

8.08 Problem Set # 12

April 27, 2005
Due May 6, 2005

Problems:

1. Problem 7.7 in K. Huang's book.
2. Silicon S_i solid has a density 2.3g/cm^3 . The velocity of the sound is 2200m/sec . The thermal conductivity at $T = 300\text{K}$ is $1.5\frac{\text{W}}{\text{cmK}}$. Assuming the thermal conductivity is due to the phonons, estimate the mean free path of the phonons. (Hint: you may need to estimate the phonon density first.)
3. Copper C_u solid has a density 8.9g/cm^3 and an electric resistivity $1.7 \times 10^{-6}\Omega\text{ cm}$. Assume the density of the conduction electrons is the same as the density of the C_u atom and the electron mass is the same as electron mass in the vacuum. Estimate relaxation time τ and the mean free path λ of the electrons in C_u solid from the Drude model.
4. (a) Estimate the mean free path of air molecules at 300K and 1 atm . Estimate the viscosity of the air.
(b) Consider a ball of radius 0.1mm moving in the air. Estimate the friction coefficient of the ball.
(c) Assume the ball is floating in the air and is doing the Brownian motion. Estimate how long does it take for the ball drift 1 mm .
5. Problem 18.2 in K. Huang's book with the following changes:
 - (a) $\varphi(t)$ has a form $\varphi(t) = Ae^{-t^2/\tau^2}$.
 - (b) Calculate the power spectrum for all frequencies.