ENTRANCE EXAMINATION IN PHYSICS FOR APPLICANTS ENTERING MASTER'S PROGRAMS OF LANDAU PHYSTECH SCHOOL OF PHYSICS AND RESEARCH

The entrance test consists of a written part (duration - 1.5 hours) and an interview (approximately one hour after the end of the written part). The final grade for the subject is based on the results of both parts of the test.

1. Laws Newton's law. Inertial and non-inertial reference systems.
2. The principle of relativity Galileo and the principle of relativity Einstein.Conversions The Lorentz method. Invariance of the interval.
3. Laws of conservation of energy and momentum. Elastic and inelastic collisions.
4. Equation of motion of a material point in relativistic mechanics. Momentum andenergy of a material point.
5. The law of universal gravitation and its laws Kepler. Motion of bodies in the gravitational field.
6. Law of conservation of angular momentum. Equation of moments. Rotation of a rigid bodyaround a fixed axis.
7. The flow of an ideal fluid. The continuity equation. The equation Bernoulli.
8. Viscous fluid movement. The formula Poiseuille. Number Reynolds, its physicalmeaning.
9. Elastic deformations. Young's modulus and coefficient Poisson's law. Energy of elastic deformation.
10. Equation of state of an ideal gas, its explanation на based on molecularkinetic theory. Non-ideal gas equation Van der Waals.
11. Quasi -static processes. The first law of thermodynamics. The amount of heat andwork. Internal energy. Enthalpy.
12. The second law of thermodynamics. Cycle Carnot. Entropy and the law of its increase. Entropy of an ideal gas.
13. Thermodynamic potentials. Conditions of equilibrium of systems.
14. Distributions Maxwell and Boltzmann.
15. Heat capacity. The law of uniform distribution of energy in degrees of freedom. Dependence of the heat capacity of gases on temperature.
16. Phase transitions. The equation Clapeyron-Clausius. State diagrams.
17. Transfer phenomena: diffusion, thermal conductivity, and viscosity. Transport coefficients ingases.
18. Fluctuations. Brownian motion. Ratio Einstein.
19. Coulomb's law. The Gauss theorem in differential and integral forms. Circulation theorem for an electrostatic field. Potential. The equation Poisson's law.
20. Electrostatic field in a substance. Polarization vector, electric induction. Boundary conditions for vectors E and D.
21. Magnetic field of direct currents in vacuum. Basic equations of magnetostatics in vacuum. The Bio-Savard law. Power Amperes. The Lorentz force.
22. Magnetic field in a substance. Basic equations of magnetostatics in matter. Boundary conditions for vectors B and H.
23. Electromagnetic induction in moving and stationary conductors. EMF of induction. Self- and mutual induction. The reciprocity theorem.
24. System of equations Maxwell 's equations in integral and differential forms. Ток Offset current. Material equations.
25. The law of conservation of energy for an electromagnetic field. Poynting vector. Pulse of the electromagnetic field.
26. Quasi -stationary currents. Free and forced oscillations in electrical circuits. The phenomenon of resonance. Q-factor of the oscillatory circuit, its energy meaning.
27. Spectral decomposition of electrical signals. Spectra of vibrationsmodulated by amplitude and phase.
28. Electrical fluctuations. Shotgun blast and thermal noise. Sensitivity limitof electrical measuring devices.
29. Electromagnetic waves. The wave equation. The equation Helmholtz.

30. Electromagnetic waves in waveguides. Critical frequency. Volume resonators.
31. Plasma. Plasma frequency. Dielectric constant of plasma.
32. Wave interference. Temporal and spatial coherence. Uncertainty ratio.
33. Principle Huygens-Fresnel method. Fresnel zones. Fresnel and Fraunhofer diffraction.Limits of applicability of geometric optics.
34. Spectral devices (prism, diffraction grating, Fabry interferometer Stylus) and their main characteristics.
35. Diffraction limit of the resolution of optical and spectral devices. CriterionRayleigh.
36. Spatial Fourier transform in optics. Diffraction on sinusoidallattices. Abbe's theory of image formation.
37. Principles of holography. The hologram Gabor. A hologram with an inclined reference beam. Three-dimensional holograms.
38. A wave packet. Phase and group velocity. The formula Rayleigh. Classical theoryof variance. Normal and abnormal variance.
39. Polarization of light. Angle Brewster. Optical phenomena in uniaxial crystals.
40. X-ray diffraction. The Bragg-Wolf formula. Refractive index of a substance for X-rays.
41. The quantum nature of light. External photo effect. The equation Einstein. Effect Compton.
42. Spontaneous and stimulated radiation. Inverse population of levels. The principle of laser operation.
43. Blackbody radiation . The formula Planck, laws Wines and Stefan- Boltzmann.
44. Wave-particle dualism. De Broglie waves. Devisson-Germer experiments and Thomson 's theory of electron diffraction.
45. The wave function. Coordinate and momentum operators. Average values of physical quantities. Uncertainty relation for coordinate and momentum. The Schrodinger equation.
46. Bohr's postulates. Energy spectrum of hydrogen -like atoms. Characteristic radiation, Moseley's law.
47. Stern's experiments and Gerlach. Electron spin. Orbital and spin magnetic moments of an electron.
48. Identity of particles. Symmetry of the wave function with respect to the permutation of particles. Bosons and fermions. Principle Pauli. Electronic structure of atoms. Table of contentsMendeleev.
49. Fine and hyperfine structure of optical spectra. Selection rules for the absorptionand emission of photons by atoms.
50. The Zeeman effect in weak magnetic fields.
51. The Zeeman effect in strong magnetic fields.
52. Nuclear and electronic magnetic resonances.
53. The law of radioactive decay. Half и -life and lifetime.
54. Tunneling of particles through a potential barrier. Alpha decay. Geiger's Law- Nattola and his explanation.
55. Types of beta decays. Explanation of the continuity of the electron energy spectrum.Neutrinos.
56. Nuclear reactions. Composite core. Cross -section of non-resonant reactions. Bethe's law.
57. Resonant nuclear reactions, formula Breit-Wigner.
58. Nuclear fission under the action of neutrons. The principle of operation of athermal neutron nuclear reactor.
59. Uncertainty relation for energy and time. Estimation of the lifetimeof virtual particles and the radii of strong and weak interactions.
60. Fundamental interactions and fundamental particles (leptons, quarks, andcarriers of interactions). Quark structure of hadrons.

Literature

1. Sivukhin D. V. General course of physics. Vol . 1-5 , Moscow: Fizmatlit Publ., 2003.
2. Collection of problems in the general course of physics. Vol. 1-3 / под ed. V. A. Ovchinkin. – Moscow: Fizmatkniga Publ., 2013.
3. Kingsep A. S., Lokshin G. R., Olkhov O. A. Osnovy fiziki [Fundamentals of physics]. Course of General Physics, Vol. 1-2, Moscow: Fizmatlit Publ., 2001