

Physics 540 Fall 2005

HW # 9 Due Tuesday November 15

1. Kittel p.124 problem 25.2 (follow Kittel's instructions and prove it for a random walk, not by integrating the Gaussian.)
2. Kittel p.124 problem 25.4
3. Consider a single free particle of mass M in a box of volume $V=L^3$, in equilibrium with a heat bath at temperature T . Show that the density matrix in momentum space is $\langle \psi_{k'} | \rho | \psi_k \rangle = (\lambda^3/V) \exp[-\hbar^2 k^2 / 2Mk_B T] \delta_{kk'}$ (where ψ_k is the plane-wave energy eigenstate for periodic boundary conditions, and k is a 3-vector). Also show that in coordinate space the answer is $\langle x' | \rho | x \rangle = (1/V) \exp[-(\pi/\lambda^2)(x-x')^2]$ where x and x' are 3-vectors. The squared thermal wavelength is $\lambda^2 = 2\pi M k_B T / \hbar^2$.