1. **Course content**
2. **MECHANICS**
Kinematics. Mechanical movement. Relativity of motion. Reference system. Material point. Trajectory. Trajectory and displacement. Speed. Acceleration. Uniform and uniformly accelerated rectilinear motion. Free fall. Acceleration of gravity. Equation of rectilinear uniformly accelerated motion.

The curvilinear motion of a point on the example of motion in a circle with a constant velocity.

Centripetal acceleration.

Basics of dynamics.

Inertia. Newton's first law. Inertial reference systems.

Objects interaction. Weight. Impulse. Force. Newton's second law. The principle of superposition of forces. Galilean relativity.

Forces in nature. Newton's law of universal gravitation. Body weight. Weightlessness. First cosmic speed. The elastic force. Hooke's law. Friction force. Friction force. The law of sliding friction.

Newton's third law.

Moment of force (torque). Equilibrium condition of bodies.

The conservation laws in mechanics.

The law of conservation of momentum. Rockets.

Mechanical work. Power. Kinetic energy. Potential energy. The energy conservation law in mechanics. Simple mechanisms. The efficiency of the mechanism.

Mechanics of liquids and gases.

Pressure. Atmospheric pressure. Change in atmospheric pressure with altitude. Pascal's law for liquids and gases. Barometers and manometers. Communicating vessels. The principle of the hydraulic press.

Archimedean force for liquids and gases. The conditions of floating bodies on the surface of the liquid.

The movement of fluid through the pipes. The dependence of fluid pressure on the speed of its flow.

Measurement of distances, time intervals, force, volume, mass, atmospheric pressure.

1. **MOLECULAR PHYSICS.**

**THERMODYNAMICS**

Basics of molecular kinetic theory.

Experimental substantiation of the main provisions of the molecular kinetic theory. Brownian motion. Diffusion. Mass and size of molecules. Measurement of the speed of molecules. Stern experience. Amount of substance. Mole. Avogadro constant. The interaction of molecules. Models of gas, liquid and solid body.

Basics of thermodynamics.

Thermal equilibrium. Temperature and its measurement. Absolute temperature scale. Internal energy. Quantity of heat. The heat capacity of the substance. Work in thermodynamics. The first law of thermodynamics. Isothermal, isochoric and isobaric processes. Adiabatic process.

Irreversibility of thermal processes. The second law of thermodynamics and its statistical interpretation. Energy conversion in heat engines. Efficiency of the heat engine.

Ideal gas. The relationship between pressure and the average kinetic energy of ideal gas molecules. The relationship of temperature with the average kinetic energy of gas particles. The ideal gas law (the general gas equation, Clausius–Clapeyron relation). Ideal gas constant.

Fluids and solids. Evaporation and condensation. Vapor pressure, saturated and not saturated vapor. Air humidity. Liquid boiling.

Crystalline and amorphous bodies. Energy conversion with changes in the aggregate state of matter.

Measurement of gas pressure, air humidity, temperature, substance density.

1. **BASICS OF ELECTRODYNAMICS**

Electrostatics.

Physical bodies electrification. Electric charge. The interaction of charges. Elementary electric charge. The law of conservation of electric charge. Coulomb's law.

Electric field. Electric field strength. Electric field of a point charge. Potentiality of an electrostatic field. Potential difference. The principle of superposition of fields.

Conductors in the electric field. Electrical Capacity. Capacitor. Capacity of a flat capacitor.

Dielectrics in an electric field. Permittivity. The electric field energy of a flat capacitor.

Direct electric current

Electricity. Current strength. Voltage. Carriers of free electric charges in metals, liquids and gases. Conductor resistance. Ohm's law for the circuit part. Serial and parallel connection of conductors. Electromotive force. Ohm’s law for complete circuit. Work and power of electric current. Joule-Lenz law.

Semiconductors.

Intrinsic and extrinsic conductivity of semiconductors, pn-junction.

Magnetic field.

Electromagnetic induction. The interaction of magnets. The interaction of conductors with current. Magnetic field. The effect of a magnetic field on electric charges. Magnetic field strength. Ampere force. Lorenz force. Magnetic flux. Electric motor

Electromagnetic induction.

Faraday's law of electromagnetic induction. Lenz law. Eddy electric field. Self-induction. Inductance. Magnetic field energy.

Measurement of electric current, voltage, conductor resistance.

1. **OSCILLATIONS AND WAVES**

Mechanical vibrations and waves.

Harmonic vibrations. Amplitude, period and frequency of oscillations. Free vibrations. Mathematical pendulum. The period of oscillation of the mathematical pendulum. Energy conversion with harmonic oscillations. Driven oscillations. Resonance. The concept of self-oscillations.

Mechanical waves.

Wave propagation speed. Wavelength. Transverse and longitudinal waves. Harmonic Wave Equation.

Sound.

