ECE 476/576

HW #4

7.2

$$\left.\frac{dN_2}{dt}\right|_{stim} = B_{21}N_2\rho(\nu) = \frac{(c')^3}{8\pi h\nu^3} A_{21}N_2\rho(\nu); \left.\frac{dN_2}{dt}\right|_{spont} = -A_{21}N_2$$

But $\rho(\nu) = \frac{8\pi h\nu^3}{(c')^3} N_p$, where N_p= photons per mode; $\therefore \frac{\text{stimulated rate}}{\text{spontaneous rate}} = N_p$

7.3

$\int_0^\infty g(\nu)d\nu = 1 = K\cdot(2.667\ cm^{-1})$ or one could convert to frequency units;

$\therefore K\cdot(8\times10^{+10}\ Hz) = 1;\ K = 1.25\times10^{-11}\ sec = g(\nu_0);\ \bar{\nu}_0 = 15{,}713\ cm^{-1};\ \lambda_0 = 0.6364\ \mu m$

$\sigma_{SE} = \frac{\lambda^2}{8\pi} A_{21}g(\nu_0) = 2.01\times10^{-20}\ cm^2;\ \ g_2 = 3,\ g_1 = 5,\ \sigma_{abs} = 1.21\times10^{-20}\ cm^2$

7.5

The intent of this problem is to introduce some of the numerical factors associated with optical transitions. Given information: $\lambda_0 = 5000$ Å and a wave length interval of $\Delta\lambda = 1$ Å, $V = 2\ cm^3$. While λ is one of the easiest parameters to measure, frequency ν is a better theoretical variable. $\therefore \nu_0 = 600$ THz. We convert the wavelength interval into a frequency one by: $\frac{\Delta\nu}{\nu} = \frac{\Delta\lambda}{\lambda}$ or $\Delta\nu = 1.2\times10^{+11}$ Hz or $\Delta\nu = 120$ GHz or $\Delta\bar{\nu} = 4\ cm^{-1}$ (a)

There seems to be a "natural" tendency for the student to make the following mistake once, so let me make it for you in hopes that you will **NOT do the following:**

$$\boxed{\Delta\nu = \frac{c}{\Delta\lambda} \quad \text{which is absolutely wrong}}$$

(Check the numbers: If the above were correct, then $\Delta\nu = 3^{+18}$ Hz which is far greater than the central frequency of 600 THz.)

The number of modes in the volume V is: $N = [8\pi\nu^2\Delta\nu/c^3]\ V = 8.04\times10^{+10}$ modes which is the total number of ways that electromagnetic energy can appear in that wavelength interval. Now lets look at the spectral issue on a frequency scale with zero suppressed (or in the next county). The FSR = c/2d = 750 MHz