MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

TERNOPIL VOLODYMYR HNATIUK NATIONAL PEDAGOGICAL UNIVERSITY

FACULTY OF PHYSICS AND MATHEMATICS

«I approve»

Rector _____ Bogdan BUYAK

April 27, 2023

**PROGRAM
PROFESSIONAL ENTRANCE TEST
TO OBTAIN THE SECOND (MASTER'S)
LEVEL OF HIGHER EDUCATION
(BRANCH OF KNOWLEDGE: 01 EDUCATION/PEDAGOGY
SPECIALIST: 014.08 SECONDARY EDUCATION (PHYSICS)
EDUCATIONAL AND PROFESSIONAL PROGRAM
«SECONDARY EDUCATION (PHYSICS, MATHEMATICS)»)**

Considered and approved at the
meeting of the Department of
Physics and Methods of its Teaching
(Protocol № 10 of April 19, 2023)

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EXPLANATORY NOTE

The program of the entrance exam in physics is intended for applicants entering the training for a master's degree in the specialty **014.08 Secondary education (Physics and Astronomy)**. it aims at a comprehensive check of the level of professional competence of applicants, checking the level of assimilation by applicants of the basic laws and regulations of physics, the depth of the material learned, the ability to use the acquired knowledge to analyze physical phenomena and processes in solving physical problems.

The basis of the exam program is the current curricula in the disciplines of "General Physics", including all the main questions related to the course of general physics. The course consists of traditional sections of general physics: "Mechanics", "Molecular Physics and fundamentals of thermodynamics", "Electromagnetism", "Optics", "Quantum Physics".

To successfully pass the exam, the applicant must know the actual material from the course of general physics, which includes scientific concepts, experimental facts and laws of both classical theory and modern physics, in particular, classical mechanics, molecular kinetic theory of the structure of matter, thermodynamics, classical electrodynamics and electronic theory of matter, the photonic nature of light, special and general relativity, quantum mechanics, physics of the atomic system of elementary particles, etc. Also, the applicant must understand the importance of theory in the development of physics and the role of theoretical research methods, be aware of the role of the experiment in physical science, understand the relationship between theory and experiment, their inseparable connection, be able to apply theoretical knowledge, practical skills and abilities when solving problems of different types.

LIST OF THEORETICAL QUESTIONS SUBMITTED FOR ENTRANCE TEST

1. Mechanical movement. Ways to set the movement. Speed and acceleration of straight and curvilinear motion. Kinematic equations of motion. Rules for adding Galileo's speed.
2. Body weight. Force. Newton's laws and the limits of their applicability.
3. Conservation laws in mechanics. Momentum. Moment momentum. Mechanical energy. Mechanical work. The law of conservation of momentum, momentum, energy.
4. Mechanics of liquids and gases. Hydrostatic laws. Archimedes' Law. Pascal's Law. Stationary movement of the ideal liquid. Bernoulli's equation. The equation of continuity.
5. Harmonic fluctuations. Mathematical and physical pendulum. Own, free and forced fluctuations. Fading fluctuations. Kindness. Resonance.
6. Dynamic equations for the rotational motion of an absolutely solid. A moment of inertia. Momentum momentum. Instant rotation axis. Gyroscope.
7. Inertial and non-inertial reference systems. Movement of the body in the non-inertial reference system. Forces of inertia. Centrifugal force of inertia and coriolis strength.
8. The Law of Gravitational Interaction. Gravitational field. The intensity and potential of the gravitational field. Kepler's laws. Space speeds.
9. The main provisions of the molecular-kinetic theory of matter. The perfect gas. The basic equation of molecular-kinetic theory of ideal gas. Equation of the state of the ideal gas. Isoprocesses in perfect gas.
10. Maxwell's distribution by speed, by velocity projection, by speed module. Properties of distribution functions. Characteristic velocques of particles of ideal gas.
11. Barometric formula. Distribution function. Boltzmann's distribution. Maxwell-Boltzmann distribution.
12. Transfer processes in an ideal gas. Collision of particles of ideal gas. Self-diffusion, viscosity and thermal conductivity in an ideal gas.
13. The first law of thermodynamics. Application of the first law of thermodynamics to isoprocesses in an ideal gas. Specific and molar heat capacity of the ideal gas. Adiabatic process. Polytropic process.
14. Heat and refrigeration machines. The second law of thermodynamics in the formulations of Thomson and Boltzmann. Carnot cycle. Efficiency of the Carnot cycle. Clausius inequality. Entropy.

