INTERNATIONAL EUROPEAN UNIVERSITY

APPROVED BY
Head of the Admission Committee,
_____ Serhii KURILO
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PHYSICS PROGRAM

for specialized entrance examination for foreign citizens and stateless persons desiring to receive higher education based on secondary education

Kyiv – 2020

CONTENT

No.	Section, topic	Knowledge	Subject skills and methods of training activities
		1. Mechanics	
1.1	Kinematics.	Mechanical motion. Key goal of mechanics and methods of body motion description. Uniform and non-uniform straight motion. Motion relativity. Velocity addition law. Acceleration. Uniformly accelerated motion. Diagram of dependence of kinematic values on time for uniform and uniformly accelerated straight motion. Full-circle uniform motion of material point. Centripetal acceleration. Angular and linear speed, their interaction.	*To apply* the rules of calculating scalar and vector values. *To define* the nature of mechanical motion and its characteristics. *To use* formulas while calculating motion characteristics. *To draw* diagrams of dependence of kinematic values on time. *To resolve* standard problems and *analyze* obtained results in terms of their credibility. *To explain* regularities and formulas of kinematics, reasonability of their application while resolving problems.
1.2	Laws of dynamics and their application.	Force. Inertial reference frames. Galileo's principle of relativity. Mass. Newton's laws and their application to resolve problems. Gravitational interaction. Universal law of gravitation. Gravity force and body weight. Body motion in the gravity field. Free fall. Body motion as affected by several forces. Archimedes' principle. Body equilibrium. Force moment. Body equilibrium conditions. Center of gravity and body mass center.	*To apply* the rules of dynamics while explaining mechanical phenomena. *To define* forces affecting the body and their resultants, display them in diagram form. *To use* formulas of vector algebra and trigonometry. *To resolve* standard problems and *analyze* obtained results in terms of their credibility. *To explain* formulas of dynamics and physical forces, reasonability of their application while resolving problems. *Find* the numerical result of problem resolving in the International System of Units (ISU).
1.3	Conservation laws in mechanics.	Impulse, impulse law. Kinetic and potential energy. Power. Law of the conservation of mechanical energy. Application of conservation laws in mechanics.	*To apply* conservation laws while explaining mechanical phenomena and resolving problems. *To define* the body and body system impulse, kinetic, potential and total mechanical energy of the body and body system. *To resolve* standard problems and

			analyze obtained results in terms of their credibility. *To explain* formulas of conservation laws, reasonability of their application while resolving problems.
1.4	Relativistic mechanics. Elements of the special theory of relativity (STR)	Bounds of application of classical mechanics laws. General provisions for STR and their consequences. Relativistic velocity addition law.	*To apply* STR laws while explaining relativistic phenomena and resolving problems. *To resolve* standard problems dedicated to the application of STR formulas. *To explain* STR formulas, reasonability of their application while resolving problems.
2. Molecular physics and thermodynamics			
2.1	Molecular-kinetic theory of substance. Perfect gas.	General provisions for molecular-kinetic theory (MKT). Brownian motion, diffusion. Mass and size of atoms and molecules, Avogadro constant, amount of substance. Relative molecular and molal mass. Perfect gas. Gas pressure. Fundamental equation of the molecular-kinetic theory of perfect gas. Absolute scale of temperature. Perfect gas equation. Isoprocesses.	*To apply* the molecular-kinetic theory while explaining heat phenomena, diffusion, Brownian motion. *To define* perfect gas parameters and their relation. *To draw* isoprocess diagrams. *To resolve* standard problems.
2.2.	Thermodynamics	Body internal energy. Amount of heat. Thermodynamic process operation. First law of thermodynamics. Adiabatic process. Thermal machines. Operating principles of thermal machines. Cycle of thermal machines. Efficiency of thermal machines. Irreversibility of thermal processes. Entropy.	*To apply* thermodynamics laws while describing heat phenomena. *To define* the internal energy, amount of heat and perfect gas operation in isoprocesses. *To draw* diagrams of thermal machine cycles. *To resolve* standard problems. *To explain* heat phenomena based on the molecular-kinetic theory.
2.3	Application of the molecular-kinetic theory and thermodynamics.	Properties of saturated and unsaturated steam. Air humidity. Liquid tension. Wetting. Capillary phenomena. Deformation. Mechanical properties of solid bodies. Young's modulus.	*To apply* the molecular-kinetic theory and thermodynamic laws while describing phenomena of humidity, liquid tension, mechanical deformation and elasticity. *To define* physical characteristics of substances in different aggregative states. *To resolve* standard problems.
3. Electrodynamics			
3.1	Electrostatics.	Electromagnetic interaction. Electric field. Dielectric field intensity. Superposition principle. Electric interaction of point charges. Coulomb's	*To apply* electrostatics laws while describing electric phenomena. *To define* intensity and electric field potential, condenser electric

