CHM 330 - Worksheet 4
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Name_____ **Section**_____

1. Using the particle in a 1-D box model with infinitely high potential walls, calculate the **wavelength** of the photon, in nm, that is emitted when an electron goes from the LUMO to the HOMO in 1,3,5,7,9-decapentaene. You may assume that C-C single bonds have a length of 154 pm and C=C double bonds have length of 135 pm. *(20 pts)*

2. For a particle trapped in the first eigenstate of the 1D particle in an box with infinitely high potential walls, the normalized eigenfunction is

$$\psi(x) = \begin{cases} \left(\frac{2}{L}\right)^{\frac{1}{2}} \sin\left(\frac{\pi x}{L}\right) & 0 \leq x \leq L \\ 0 & \text{othewise} \end{cases}.$$

   What is the **probability** of finding the particle between $\frac{L}{4}$ and $\frac{3L}{4}$? *(20 pts)*

3. Suppose a particle in a 1D box is in a state represented by the normalized eigenfunction

$$\psi(x) = \begin{cases} \left(\frac{30}{L^5}\right)^{\frac{1}{2}} x(L-x) & 0 \leq x \leq L \\ 0 & \text{othewise} \end{cases}$$

   What is the **expectation value** of the **total energy** for this eigenstate? *(20 pts)*

4. The infrared spectrum of $^{75}Br^{19}F$ consists of an intense band (which is $\bar{\nu}_0$) at 380 cm^{-1}. What is the value of the **force constant**, k, in $N{\cdot}m^{-1}$ for $^{75}Br^{19}F$. *(20 pts)*

5. It takes photons with a maximum wavelength of 564 nm to eject electrons from potassium metal. What is the velocity (in $m{\cdot}s^{-1}$) of electrons ejected from potassium metal if the **incident** radiation has a wavelength of 410 nm. (*20 pts.*)

6. For the following two angular wavefunctions ($Y_l^{m_l}$), demonstrate that they are normalized and orthogonal.

$$Y_1^0(\theta,\phi) = \left(\frac{3}{4\pi}\right)^{\frac{1}{2}} \cos(\theta)$$

$$Y_2^1(\theta,\phi) = \left(\frac{15}{8\pi}\right)^{\frac{1}{2}} \sin(\theta)\cos(\theta)\cos(\phi)$$