Electromagnetic oscillations and waves.

Oscillator circuit (RLC). Free electromagnetic oscillations in the circuit. The transformation of energy in the oscillator circuit. The natural frequency of oscillation in the circuit. Forced electrical oscillations. AC electric current. Alternator. Effective values ​​of current and voltage. Active, capacitive and inductive resistance. Resonance in the electrical circuit.

Transformer. Production, transmission and consumption of electrical energy.

The ideas of the theory of Maxwell. Electromagnetic waves. The speed of propagation of electromagnetic waves. Properties of electromagnetic waves. Principles of radio communication. Electromagnetic wave scale.

1. **OPTICS**

Light as an electromagnetic wave.

Rectilinear propagation, reflection and refraction of light. Ray. The laws of reflection and refraction of light. Refractive index. Full reflection. The critical angle of total internal reflection. The path of the rays in the prism. Image formation in a flat mirror.

Converging and diverging lenses. Thin lens formula.

Image formation in the lenses. Camera. Eye. Glasses.

Light interference. Coherence. Diffraction of light. Diffraction grating. Polarization of light. Transversality of light waves.

Light dispersion.

Measurement of the focal length of the collecting lens, the refractive index of the substance, the wavelength of light.

1. **BASICS OF SPECIAL RELATIVITY THEORY**

Invariance of the speed of light. Einstein's principle of relativity. Space and time in the special theory of relativity. The relationship of mass and energy.

1. **THE QUANTUM PHYSICS**

Thermal radiation. Planck's constant. Photoelectric effect. Experiments of Stoletov. Einstein’s equation for photoelectric effect.

The hypothesis of Louis de Broglie. Electron diffraction. Wave-particle duality.

Radioactivity.

Alpha, beta, gamma radiation. Methods of observation and registration of particles in nuclear physics.

Rutherford's experiment in alpha-particle scattering. Planetary model of the atom. Bohr’s model of the hydrogen atom. Spectra. Luminescence.

Lasers.

The law of radioactive decay. Nuclear shell model. Nucleus charge. Nucleus mass number. The binding energy of particles in the nucleus. Nuclear fission. Synthesis of nuclei. Nuclear reactions. Conservation of charge and mass number during nuclear reactions. Energy release during fission and nuclear fusion. The use of nuclear energy.

Dosimetry. Elementary particles. Fundamental interactions.

1. **METHODS OF SCIENTIFIC KNOWLEDGE AND PHYSICAL PICTURE OF THE WORLD**

Experiment and theory in the process of knowing the world. Modeling of phenomena and objects of nature. Scientific hypotheses. Physical laws and limits of their applicability. The role of mathematics in physics. The principle of conformity. The principle of causality. The physical picture of the world.

**Exam ticket sample**

**TICKET number 1**

1. Two points move along the x-axis: the first moves according to the law $x1 = 7t - 2$, the second according to the law $x2 = 14t— 9$. In how much time will they meet?

(8 points)

2. A homogeneous cube rests with one edge on the floor, the other on the vertical wall. The arm of the force $mg$ relative to the axis passing through point A, perpendicular to the plane of the figure is indicated ...

(9 points)

3. A weightlifter lifts a barbell weighing 150 kg for 1.5 s from the floor to a height of 2 m. Determine the power developed by the athlete during this time.

(9 points)

4. Determine the length of the nickel wire with the cross-sectional area 0.1 mm2 required for the manufacture of a spiral with a resistance of 120 Ohms. The resistivity of nickel is 0.4 ohm • mm2 / m.

(11 points)

5. At a certain time the impulse of a body of mass m = 2 kg, moving translationally, is equal to p = 2 kg · m / s. What is the kinetic energy of the body at this moment?

(13 points)

6. The area of ​​the ice floe is 4 m2, the thickness is 0.25 m. Will the floe sink entirely in the water, if there is a person in its middle, whose weight is 700 N? Ice density is 900 kg / m3, and water density - 1000 kg / m3.

(15 points)

7. The figure shows the cycle for $v$ mole of helium, consisting of two sections of linear dependence of pressure $P$ on volume $V$ and isobar. On Isobar 1-2 gas did work $A$, and its temperature increased 4 times. Temperatures in states 1 and 3 are equal. Points 2 and 3 on the $p, V$ diagram lie on a straight line passing through the origin point. Determine the temperature at point 1 and work of the gas per cycle.

(15 points)

8. Traffic lights are installed on a long highway at a distance of 1 km from each other. The red signal of each traffic light is on for 30 seconds, green for the next 30 seconds. In this case, all cars moving at a speed of 40 km / h, passing one of the traffic lights on the green light, pass without stopping, that is, also on the green light, and all the following traffic lights. With what other speeds can cars move, so that after driving one traffic light into the green light, then never stop anywhere? The problem to be solved graphically.

(20 points)