Statistical Physics

May 22, 2025

16-6 The experimental value of c_v for diamond is 2.68×10^3 J/kmole K at a temperature of 207 K. For diamond the Einstein temperature is 1450 K and the Debye temperature is 1860 K. Calculate c_v at 207 K using the Einstein and Debye models and compare the results with the experimental value.

17-2 (a) For the hydrogen atom of Problem 17-1 show that the orbital magnetic dipole moment is $ea^2\omega/2$, where ω is the electron's angular velocity.

(b) Show that the torque produced by a magnetic field parallel to the plane of the orbit is $ea^2\omega B/2$.

(c) By equating the Coulomb force and the mass times the centripetal acceleration, show that

$$\omega = \left(\frac{4\pi\epsilon_0 m a^3}{e^2}\right)^{-1/2}.$$

(d) Find values for the angular velocity, torque, and orbital magnetic moment for a hydrogen atom, where $a = 5.29 \times 10^{-11}$ m; let $B = 1$ T.

17-4 The paramagnetic salt iron ammonium alum has the magnetic ion Fe^{+++}. The spin system has $S = 5/2$ and the orbital angular momentum is quenched ($L = 0$). Thus $J = 5/2$ and $g = 2$. Find the mean dipole moment $\bar{\mu}_z$ of the paramagnetic salt in a magnetic field of 1 tesla at a temperature of 2 K. What is the saturation value of $\bar{\mu}_z$?

17-9 Prove Equation (17.41) starting with Equation (17.40) and using Stirling's approximation. Show that the entropy is a maximum when the total energy U is zero, corresponding to equal populations of the two energy levels of the system.