{Ca} + \text{HCl} \rightarrow \quad \text{Na} + \text{H}_2\text{O} \rightarrow \]
\[ \text{K} + \text{NaOH} \rightarrow \quad \text{Zn}(\text{CH}_3\text{COO})_2 + \text{Sr} \rightarrow \]

**Variant № 7**

1. Ions \( \text{CO}_3^{2-} \) are formed during dissociation in an aqueous solution of:

A. \( \text{H}_2\text{CO}_3 \), \quad \text{Б.} \text{CaCO}_3, \quad \text{В.} \text{Na}_2\text{CO}_3, \quad \Gamma. \text{NiCO}_3.

2. Bases - are dissociated with forming of:

A. metal atoms (or ion \( \text{NH}_4^+ \)) \quad \text{B.} \quad \text{acid residue}

\( \text{Б.} \quad \text{hydroxyl group} - \text{OH}^-. \) \quad \Gamma. \quad \text{Hydrogen atom}

3. To write molecular, complete and net ionic equations:

\[ \text{CuCl}_2 + \text{Na}_3\text{PO}_4 \rightarrow \quad \text{BaCl}_2 + \text{H}_2\text{SO}_4 \rightarrow \]
\[ \text{Fe(CH}_3\text{COO})_2 + \text{HNO}_3 \rightarrow \quad \text{Na}_2\text{CO}_3 + \text{Ca(OH)}_2 \rightarrow \]
\[ \text{Cr(OH)}_3 + \text{NaOH} \rightarrow \quad \text{CuO} + \text{HClO}_4 \rightarrow \]

4. To write the dissociation equation for the ions of the following compounds: plumbum (II) hydroxide, calcium nitrate, sulfuric acid.

5. Specify the number of lost or attached electrons according to the scheme

\[ \text{MnO}_4^- \rightarrow \text{MnO}_4^{2+} \]

A. +2, \quad \text{B.} -2, \quad \text{В.} +1, \quad \Gamma. -1.

6. Balance Redox reactions using method of electron balance. Point out oxidizing and reducing agents:

\[ \text{Cu} + \text{H}_2\text{SO}_4 \text{conc.} \rightarrow \quad \text{Ba} + \text{HNO}_3 \text{dil.} \rightarrow \]
1. Ions Cr^{3+} are formed during dissociation in an aqueous solution of:
   A. CrBr_{3},             B. Cr(OH)_{3},            C. K_{2}CrO_{3},             D. Cr_{2}O_{3}.

2. Determine weak electrolytes:
   A. H_{2}CO_{3}, Na_{2}SO_{3}, Al_{2}(SO_{4})_{3},
   B. Ba(OH)_{2}, Mn(CH_{3}COO)_{2}, HBr,
   C. Na_{3}AlO_{3}, NH_{4}OH, Sr(OH)_{2},
   D. HF, HNO_{2}, H_{2}CO_{3}.

3. To write molecular, complete and net ionic equations:
   Ca(CH_{3}COO)_{2} + HJ →
   (NH_{4})_{2}CO_{3} + NaOH →
   Pb(OH)_{2} + Ca(OH)_{2} →

4. To write the dissociation equation for the ions of the following compounds:
   beryllium hydroxide, ammonium carbonate, phosphate acid.

5. Specify the number of lost or attached electrons according to the scheme
   Cr^{2+} → Cr^{3+}:
   A. +2,             B. -2,             C. +1,             D. -1.

6. Balance Redox reactions using method of electron balance. Point out oxidizing and reducing agents:
   Ag + H_{2}SO_{4} conc. →
   Co + HCl→
   Be + NaOH →

Variant № 9

1. Ions SO_{3}^{2-} are formed during dissociation in an aqueous solution of:
   A. H_{2}SO_{3}            B. CaSO_{3},            C. Na_{2}SO_{3},            D. NiSO_{3}.

2. Salt are dissociated with forming of:
   A. metal atoms (or ion NH_{4}^{+})
   B. hydroxyl group – OH.
   C. Hydrogen atom

3. To write molecular, complete and net ionic equations:
   CH_{3}COOH + Na_{2}CO_{3} →
   Cu(OH)_{2} + HCl →
   Sn(OH)_{2} + NaOH →

4. To write the dissociation equation for the ions of the following compounds:
   chromium hydroxide, ammonium sulfate, carbonate acid.

5. Specify the number of lost or attached electrons according to the scheme
   H_{2}S → SO_{3}^{2-}:

6. Balance Redox reactions using method of electron balance. Point out oxidizing and reducing agents:
   Cu + H_{2}SO_{4} conc. →
   Mg + HCl→
   Ca + LiOH →

Variant № 10

1. Ions Cd^{2+} are formed during dissociation in an aqueous solution of:
   A. CdBr_{2},             B. Cd(OH)_{2},            C. CdS,             D. CdO.

2. Determine weak electrolytes:
3. To write molecular, complete and net ionic equations:

A. \( \text{H}_2\text{CO}_3, \text{Na}_2\text{SO}_3, \text{Al}_2(\text{SO}_4)_3 \)

B. \( \text{Ba(OH)}_2, \text{Mn(CH}_3\text{COO)}_2, \text{HBr}, \)

B. \( \text{AgOH, NH}_4\text{OH, H}_2\text{SO}_3 \)

Г. \( \text{HF, HNO}_2, \text{Sr(OH)}_2 \)

4. To write the dissociation equation for the ions of the following compound:

stannum (II) hydroxide, sodium sulfide, phosphate acid.

