

Examination program in physics

Theme 1. Mechanics.

Mechanical motion. Relativity of mechanical motion. Material point. Reference frame. Trajectory. The displacement vector and its projection. Way. Velocity. Addition of velocities.

Acceleration. Addition of accelerations. Linear uniform and uniformly accelerated motion. The dependence of velocity, coordinates and way on the time. Curvilinear motion. Circular motion. Angular velocity. The period and frequency of circulation. Acceleration of the body when driving in a circle. Tangential and normal acceleration.

Free fall of bodies. The acceleration of a freely falling body. Motion of the body thrown at an angle to the horizon. Distance and height of the flight.

The translational and rotational motion of a solid body.

Theme 2. Dynamics.

The interaction of bodies. Newton's first law. The concept of inertial and non-inertial reference frames. Galileo's principle of relativity.

Force. The forces in mechanics. Addition of forces acting on a material point. The inertness of bodies. Mass. Density.

Newton's Second Law. Units of measurement of force and mass.

Newton's Third Law. The law of gravity. Gravitational constant. Gravity. Dependence of gravity on height.

Elasticity forces. The concept of deformations. Hooke's Law. Young's modulus.

The forces of friction. Dry friction: static friction and sliding friction. The coefficient of friction. Viscous friction. Application of Newton's laws to the translational motion of bodies. Body weight. Weightlessness. Overload.

Application of Newton's laws to the motion of a material point in a circle. Motion of artificial satellites. The first cosmic speed.

Theme 3. Conservation laws in mechanics.

Momentum (quantity of motion) of the material point. Force momentum. The relationship between the increment of momentum of a material point and force

momentum. The momentum of a system of material points. Mass center . The law of conservation of momentum. Jet motion.

Mechanical work. Power. Energy. Units of measurement of work and power. The kinetic energy of the material point and system of material points. The relationship between the increment of the kinetic energy of the body and the work of forces applied to the body. Potential energy. The potential energy of bodies near the Earth's surface. The potential energy of elastically deformed body. The law of conservation of mechanical energy.

Theme 4. Statics of a solid body.

Addition of forces applied to a solid body. Moment of force relative to the rotation axis. The rule of moments.

Body equilibrium conditions. The body's center of gravity. Stable, unstable and indifferent equilibrium of bodies.

Theme 5. Mechanics of liquids and gases.

Pressure. Pressure measurement units: Pascal, mercury millimeter.

The law of Pascal. Hydraulic press. The liquid pressure at the bottom and walls of the vessel. Communicating vessels. Atmosphere pressure. Experience of Torricelli.

Atmospheric pressure change with height.

Archimedes' Law. Swimming of bodies. Liquid motion. Bernoulli's equation.

Theme 6. Mechanical oscillations and waves. Sound.

The concept of the oscillatory motion. Period and frequency of oscillation. Harmonic oscillations. Offset, amplitude and phase at harmonic oscillations .

Free oscillations. Oscillation of load on the spring. Mathematical pendulum. The periods of oscillation. Transformation of energy at harmonic oscillations. Damped oscillations.

Forced oscillations. Resonance.

The concept of wave processes. Transverse and longitudinal waves. Wavelength. The speed of wave propagation. The wave front. The equation of a traveling wave. Standing waves. Interference of waves. Huygens' principle. Diffraction of waves.

Sound waves. Speed of sound. The volume and pitch of the sound.

Theme 7. Fundamentals of molecular kinetic theory.

The main provisions of the molecular kinetic theory and their experimental justification. Brownian motion. Weight and size of molecules. Mole of substance. Avogadro constant. The nature of the motion of molecules in gases, liquids and solids. Thermal equilibrium. Temperature and its physical meaning. Celsius temperature scale.

Ideal gas. The basic equation of molecular kinetic theory of ideal gas. The average kinetic energy of molecules and temperature. Boltzmann constant. The absolute temperature scale.

Clapeyron-Mendeleev equation (the equation of state of an ideal gas). Universal gas constant. Isothermal, isochoric and isobaric processes.

Theme 8. Elements of thermodynamics.

Thermodynamic system. The internal energy of the system. The amount of heat and work as measures of internal energy change. The heat capacity of the body. The concept of an adiabatic process. The first law of thermodynamics. Application of the first law of thermodynamics to isothermal, isochoric and isobaric processes. Calculation of the gas work with the help of pV-diagrams. The heat capacity of a monatomic ideal gas under isobaric and isochoric processes.

The irreversibility of processes in nature. The second law of thermodynamics. Physical basics of heat engines. Thermal engine efficiency and its maximum value.

Theme 9. The change of the aggregate state of matter.

Vaporization. Evaporation, boiling. Enthalpy of vaporization. Saturated steam. The dependence of pressure and density of saturated steam on temperature. The dependence of the boiling point on the pressure. The critical temperature. Humidity. Relative humidity.

Crystalline and amorphous state of matter. Enthalpy of fusion. The equation of the heat balance.

Theme 10. The surface tension in liquids.

The strength of the surface tension. The phenomena of wetting and non-wetting. The pressure under the curved surface of fluid. Capillary phenomena.

Theme 11. The thermal expansion of solids and liquids.

The thermal linear expansion. Thermal volume expansion. Features of thermal expansion of water.

Theme 12. Electrostatics.

