Assignment number 1 CD100 August 20, 2007 SKH

(1) Express Planck's distribution law, in terms of wavelength, that is

$$U_{\lambda} d\lambda = -\frac{8\pi hc}{\lambda^5} \cdot \frac{d\lambda}{e^{\frac{hc}{\lambda}kT} - 1}$$

Clue: Express λ in terms of ν. Take a derivative and plug into the Distribution law.

(2) Show that Unit of $U_{\nu} d\nu$ Rayleigh-Jean's law and Planck's distribution law is Joules per cubic meter.

(3) Based on thermodynamic arguments total radiation energy per unit area per unit time from the black body is given by $R = \sigma T^4$ which is known as Stefan-Boltzmann law. The experimental value for Stefan-Boltzmann constant σ is 5.6697×10^{-8} J m^{-2} $K^{-4}s^{-1}$. Integrate Planck's distribution law over all the frequencies (0 to ∞) and compare the results with Stefan-Boltzmann law.

Use standard integral,

$$\int_0^{\infty} \frac{x^3 dx}{e^x - 1} = \frac{\pi^4}{15}$$

(4) Before Planck's Theoretical work on the black body radiation, Wien showed empirically that,

$\lambda_{max} T = 2.9 \times 10^{-3} m\ K$. Estimate the surface temperature of Sirus (One of the hottest known stars) whose λ_{max} is measured to be 2600A°.