Physics Entrance Exam

6th and older semesters

20 January 2022

1. Find the pressure at the center of a planet with mass *M*, due to gravitational compression. Consider the planet as a uniform sphere of radius *R*, and the planet's substance as a liquid with constant density.

2. One mole of an ideal gas participates in a reversible process in which the dependence of entropy *S* on temperature *T* has the form $S = B/T^2$, where *B* is constant. Find the amount of heat supplied to the gas if its temperature has changed from T_1 to T_2.

3. A flat capacitor with circular plates of radius *R* is charged so that the electric field inside the capacitor changes according to the law $E(t) = E_0 + \alpha t$. The distance between the plates is much smaller than *R*. Find the magnetic field *H* inside the capacitor at the distance $r = R/3$ from the axis. Neglect the edge effects.

4. Optical radiation containing two spectral lines (λ_1 = 600 nm and λ_2 = 600.1 nm) of the same intensity falls normally on a diffraction grating with a total number of slits*N* = 1800. At diffraction angle $\theta = 30^0$, the spectral lines are observed at the resolution limit (according to the Rayleigh criterion). Find the period of the grating.

5. In a homogeneous magnetic field with induction *B*, nonrelativistic protons move along a circular trajectory of radius *R*. Find the de Broglie wavelength of the protons.