15. Aggregate states of the substance and their properties. Phase transitions and their types. Specific heat phase transition. Evaporation and boiling. Boiling conditions. Clapeyron–Clausius equation.
16. Electric charge. Electrostatic interaction. Coulomb's Law. Tension and induction of the electric field. Ostrohradsky-Gauss theorem.
17. Potentiality of the electric field. Potential, potential difference. Mechanical operation of the electric field. Capacitors. Energy and energy density of the electric field.
18. Electric dipole in an electric field. Polarization of dielectrics and its types. Electric field in dielectric. Dielectric permeability of the substance. Conductors in an electric field.
19. Electric current. Ohm's law for the circle area (integral and differential forms). Ohm's law for a vicious circle. Combination of conductors and current sources. Kirchhoff's rules.
20. Magnetic field. Induction and intensity of the magnetic field. Bio-Savarra-Laplace Act. The law of full current. Magnetic field of solenoid. Ampere's strength. Leakage with current in the magnetic field. Lorenz's strength.
21. The phenomenon of electromagnetic induction. The phenomenon of self-induction. Faraday's Law. Inductance. Energy and energy density of the magnetic field. The law of conservation of energy in the phenomena of electromagnetic induction and self-induction.
22. Electromagnetic field. Maxwell's equation. Electromagnetic waves (EMW). The rate of spread of EMW. Energy density, energy flow, energy flow density and intensity of electromagnetic radiation.
23. Look at the electromagnetic radiation. Light radiation. Superposition of light waves. Interference of light and the influence of coherence on its observations. Experiments on the observation of light interference.
24. Huygens-Fresnel principle. Diffraction of light. Areas of diffraction. Fraunhofer diffraction on the gap, round hole and on a one-dimensional diffraction lattice. Diffraction of X-radiation on the crystal.
25. Transverse electromagnetic waves. Look at the polarization. Polarization of light due to reflection from the surface of the dielectric. Brewster's Law. Polaroids. Malus's Law.
26. Thermal radiation. Absolutely black body (ABB). Spectral distribution of the radiative ability of APT. The laws of Stephen-Boltzmann and Vin. Limitations of the classical theory of thermal radiation. Quanta hypothesis. Planck formula.

27. External photo effect. Einstein's equation. Photon hypothesis. Energy, mass and pulse of the photon. The Compton effect. Corpuscular-wave dualism of electromagnetic radiation.
28. De Broyle waves. Corpuscular-wave dualism in the microcosm. Heisenberg's uncertainty principle. Wave function and its statistical interpretation. Schrödinger's stationary equation. Quantizing the energy of linked systems.
29. Application of Schrödinger's stationary equation to the hydrogen atom and hydrogen-like ion. Quantum of energy, momentum module and momentum projection.
30. Properties of the atomic nucleus: dimensions, mass, electric charge, spin. Nucleon model of the atomic nucleus. Nuclides. Isotopes. Defect in mass and bond energy of the atomic nucleus. Radioactivity. Types at the radioactivity. The law of radioactive decay. Conservation laws in radioactive decay.

THE STRUCTURE AND CONTENT OF THE EXAM, THE FORM OF CONDUCT

Professional entrance test is conducted in the form of <u>an oral exam</u> based on tickets approved by the head of the admissions committee.

The ticket contains one theoretical question and two tasks. The applicant is given 45 minutes to prepare, after which he gives an oral answer to the tasks of the selected ticket. This time is enough for preparation, problem solving and psychological adaptation.

Evaluation criteria

The assessment of the response is carried out on a scale of assessment from 100 to 200 points. The distribution of points is given in the table.

Theoretical question	Task № 1	Task № 2	Amount
40	30	30	100

The transfer of the number of points of the entrance exam to the rating (on a scale of 100-200 points) is carried out according to the table given at the end of the program.

Entrants are allowed to participate in the competitive selection for admission to training, the score of which for a professional test is **not less than 124**.