		law. Substance in the electric field. Conductors and dielectrics in the electric field. Operation during charge displacement in the uniform electric field. Electric field potential. Potential difference. Interconnection between dielectric field intensity and potential difference. Electric capacity. Electric capacity of plate condenser. Condenser connection. Electric field energy. Application of condensers in equipment.	capacity. *To resolve* standard problems.
3.2	Electric current.	Constant electric current. Electromotive force. Ohm's law for complete circuit. Calculation of electric circuits with multiple series of conductors. Operation and power of electric current. Safety during electrical appliance operations. Electric current in metals. Dependence of resistivity on the temperature. Superconductivity. Conductibility of semi-conductors. Intrinsic conduction and impurity conductivity of semi-conductors. Electron-hole junction: its properties and application. Semiconducting element base of modern microelectronics. Electric current in solutions and electrolyte fusions. Electrolysis and its laws. Gas discharges and their application. Plasma. Electric current in vacuum. Thermal electron emission. Application of electric current in different environments, equipment and technologies.	*To apply* electrostatics laws while describing electric current in different environments. *To define* the current rate, electric tension, electric resistance, operation and power of current. *To resolve* standard problems.
3.3	Magnetic field. Electromagnetic induction.	Electric and magnetic interaction. Interaction between conductors and current. Current magnetic field. Magnet-like lines of direct and circular currents. Magnetic field induction. Magnetic induction flux. Magnetic field action on a current-carrying conductor. Ampere force. Magnetic field action on moving charged particles. Lorentz force. Operating principle of electric motors. Electromagnetic induction. Magnetic flux. Faraday law of induction. Self-induction. Inductivity. Magnetic field energy. Application of electromagnetic induction phenomenon in modern	*To explain* the electromagnetic induction phenomenon and operating principles of electric devices. *To use* the Ampere rule and Maxwell' rule to define the direction of the magnetic field, Ampere force, Lorentz force and induction current in a conductor. *To apply* electrodynamics laws while describing electromagnetic phenomena. *To define* Ampere force, Lorentz force, electromotive force of induction and self-induction. *To resolve* standard problems.

		equipment and technologies.	
4. Vibrations and waves			
4.1	Mechanical vibrations and waves.	Mechanical vibrations. Harmonic vibrations. Harmonic vibration equations. Mathematical and spring-loaded pendulums. Energy conversion during vibrations. Forced vibrations. Concept of auto vibrations. Resonance. Propagation of mechanical vibrations in the elastic medium. Huygens' principle.	*To explain* mechanical vibration and wave motion laws, their characteristics, the phenomenon of auto vibrations and resonance. *To define* the period, frequency and amplitude of vibrations; the length, frequency and speed of the wave. *To work out* differential equations of vibrations. *To resolve* standard problems.
4.2	Electromagnetic vibrations and waves.	Free electromagnetic vibrations. Vibrating contour. Forced electromagnetic vibrations. Alternating current and its characteristics. Effective voltage and current rate. Transformer. Production, transfer and application of electric current energy. Creation and propagation of electromagnetic waves. Properties of electromagnetic waves. Physical basis of telecommunication connection.	*To explain* electromagnetic vibration and wave phenomena based on electrodynamics laws, operating principles of electromagnetic devices and telecommunication connection principles. *To resolve* standard problems.
4.3	Optical phenomena.	Light as an electromagnetic wave. Light propagation in different environments. Doppler effect. Light absorption and dispersion. Interference and diffraction of light waves. Polarization and dispersion of light. Core photometric quantities and their measurement. Geometric optics as an extreme wave case. Geometric optics laws. Creation of images obtained using lens and mirrors. Vision angle. Optical devices and their application.	*To explain* optical phenomena based on electrodynamics and wave theory, operating principles of optical devices. *To use* reflection and refraction laws. *To create* images using lens and mirrors. *To define* characteristics of lens and images. *To resolve* standard problems.
5. Quantum physics			
5.1	Quantum theory and its application.	Quantum properties of atom. Quantum Bohr postulates. Light emission and absorption by atoms. Atomic and molecular spectra. Continuous light spectrum. Spectroscope. Spectrum analysis and its application. Quantum light properties. Planck's hypothesis 'Light quantum'. Photon energy and momentum. Photo effect. Photo effect equation. Photo effect application. Solar batteries.	*To explain* light emission and absorption laws based on the quantum theory. *To use* quantum physics laws. *To resolve* standard problems.

5.2	Physics of atomic nucleus and elementary particles.	Atomic nucleus. Nuclear forces and their features. Nuclear reactions. Radioactivity. Radioactive decay law. Interaction between mass and energy. Nuclear energetics. Dosimetry. Radiation doses. Protection against ionizing radiation. Elementary particles. General characteristics of elementary particles. Quarks. Cosmic radiation. Registration methods of elementary particles.	*To explain* the composition and structure of atomic nucleus, radioactive decay laws, nuclear energetics principles. *To use* radioactive decay laws and nuclear transformation rules. *To define* characteristics of ionizing radiation. *To apply* knowledge of dosimetry and protection against ionizing radiation. *To resolve* standard problems.

