Phys 208 – Homework (HW01) – SP13   (Due Monday, January 28, 2013)

Read/Peruse Chapter 1, Sections 1 through 15.

Problems: 1.10.10, 1.10.11, 1.13.2, 1.13.3, 1.13.4

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Phys 208 – Homework (HW02) – SP13   (Due Wednesday, January 30, 2013)

Problems: 1.13.13, 1.13.19, 1.15.29, 1.15.33, 1.16.2, 1.16.13

Answers: 1.16.2 $d_n = \dfrac{L}{2n}$

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Phys 208 – Homework (HW03) – SP13   (Due Friday, February 1, 2013)

Read Chapter 2, Sections 1 through 9.

HW3.1 Blackbody Radiation: The energy per unit volume per unit of frequency is given by $\rho_\nu d\nu = \dfrac{8\pi\nu^2}{c^3} E_{avg}\, d\nu$, where ν is the frequency and c is the speed of light in a vacuum. Classically one finds $E_{avg} = kT$, where k is the Boltzmann constant and T is the absolute temperature. Planck assumed that the radiated energy was quantized in units of $h\nu$ so that $E_n = nh\nu$, where $n = 0, 1, 2, 3, \cdots$.

The average energy is defined as $E_{avg} = \dfrac{\sum_{n=0}^{\infty} E_n e^{-E_n/kT}}{\sum_{n=0}^{\infty} e^{-E_n/kT}} = kT\, \dfrac{\sum_{n=0}^{\infty} n\alpha e^{-n\alpha}}{\sum_{n=0}^{\infty} e^{-n\alpha}}$, where $\alpha = \dfrac{h\nu}{kT}$. Also note that $\dfrac{d\, e^{-n\alpha}}{d\alpha} = -n\, e^{-n\alpha}$, so that you can interchange the derivative and the sum in the numerator.

HW3.2 The energy per unit volume per unit of wavelength is given by $\rho_\lambda d\lambda = \dfrac{8\pi hc}{\lambda^5} \dfrac{d\lambda}{e^{hc/\lambda kT} - 1}$. Define $x = \dfrac{hc}{\lambda kT}$ to obtain $g(x) = \dfrac{x^5}{e^x - 1}$ so that $\rho_\lambda = (\text{constant})\, g(x)$. Show that the maximum value for x is given by the equation $x = 5(1 - e^{-x})$. The solution is close to 5, so make an expansion about 5. Set $x = 5 - \varepsilon$ and solve for x up to order ε^2. Show that $x = 4.965$ and thus $\lambda_{\max} T = 2.897 \times 10^{-3}\ K^{\circ} \bullet m$. This is called Wien's Law for blackbody radiation.

HW3.3 The relativistic momentum is defined as $p = \frac{mv}{\sqrt{1-v^2/c^2}}$, where m is the mass of a particle, v its speed, and c is the speed of light. Thus the relativistic force is written as $F = \frac{dp}{dt}$. The work done on a particle is its kinetic energy if the particle starts from rest at time $t = 0$. Use this fact to derive an expression for the relativistic kinetic energy K. Use the work-energy theorem to calculate $W = \Delta K = K = \int_0^x F\,dx$ if $K = 0$ at $t = 0$. Note that $v = dx/dt$, so that $K = \int_0^t v\frac{dp}{dt}dt$. Hint: Show that $v\frac{dp}{dt} = \frac{d}{dt}\left(\frac{mc^2}{\sqrt{1-v^2/c^2}}\right)$. Expand your result for $v/c \ll 1$ to show that it yields the classical result for kinetic energy.

Problems: 2.5.5, 2.5.10, 2.5.27, 2.5.34, 2.5.42