PHY3063 Spring 2017

HOMEWORK D

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Due: February 16

HW 1:In class we derived the the angle dependence of a photon energy $E(\theta)$ scattered off a particle of mass m_o at rest:

$$E(\theta) = \frac{E_o}{1 + \left(\frac{E_o}{m_o c^2}\right)(1 - \cos\theta)},$$

where E_o is the initial photon energy. Using the Planck's energy-wavelength relation, show that the above equation can be expressed in terms of photon wavelength by

$$\lambda - \lambda' = \frac{h}{m_o c}(1 - \cos\theta),$$

where $\frac{h}{m_o c}$ is called the Compton wavelength. *Hint: Start with* $E(\theta)^{-1}$.

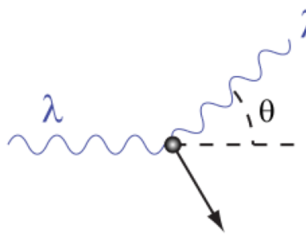

FIG. 1:

HW 2: Kirchoff argued that the radiation in the cavity in thermal equilibrium should be isotropic and homogeneous. If that is the case, the emissive power per unit area $R(\lambda, T)$ is connected with the energy density inside the blackbody cavity $u(\lambda, T)$ through a universal relation:

$$u(\lambda, T) = \frac{4R(\lambda, T)}{c}.$$

The derivation of the above relation will give you a clear picture of how the two quantities are related. Check the dimensional homogeneity of the relation.
Hint: Consider a blackbody cavity depicted as a large cube with an opening of area δA *at the bottom where the radiation is emitted. The cavity is in thermal equilibrium at* T *and the inside has a uniform energy density* $u(\lambda, T)$. *The small cube represents a volume element in the polar coordinate* $dV = r^2 \sin\theta dr d\theta d\phi$ *located at* (r, θ, ϕ). *The energy contained in this volume element is* $u(\lambda, T)dV$. *Since the radiation in the cavity is isotropic, the volume element will radiate isotropically. Then the radiation energy going through the opening is*

$$d\psi = \frac{\delta A \cos\theta}{4\pi r^2} u(\lambda, T) dV.$$

In δt of time, all the volume elements inside the hemisphere of radius $r = c\delta t$ will contribute to the total radiation energy passing through the opening.

$$R(\lambda, T) = \frac{\psi}{\delta A \delta t}.$$

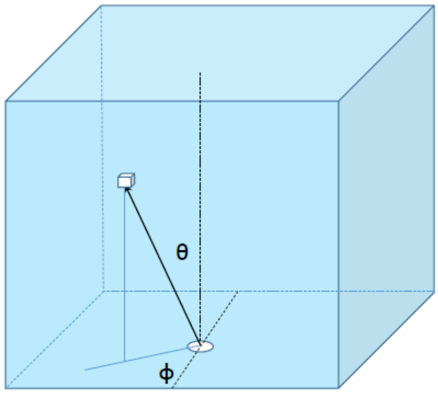

FIG. 2:

HW 3: Harris 3.13

HW 4: Harris 3.23

HW 5: Harris 3.48

HW 6: Harris 3.49

Back-of-the-Envelop Physics I measure my weight everyday using my bathroom scale. My weight is about 150 lb. One day I started to worry about the buoyancy. Should I?
In back of the envelop estimation, sometimes it is convenient to use a ratio. This could be the case. The ratio of your weight to the buoyance is simply that of ???.