Quiz 6 – Core Course 2002 Name: ______________________________

Please show your work, and your thinking, in the space provided. Be brief, but complete. Long, wandering answers typically demonstrate a lack of understanding…

$\hbar = 1.054x10^{-34} J\, s$

$h = 6.626x10^{-34} J\, s$

$m_e = 9.109x10^{-31} kg$

$c = 2.998x10^{8} m\, s^{-1}$

$k = 1.381x10^{-23} J\, K^{-1}$

$e = 1.602x10^{-19} C$

$4\pi\varepsilon_o = 1.113x10^{-10} J^{-1}\, C^2\, m^{-1}$

$N_0 = 6.022x10^{23} mol^{-1}$

$\pi = 3.14159$

Particle in a 1D box

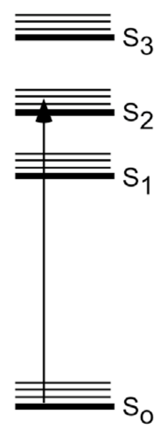
$$\psi_n = \left(\frac{2}{L}\right)^{1/2} \sin\left(\frac{n\pi x}{L}\right)$$

$$E_n = \frac{n^2 h^2}{8mL^2} \qquad n = 1,2,3,\ldots$$

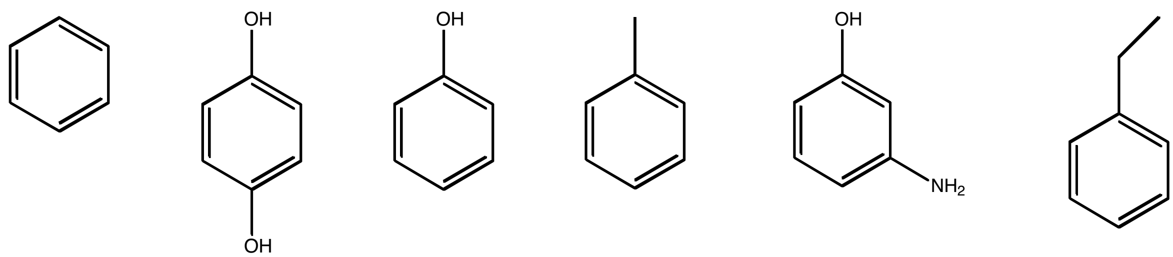
$$H_{translational} = \frac{-\hbar^2}{2m}\frac{d^2}{dx^2} \qquad p_{translational} = \frac{\hbar}{i}\frac{d}{dx} \qquad A = \frac{I_{\parallel} - I_{\perp}}{I_{\parallel} + 2I_{\perp}}$$

$$For \quad z = x + iy, \qquad z^* = x - iy$$

1. (20 points) You are carrying out fluorescence measurements on a molecule in solution whose electronic properties are described at right. When you go to carry out fluorescence anisotropy measurements using the S_o to S_2 transition shown, you find that the anisotropy is *negative*. What behavior would lead to negative anisotropy? Explain how this might occur.



2. Consider the following molecules:



A **B** **C** **D** **E** **F**

In the following, indicate ranking as follows: **C < D < (A,B) < E**
where, for example, (A,B) indicates that you don't have enough information to predict a significant difference between A and B.

Don't pull your hair out on this one…

a) (10 points) use simple considerations to rank them in terms of their expected extinction coefficients (lowest to highest):

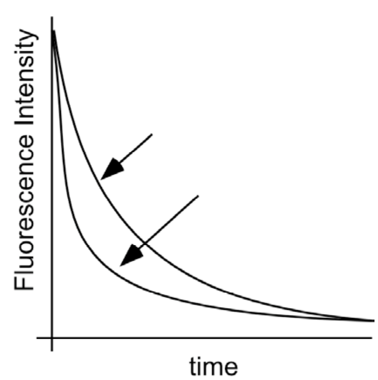
b) (10 points) use simple considerations to rank them in terms of their expected wavelengths of maximal absorbance (lowest to highest):

3. Consider fluorescence for two otherwise identical molecules you are studying.
   Molecule A has an internal conversion rate constant of **0.2 nsec^{-1}**.
   Molecule B has an internal conversion rate constant of **1.0 nsec^{-1}**.

   Assuming all else equal:

   a) (15 points) Which will have the higher fluorescence intensity?

   b) (15 points) Consider the fluorescence decay curves shown at right. In the experiment, you excite briefly with a laser, turn it off, and then monitor fluorescence as a function of time. Assign each curve to either molecule A or B.



4. The location of an electron constrained to move on a ring is given by the angle ϕ, where $0 \le \phi \le 2\pi$. The Hamiltonian for the system is:

$$H = \frac{-\hbar^2}{2I}\frac{d^2}{d\phi^2} \qquad I = m_e r^2$$

Given the wavefuntion: $\psi_m(\phi) = Ae^{im\phi}$ (in this case, *m* is a quantum number)

a) (15 points) Derive the value of the constant A (do not use a calculator)

b) (15 points) Derive the energy levels for this system (do not use a calculator).

c) (Small extra credit) What molecule might this be good for?