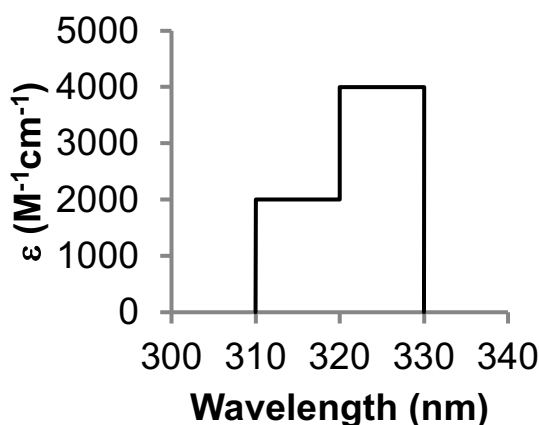


- Convert the following energy values into units of kcal/mole
a) 500 nm b) 10,000 cm^{-1} c) 1 eV d) 100.8 MHz (FM Channel)
- Using the Boltzmann distribution, calculate the population distribution of 1000 molecules between ground and excited states when the energy gap between the states is a) 220 nm b) 3657 cm^{-1} c) 80 kcal/mole d) $6.3 \times 10^{11} \text{Hz}$
- If a protein that contains six tryptophan residues and three tyrosine residues, calculate the absorbance for 1 mg/mL sample at 280 nm in aqueous buffer given molecular weight is 14,313 Da. [ϵ_{Trp} (280 nm) = 5700 $\text{M}^{-1} \text{cm}^{-1}$; ϵ_{Tyr} (280 nm) = 1300 $\text{M}^{-1} \text{cm}^{-1}$]
- The C–C bond dissociation enthalpy is 348 kJ/mole. Calculate the λ corresponding to this energy. If one shines light at this wavelength, will it break all C–C bonds? Explain.
- A student records the following absorbance values for his samples in an experiment: 0.06, 0.12, 0.21, 0.37, 0.48, 0.51, 0.75, 0.9, 1.5
Should she trust all of the readings above? If no, which readings are likely to be error prone. Justify your answer.
- Consider a dilute but fine suspension of sand particles from Brahmaputra shore in water. How will the absorbance spectrum of such a sample look like between 300–600 nm.
- Derive the Beer-Lambert equation $A = \epsilon \cdot c \cdot l$
- The graph below shows absorption spectrum of a molecule in water ($n = 1.33$). The spectrum is simplified for ease of integration. Calculate the dipole strength of the absorption band, the transition dipole moment and the oscillator strength. Specify the units of all quantities.



- Take the CARBONYL chromophore in formaldehyde with MO configuration $\{\sigma_{\text{CO}}^2 \pi_{\text{CO}}^2 n_{\text{CO}}^2\}$. Draw the energy level diagram and show the following transitions between singlet states:

- a. n to π^*
- b. π to π^*
- c. σ to σ^*

10. What is the Born-Oppenheimer approximation?

11. What is the Frank-Condon principle?

12. A chromophore absorbs one photon of light at 400 nm and promptly jumps to a higher energy electronic state with a matching energy gap. If light of 800 nm is incident on the same sample, can the chromophore absorb two photons and make a transition to a similar higher energy electronic state. Justify your answer.

13. A sample of 1 cm pathlength rotates 200 nm polarized light by 0.01 deg. Calculate

(a) $n_L - n_R$

(b) $[\phi]$ if $C = 0.0001$ M

14. A sample of 1 cm pathlength has an ellipticity of 0.01 deg. Calculate

(a) axial ratio (a/b) of ellipse

(b) $A_L - A_R$

(c) $[\theta]$ if $C = 0.0001$ M

15. Show that $[\theta] = 3298 \Delta\epsilon$

16. A student wishes to monitor the unfolding of a protein with addition of urea. Explain how she can determine when the protein is fully unfolded?