«APPROVED BY»
Head oft he General Physics Department
__________________Lider A.M.
« ____» _________ 2016 г.

COURS ANNOTATION

1. Title of the discipline **«Theoretical Physics. Statistical Theory»**

2. Code **ДИСЦ.Б**

3. Speciality (ООП) **03.03.02 Physics**

4. Specialization Program
Physics of Condensed Matter

5. Qualification degree - **bachelor**

6. Provided by **General Physics Department**

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9. Short review:
Knowledge meaning and content of all the beginnings of thermodynamics. Zero (existence of temperature), First (conservation of energy), Second (increase of entropy, maximum efficiency of a thermal machine) and Third (Nernst's theorem on unattainability of absolute zero temperature); To understand that the probabilistic approach does not lie in the nature of things, as in quantum theory, but is connected with the impossibility of a detailed description of systems with a huge number of degrees of freedom; To understand the concepts of temperature and entropy, and to know when a canonical, canonical or large canonical distribution can be applied; Special cases: the classical Maxwell and Boltzmann distributions, as well as the quantum distributions of Fermi-Dirac, Bose-Einstein, and Planck.

The ability to calculate, using statistical distributions for different systems, mean values and fluctuations of physical quantities; Use the conceptual and terminological apparatus in the professional sphere / research work; Independently find solutions to the task; Use estimates of the applicability of approximations; Critically evaluate the theoretical results obtained and compare them with the experimental data; Predict the impact of the use of science-intensive, technical means and be responsible for the consequences of its activities; To assume the influence of approximations, to explain at the level of hypotheses the deviations of the experimental data obtained from known theoretical and experimental dependences; Work with scientific and technical information. Possession of experience in the analysis of information sources, incl. Internet resources; Speeches with reports and presentations and participation in discussions; Elementary skills in setting tasks for research and development; Separation of scientific and non-scientific knowledge; Work with modern tools of analytical programming for solving problems of statistical physics; Elementary skills in setting the problem and analyzing the methods of solutions and the approximations used in the studies; Independent solution of the problem; Taking into account social, legal and ethical aspects in professional activities.

10. Contents of the module.
Classical and quantum statistical ensembles. The subject of statistical physics. Dynamic and statistical description. Statistical equilibrium. Gibbs ensemble The function of statistical distribution. The Liouville theorem. The canonical Gibbs distribution. Quantum mechanical description. Statistical operator (density matrix). Statistical sum. The energy distribution of a monatomic ideal gas as a whole. The principle of equal probabilities for closed systems. Microcanonical distribution. Entropy and temperature. Independence of entropy from the uncertainty of the energy of the system. Derivation of the canonical Gibbs distribution from the microcanonical one. The general definition of entropy. Additivity of entropy. Maximum entropy for equilibrium distributions. The second law of thermodynamics. Fluctuation of energy in the canonical ensemble. Thermodynamic equalities for the canonical ensemble. Thermodynamic potentials. Basic thermodynamic identity. Work and heat. Heat capacity. Thermodynamic potentials. Identities for thermodynamic potentials. Thermodynamic transformations. Maxwell relations. Temperature dependence of the energy density of equilibrium (black) radiation. Thermodynamic temperature scale. Nernst's theorem. Maximum work. Carnot cycle. Thermodynamic description of Schwarzschild black holes. Temperature and entropy of the black hole. Estimates for a black hole with the mass of the Sun. The grand canonical Gibbs distribution. Chemical potential. Thermodynamic equalities for a grand canonical ensemble. Dependence of thermodynamic quantities on the number of particles. Conditions for thermodynamic equilibrium. Fluctuations in the number of particles. Ideal gases. Ideal gases of identical particles. Distribution of Fermi-Dirac and Bose-Einstein. Boltzmann distribution. The condition for the applicability of the Boltzmann statistics. Thermodynamic quantities of a Boltzmann ideal gas. Fermi and Bose gases of elementary particles. Quantum correction to the equation of state of a Boltzmann ideal gas. The degeneracy temperature. Strongly degenerate Fermi gas. Fermi energy. Heat capacity of a degenerate Fermi gas. Fluctuations in the occupation numbers of quantum states and the total number of fermions. Degenerate Bose gas. Condensation of Bose-Einstein. Thermodynamic functions of an ideal Bose gas. Black radiation. Planck distribution. Planck's formula. Thermodynamic functions of black radiation. The intensity of blackbody emission. Relic radiation. Equilibrium in chemical reactions. Law of the acting masses.

Ionization equilibrium. Equilibrium in relation to education -pairs. Thermodynamic fluctuations. Nyquist's theorem. Cosmic background of microwave radiation.

11. Course is developed for third-year students. Should be provided during the 6th semester.

12. Prior knowledge requires: Mathematics: Analysis, Differential, Integration Calculus, Linear Algebra, General Physics

13. Correspondence: Physics of Condensed Matter, Research Work.

14. Type of attestation exam

Developed by, Prof. Bekhtereva E. S.