

## CHEM 4616: Homework #7

Corresponds to the quiz to be given in class on Thursday, March 27th, 2008

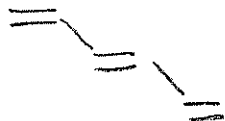
Chang, Chapter 17: Problems 28, 29, 48, 50-54

17.28 Think of the two molecules as boxes containing  $n$  electrons, much like the polyene example from Ch. 14. The transition between adjacent levels in the 1-D particle in a box model is:

$$\Delta E_n = E_{n+1} - E_n = \frac{\hbar^2 \pi^2}{2mL^2} [(n+1)^2 - n^2] = \frac{\hbar^2 \pi^2}{2mL^2} [2n+1]$$

The longer the box, the smaller  $\Delta E_n$ , and the longer the wavelength of light need to cause the transition. Thus, anthracene exhibits an electronic transition in the UV, while tetracene exhibits a transition in the visible.

17.29

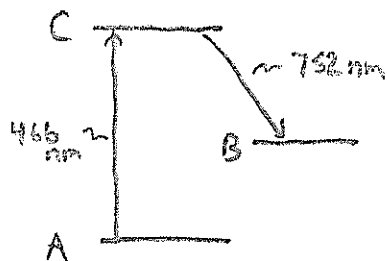


$$\text{Length of box, } L = 3(1.35) + 2(1.54) + 2(0.77) \\ = 8.67 \text{ \AA}$$

$$\text{Eq. 14.37: } \lambda = \frac{8m_e L^2 c}{h(N+1)} = \boxed{354 \text{ nm}}$$

17.49 Intensity, coherence, monochromaticity

17.50



$$E = \frac{hc}{\lambda} \quad E_{AC} = 4.26 \times 10^{-19} \text{ J}$$

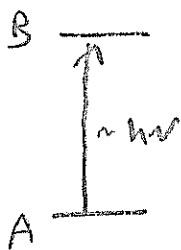
$$E_{BC} = 2.64 \times 10^{-19} \text{ J}$$

$$E_{AC} = E_{AB} + E_{BC}$$

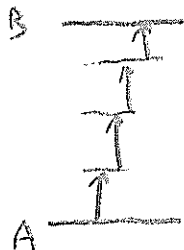
$$E_{AB} = E_{AC} - E_{BC} = 1.62 \times 10^{-19}$$

$$\lambda = \frac{hc}{E} = 1.23 \times 10^{-6} \text{ m} = \boxed{1230 \text{ nm}}$$

17.51



single-photon  
process



multi-photon  
process

The high intensity of a laser field can provide the photons needed for multi-photon absorption.

17.52

One unpaired electron:  $S = \frac{1}{2}$  multiplicity =  $2S+1 = 2$  (doublet)

Two unpaired electrons:  $S = 1 = \frac{1}{2} + \frac{1}{2}$  multiplicity =  $2S+1 = 3$  (triplet)

Three unpaired electrons:  $S = \frac{3}{2} = \frac{1}{2} + \frac{1}{2} + \frac{1}{2}$  multiplicity =  $2S+1 = 4$  (quartet)

17.53

Dropped

17.54

If 74.6% of the light is absorbed, 25.4% is transmitted:

$$T = \frac{I}{I_0} = 0.254$$

$$\epsilon = 895 \text{ L mol}^{-1} \text{ cm}^{-1}$$

$$-\log T = \epsilon bc$$

$$b = 2.0 \text{ cm}$$

$$c = -\frac{\log T}{\epsilon b} = \boxed{3.3 \times 10^{-4} \text{ mol/L}}$$