5. Specify the number of lost or attached electrons according to the scheme

\[ \text{Mg}^{2+} \rightarrow \text{Mg}^0 \]

A. +2, Б. -2, В. +1, Г. +8.

6. Balance Redox reactions using method of electron balance. Point out oxidizing and reducing agents:

\[ \text{Ca} + \text{H}_2\text{SO}_4 \text{ cons.} \rightarrow \]

\[ \text{Fe} + \text{HNO}_3 \text{ dil.} \rightarrow \]

\[ \text{Ag} + \text{HCl} \rightarrow \]

\[ \text{Ca} + \text{H}_2\text{O} \rightarrow \]

\[ \text{Sb} + \text{NaOH} \rightarrow \]

\[ \text{ZnCl}_2 + \text{Ca} \rightarrow \]
8. Methods of teaching

In conducting lectures appropriate to use verbal teaching methods: explanation, narration, discussion, educational debate, with a combination of visual learning methods: illustration, showing. In carrying out laboratory work should be used such as verbal learning method of instruction on the combination of visual learning methods of illustration and demonstration, the aspect of these studies is that they facilitate communication theory and practice. Laboratory work in the laboratory are equipped basic chemical and electrochemical equipments.

9. Forms of control

The main methods of control of knowledge and skills students have to study the subject "Remote sensing for land resources monitoring" are: oral examination, written and practical test, standardized control in the form of modular test papers, assessment for individual learning task, the final test. The total value of these methods is to make the best possible to ensure timely and comprehensive feedback between students and teachers, by which establishes how students perceive and learn the material. The purpose determines the choice of control methods, it should be borne in mind that these methods can be applied in all kinds of control - only complete applications allows regularly and objectively identify the dynamics of the formation of knowledge and skills of students. Each control method has its advantages and disadvantages, scope of application, none of them can not be the only one able to diagnose all aspects of the learning process. So: - to control the absorption of lectures: oral questioning, written modular test papers, current testing score for an individual learning task, the final test. - for the monitoring and evaluation of laboratory work: practical test and evaluation of each laboratory work.

10. Distribution of grades received by students during study.

<table>
<thead>
<tr>
<th>Current testing</th>
<th>Rating of educational work</th>
<th>Rating of additional work</th>
<th>Negative Rating</th>
<th>Final test</th>
<th>Total amount of scores</th>
</tr>
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<tbody>
<tr>
<td>Module 1</td>
<td>Module 2</td>
<td>Module 3</td>
<td>R_{HP}</td>
<td>R_{ДР}</td>
<td>R_{ШТР}</td>
</tr>
<tr>
<td>0-100</td>
<td>0-100</td>
<td>0-100</td>
<td>0-70</td>
<td>0-20</td>
<td>0-5</td>
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</table>

\[
R_{HP} = \frac{0.7 \cdot (R_{13M} \cdot K_{13M} + \ldots + R_{n3M} \cdot K_{n3M})}{\sum_{i=1}^{n} K_{i3M}} + R_{ДР} - R_{ШТР},
\]

\[K_{ДИС} = K_{13М} + \ldots + K_{n3М} \text{ – total amount of credits ECTS;}

де \( R_{13M}, \ldots, R_{n3M} \) – rating of 1st, 2nd and 3d modules by 100 mark scale;

\( n \) – number of modules;

\( K_{13М}, \ldots, K_{n3М} \) – credits ECTS.
\( R_{ДР} \) – rating of additional work;
\( R_{ШТР} \) – penal rating.

A rating of discipline can be calculated by formula:

\[
0.7 \cdot (R_{13М}^{(1)} + \ldots + R_{13М}^{(n)}) + R_{ДР} - R_{ШТР}. \\
\]

**Ratio between national and ECTS values and rating from the discipline**

Grading is based on tests, homework assignments, quizzes and laboratory investigations by to the following table.

<table>
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<tr>
<th>Rating, points</th>
<th>ECTS</th>
<th>National value</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 – 100</td>
<td>A</td>
<td>Excellent</td>
</tr>
<tr>
<td>82-89</td>
<td>B</td>
<td>Very good</td>
</tr>
<tr>
<td>74-81</td>
<td>C</td>
<td>Good</td>
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<tr>
<td>64-73</td>
<td>D</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>60-63</td>
<td>E</td>
<td>Satisfactory enough</td>
</tr>
<tr>
<td>35-59</td>
<td>FX</td>
<td>Unsatisfactory</td>
</tr>
<tr>
<td>0-34</td>
<td>F</td>
<td>Unsatisfactory – serious work is needed</td>
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<table>
<thead>
<tr>
<th></th>
<th>National value</th>
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</thead>
<tbody>
<tr>
<td>Examination</td>
<td>Test</td>
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<tr>
<td></td>
<td>passed</td>
</tr>
<tr>
<td></td>
<td>not passed with the possibility of re-compiling</td>
</tr>
<tr>
<td></td>
<td>not passed with the obligatory re-learning course</td>
</tr>
</tbody>
</table>
Required and recommended literature

11. Methodical support


12. Basic literature


Supplemental materials


13. IT resources

13. https://www.youtube.com/channel/UCD2fRmgV93G8ZUxZTGLhScA