Evaluation of the theoretical part of the entrance test

40-30 – is applied when the applicant shows a correct understanding of the physical content of phenomena and patterns, laws and theories under consideration, gives a precise definition and interpretation of basic concepts, laws and theories, as well as the correct definition of physical quantities. , units and methods of their measurement; correctly performs drawings, diagrams and graphs that accompany the answer; builds the answer according to own plan, accompanies the story with own examples;

29-20 – is put if the answer satisfies the basic requirements, but it does not use its own narrative plan, its examples, knowledge does not apply in the new situation;

19-10 – is put if most of the answer satisfies the basic requirements, but there are some gaps in the knowledge of theoretical material;

9-0 – is applies when the applicant does not have the basic knowledge and skills in accordance with the requirements of this test.

Assessment of the practical part of the entrance test

30-20 – is set when the applicant solves the problem, which should end with a formula and a number, or only a formula, if the problem does not provide for calculations.

19-10 – is set if the correct path is chosen in solving the problem, but the solution is not completed.

9-0 – is put when the right path of solution is chosen, but there is no solution.

Table of transfer of the number of points of the entrance exam to the rating (on a scale of 100-200 points)

Number of points of the entrance exam	Rating	Number of points of the entrance exam	Rating	Number of points of the entrance exam	Rating
0-23	Not composed	49	149	75	175
24	124	50	150	76	176
25	125	51	151	77	177
26	126	52	152	78	178
27	127	53	153	79	179
28	128	54	154	80	180
29	129	55	155	81	181
30	130	56	156	82	182
31	131	57	157	83	183
32	132	58	158	84	184
33	133	59	159	85	185
34	134	60	160	86	186
35	135	61	161	87	187
36	136	62	162	88	188
37	137	63	163	89	189
38	138	64	164	90	190
39	139	65	165	91	191
40	140	66	166	92	192
41	141	67	167	93	193
42	142	68	168	94	194
43	143	69	169	95	195
44	144	70	170	96	196
45	145	71	171	97	197
46	146	72	172	98	198
47	147	73	173	99	199
48	148	74	174	100	200

LIST OF RECOMMENDED SOURCES

1. 25 Free General Physics Books. ULR:https://www.infobooks.org/free-pdf-books/physics/general-physics/
2. Textbook for students of higher technical and pedagogical educational institutions / Kucheruk I. M., Gorbachuk I. T., Lutsyk P. P. for ed. Kucheruka I.M. - K. : Technics, 1999. Volume 1: Mechanics. Molecular physics and thermodynamics. - 536 cc
3. Textbook for students of higher technical and pedagogical educational institutions / Kucheruk I. M., Gorbachuk I. T., Lutsyk P. P. for ed. Kucheruka I.M.-K.:Technique,2001.Volume 2: Electricity and magnetism. - 452 cc
4. Textbook for students of higher technical and pedagogical educational institutions / Kucheruk I. M., Gorbachuk I. T.; for ed. Kucheruka I. M. - K.: Technique,1999.Volume 3: Optics. Quantum physics. - 520 cc
5. Bushock, G.F. Physics course [Text] : textbook for stud. physi-mat. fak. Ped. universities: in 3 kn. Kn. 1: Physical foundations of mechanics. Molecular Physics and Thermodynamics / G. F. Bushock, E. F. Wenger. – K. : Higher school, 2002. – 375 p.
6. Bushock, G.F. Physics course [Text] : textbook for stud. physi-mat. fak. Ped. universities: in 3 kn. Kn. 2 : Electricity and magnetism / G. F. Bushock, E. F. Wenger. – K. : Higher school, 2003. – 378 p.
7. Bushock, G.F. Physics course [Text] : textbook : in 2 kn. Kn. 2: Optics. Physics of the atom and atomic nucleus. Molecular Physics and Thermodynamics / G. F. Bushock, E. F. Wenger. – 2nd type. – K. : Lybid, 2001. – 424 cc.
8. Mohun, S. V. Physical foundations of mechanics. Course of lectures: teaching. manual [Text] / S.V. Mohun; Ternopil National Pedagogical University. – Ternopil, 2016. – 255 p.
9. General course of physics: Collection of tasks / For ed. I.P.Garkushi, I.T.Gorbachuk, V.P.Kurinnyi, etc.; By Ed. I.P.Garkushi. – K.: Technics, 2003. – 359 p.
10. Voznyuk S.Yu., Voznyuk A.S., Voznyuk S.S. General physics: Test control of educational achievements. — Ternopil, Textbooks and Manuals, 2006.
11. Mohun S.V. General Physics. Mechanics. Collection of tasks: Teaching. sibn. – Ternopil: TNPU, 2019. – 260 p.: Ill.