Exam #3

Instructions: This exam is worth 100 points. Some questions allow a choice as to which parts are answered. Do not answer more parts than are requested.

Conversion Factors

1 µm = 10⁻⁶ m

Equations

\[ F = kP_o(1 - 10^{-ebC}) \]
\[ F? = kP_o(2.303)ebC \]
\[ I(d) = 0.5 I(?) (1 + \cos(2pd/\theta)) \]
\[ I(t) = B(?) + B(?) \cos(2p?2Vt) \]
\[ ? = 1/? \]
\[ f = ??V \]
\[ I(d) = ?B(?) \cos(2p?d) \ d? \]
\[ B(?) = ?I(d) \cos(2p?d) \ dd \]
1. (40 points) Provide brief answers to five of the following.

a. A Fourier transform infrared spectrometer typically has both a TGS pyroelectric detector and a silicon photodiode. What is the function of each detector?

b. Name two types of electronic transitions that are typically observed in UV-visible absorption spectra.

c. Differentiate between internal and external conversion.

d. Name four quantities that directly influence the sensitivity of an analysis based on luminescence spectroscopy. Do not answer with experimental variables such as temperature and pH.

e. How is spectral resolution increased in Fourier transform spectroscopy?

f. Name three reasons why signal averaging is typically more important in infrared spectroscopy than in UV-visible spectroscopy.

2. (10 points) Answer one of the following.
a. Draw a labeled diagram of a double-beam luminescence spectrometer.

b. Draw a labeled diagram of a Fourier transform infrared spectrometer.

3. (39 points) Answer three of the following.

a. Is the excited-state lifetime of a phosphorescence transition typically less or greater than that of a fluorescence transition? Explain your reasoning.

b. A Fourier transform spectrometer allows all light frequencies to strike the detector simultaneously. Why is an interferometer required in this instrument? How does this device function?
c. Describe the mechanism by which infrared photons are absorbed by molecules.

d. Draw and label an energy level diagram for a compound that would explain why the absorption spectrum of the compound might contain bands at 250 and 350 nm, but the luminescence spectrum would contain only a fluorescence band at 450 nm. Label all relevant processes and draw the energy axis to scale.

4. (11 points) If the signal-to-noise ratio in a Fourier transform infrared spectrum based on 32 averaged scans is 100, how many scans would have to be averaged to produce a signal-to-noise ratio of 500?