Recommended reading list and references

1. Textbook "Physics. Class 7" /auth. Bariakhtar V.G., Dovhyi S.O., Bozhynova F.Y. / Kharkiv: "Ranok", 2015.
2. Textbook "Physics. Class 8" /auth. Bariakhtar V.G., Dovhyi S.O., Bozhynova F.Y., Kiriukhina O.O. / Kharkiv: "Ranok", 2016.
3. Textbook "Physics. Class 9" /auth. Bariakhtar V.G., Dovhyi S.O., Bozhynova F.Y. / Kharkiv: "Ranok", 2017.
4. Textbook "Physics. Class 10" /auth. Bariakhtar V.G., Dovhyi S.O., Bozhynova F.Y. / Kharkiv: "Ranok", 2018.
5. Textbook "Physics. Class 11" /auth. Bariakhtar V.G., Dovhyi S.O., Bozhynova F.Y., Kiriukhina O.O. / Kharkiv: "Ranok", 2019.
6. Physics. Full course of training to enter higher educational institutions/auth. M. Didovych, E. Korshak. /K.: Letter. LTD, 2012.
7. Training materials to pass external independent testing./ https://zno.osvita.ua/physics/

ASSESSMENT CRITERIA

Each test assignment of the physics entrance exam contains questions designed according to the Program for physics exams for applicants of Ukraine's higher educational institutions approved by the Ministry of Education and Science of Ukraine. Besides, test assignments are selected so that to cover all sections of the given program as much as possible and reasonably assess knowledge of applicants.

Test assignment questions are assessed due to the 200-point scale based on the fact that the final grade consists of the grade of each assignment (table 1).

The test assignment includes standard assignments distributed in the following way.

1. Assignment I.

Multiple-choice tests with one correct answer among 4 given ones, concerning physical terms, physical values and their measurement units. The correct answer is

assessed by 8 points, the incorrect answer – 0 points. The general amount of points for assignment I is 40 points.

2. Assignment II.

Assignments are focused on knowledge of physics laws and formulas. They include assignments 1 – 4 – multiple-choice tests with one correct answer among 4 given ones; assignment 5 consisting of 10 zero option questions.

Each correct answer to assignments 1 – 3 is assessed by 8 points, the incorrect answer – 0 points. The correct answer to assignment 4 is assessed by 16 points, the incorrect answer – 0 points. Each correct answer to one of the 10 questions of assignment 5 is assessed by 40 points, the incorrect answer – 0 points. The maximum amount of points for assignment 5 is 40 points. The general maximum amount of points for assignment II is 80 points.

3. Assignment III.

Application of acquired theoretical knowledge while resolving problems. The assignment contains two problems, the correct answer to each one is assessed by 40 points. The answer with insignificant errors is 30 points. The incorrect answer – 0 points. The general maximum amount of points for assignment III is 80 points.

Explanations:

Significant errors (the ones affecting the quality and value of the answer and able to reduce substantially its assessment):

- non-acquaintance of key physical terms, physical values, definitions, laws and formulas;
- non-acquaintance of physical value measurement units;
- incorrect use of physical terms, values, laws and formulas;
- incorrect interpretation of physical terms, values, laws and formulas.

Insignificant errors (the ones that do not affect the quality of the answer but can change its assessment):

- mistakes in numerous intermediate calculations of formulas, resulting in the incorrect answer;
- obtaining the result of physical value calculation without specifying its dimension;
- mistakes while transforming non-system and derivatives of system measurement units of physical values into fundamental units in the International System of Units;
- specifying the dimension of calculated physical value in non-system and derivatives of system measurement units of physical values in the International System of Units.

Taking into account the above-mentioned as well as according to the requirements of the chemistry program for applicants of Ukraine's higher educational institutions, the general assessment of applicants' knowledge is based on answers to all questions put in the test assignment.

Structure of examination test assignments and assessment of answers to each section

No.	Structure and composition of test assignment	Amount of assignments	Assessment criteria of answers	Maximum amount of points
1	Assignment I. Knowledge of physical terms, physical values and their measurement units. 4 options of answers.	5	8 points – correct answer to each test assignment; 0 – incorrect answer.	40
2	Assignment II. Knowledge of physical laws and formulas. Assignments 1 – 4 contain 4 options of answers; Assignment 5 contains 10 zero option questions.	5	8 points – correct answer to each test assignment 1 – 3, together 24 points; 16 points – correct answer to assignment 4; 4 points – correct answer to each of 10 questions of assignment 5, together 40 points; 0 – incorrect answer.	80
3	Assignment III. Problem resolving.	2	40 – correct answer ; 30 – correct answer with insignificant errors; 0 – incorrect answer.	80

Maximum amount of points – 200. Minimum amount of points that allow applicants to participate in competitive selection is 120.