Physics 401 Homework1---Due September 10

1. In class it was stated that the spectral density for black-body radiation was given by Planck's formula:

$$u(\nu, T) = \left(\frac{8\pi}{c^3}\right)\frac{h\nu^3}{e^{\frac{h\nu}{kT}} - 1}$$

a) We argued in class that for low frequencies (1 <<*kT)* this should reduce to the classical statistical mechanical result of Rayleigh and Jeans----

$$u_{R-J}(\nu, T) = \frac{8\pi\nu^2 kT}{c^3}$$

Show that it does.

b) Well before the discovery of the Planck formula data for black-body radiation was restricted to relatively high frequencies (1 >> *kT*)and was found to empirically be fit by Wien's law

$$u(\nu, T) = a\nu^3 e^{\frac{b\nu}{kT}}$$

where *a* and *b* are parameters. Starting with the Planck law, find the parameters *a* and *b* interms of fundamental constants.

2. Using the conservation of energy and momentum and assuming a two-body collision between a photon and an electron initially at rest derive the Compton formula:

$$\lambda_s - \lambda_i = \frac{h}{mc}(1 - \cos(\theta))$$

where the subscripts *i* and *s* indicate the wavelength of the incident and scattered radiation respectively. (Hint: You may want to use relativity to first solve the problem in the center of mass frame and then boost).

In addition do Problem 2.10 of Liboff.