PHYS420 (Spring 2002)
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Homework # 5
(due Monday, March 11th, 2002)

Problems

1. **SMM, Chapter 2, Problem 2.**

2. **SMM, Chapter 2, Problem 3.**

3. **SMM, Chapter 2, Problem 4.**

4. Calculate the energy of a photon whose frequency is (a) $5x10^{14}$ Hz, (b) 10 GHz, (c) 30 MHz. Express your answers in electron volts. Also determine the corresponding wavelengths for each case and what part of the EM spectrum this is. (This is essentially SMM problem 2.7 & 2.8 combined).

5. **SMM, Chapter 2, Problem 11.**

6. *Extra Credit problem 1*. Using Planck's spectral distribution formula, *u(λ,T)*, and recalling that $e_{total} = \frac{c}{4}\int_0^\infty u(\lambda,T)d\lambda$, derive Stefan's law, $e_{total} = \sigma T^4$, for the total power per unit area radiated at all wavelengths. Work out the numerical value for the constant *σ*. *Useful hint:* $\int_0^\infty \frac{x^3}{(e^x-1)}dx = \frac{\pi^4}{15}$.

7. *Extra Credit problem 2*. Using Planck's spectral distribution formula, *u(λ,T),*
(a) Derive Wein's displacement law, $\lambda_{\max}T = const$. Assume that the transcendental equation, $x = 5(1-e^{-x})$, has a non-trivial solution given by x_0. *This comment will be clear are you work through the problem.*
(b) Using a dimensionless value for the non-trivial solution of $x_0 = 4.96511423$, work out the value and units of the constant.

Planck's formula: $u(\lambda,T) = \frac{8\pi hc}{\lambda^5(e^{hc/\lambda k_bT}-1)}$, $u(f,T) = \frac{8\pi hf^3}{c^3}\frac{1}{(e^{hf/k_bT}-1)}$