Electric charges. Elementary electric charge. The law of conservation of electric charge. The interaction of electrically charged bodies. Electroscope. A point charge. Coulomb's Law.

Electric field. The electric field intensity. The lines of the electric field (force lines). A uniform electric field. The intensity of the electrostatic field of a point charge. The principle of superposition of fields. Gauss theorem. The electrostatic field of a uniformly charged plane, sphere and a ball.

The work of electrostatic forces. Potential and potential difference. Connection of potential difference and intensity of the electrostatic field. The potential of a point charge field. Equipotential surfaces.

Conductors and dielectrics in an electrostatic field. The dielectric permittivity of the substance. Electric capacity. Capacitors. Flat capacitor field. Electric capacity of flat capacitor. Series and parallel connection of capacitors. The energy of a charged capacitor.

Electric field energy

Theme 13. Direct current.

Electric current. Amperage. Conditions of existence of the DC in the circuit. The electromotive force (EMF). Voltage. Measurement of current and voltage.

Ohm's Law for subcircuit. The ohmic resistance of the conductor. Resistivity. The dependence of the resistivity on temperature. Superconductivity. Series and parallel circuits. Resistance measurement.

Ohm's law for the complete chain. Current sources and their connection. Kirchhoff's rules.

Work and power of the current. Joule–Lenz law .

Electric current in metals. Electric current in electrolytes. The laws of electrolysis. Electric current in vacuo. Thermionic emission. E-lamp diode. Cathode-ray tube.

Semiconductors. Own and impurity conductivity of semiconductors. The dependence of conductivity of semiconductors on temperature. p-n-junction and its properties. The semiconductor diode. Transistor. Thermistor and photo resistor.

Electric current in gases. Independent and non-independent level. The concept of the plasma.

Theme 14 Magnetism.

Magnetic field. The action of a magnetic field on a current frame. The induction of the magnetic field (magnetic induction). Lines of magnetic induction. Pictures of induction lines of the magnetic field of a direct current and a solenoid. The concept of the Earth's magnetic field.

The force acting on a current-carrying conductor in a magnetic field. Ampere's Law.

Action of a magnetic field on a moving charge. The Lorentz force.

Magnetic properties of substance. The hypothesis of Ampere. Ferromagnets.

Theme 15. Electromagnetic induction.

The magnetic flux. Faraday experiments. The phenomenon of electromagnetic induction. The vortex electric field. The law of electromagnetic induction. The rule of Lenz. Self-inductance. Inductance. EMF of self-induction. The energy of the magnetic field.

Theme 16. Electromagnetic oscillations and Waves.

Alternating electric current. The amplitude and the actual (effective) value of a periodically varying voltage and current.

Obtaining AC via induction generators. Transformer. Electric power transmission.

The oscillation circuit. Free electromagnetic oscillations in the circuit. Transformation of energy in the resonant circuit. The equation describing the processes in the resonant circuit, and its solution. Thomson formula for the oscillation period. The damped electromagnetic oscillations.

Forced oscillations in electrical circuits. Active, capacitive and inductive resistance in the harmonic current circuit. Resonance in electrical circuits.

Open oscillating circuit. The experiments of Hertz. Electromagnetic waves. Their properties. Scale of electromagnetic waves. Radiation and reception of electromagnetic waves. Radiocommunication principles.

Theme 17. Geometrical Optics.

The development of views on the nature of light. The law of the rectilinear propagation of light. The concept of the beam.

The intensity (flux density) of radiation. Light flow. Illumination.

The laws of reflection of light. The flat mirror. A spherical mirror. Imaging in plane and spherical mirrors.

The laws of refraction of light. Absolute and relative refractive indices. The path of rays in the prism. Total (internal) reflection phenomenon.

Thin lenses. The focal length and optic power of the lens.

Making an image in collecting and dispersing lenses. The formula of a lens. The increase given by the lenses.

Optical instruments: magnifying glass, camera, projector, a microscope. The path of rays in these devices. Eye.

Theme 18. Elements of physical optics.

The wave properties of light. Polarization of light. Electromagnetic nature of light. The speed of light in a homogeneous medium. Dispersion of light. Spectroscope. Infrared and ultraviolet radiation.

Interference of light. Coherent sources. The conditions of formation of maxima and minima in the interference pattern.

Diffraction of light. Experience of Jung. Huygens-Fresnel principle. Diffraction grating.

The corpuscular properties of light. Planck's constant. Photoeffect. The laws of photoeffect. Photon. Einstein's equation for the photoelectric effect.

Pressure of the light. Experiments of Lebedev on light pressure measurement.

The postulates of the theory of relativity (Einstein's postulates). The relationship between mass and energy.

Theme 19. The atom and the atomic nucleus.

Rutherford's experiments on the scattering of α -particles. The planetary model of the atom. Bohr's quantum postulates. The emission and absorption of energy by atom. Continuous and line spectra. Spectral analysis.

Experimental methods for the recording charged particles: Wilson chamber, Geiger counter, the bubble chamber, the photo emulsion method.

The composition of the nucleus of an atom. Isotopes. The binding energy of atomic nuclei. The concept of nuclear reactions. Radioactivity. Types of radioactive radiations and their properties. Nuclear chain reaction. The thermonuclear reaction.

Biological effects of radioactive radiations. Radiation protection.