CEM 882, Problem Set 2 – Due Tuesday, February 11 – Please email a pdf to weliky@chemistry.msu.edu

1. Photosynthetic organisms including green plants have proteins containing pigments which absorb light. The light energy is eventually converted in chemical bond energy. Using the spectra below, determine the following properties for chlorophyll b at its peak absorbance:

a. (10 points) Wavelength in nm units.
b. (10 points) Wavenumber in cm^{-1} units.
c. (10 points) Energy in kJ/mole units.
d. (10 points) Temperature in K units.

e. (10 points) Green plants have high concentrations of phycoerythin and phycocyanin pigments in their leaves. In a few sentences provide a hypothesis for why this could be advantageous to the plant.

2. The chemical reaction driven by photosynthesis is:

$$2\ NADP^+ + 2\ H_2O \rightarrow\ 2\ NADPH + O_2 + 2H^+$$

$NADP^+$ is nicotinamide adenine dinucleotide phosphate and NADPH is the reduced form of NADPH.

a. (15 points) For this reaction, $\Delta G = 438$ kJ/mole. Determine the minimum number of 540 nm photons which must be absorbed to drive formation of one molecule of O_2.
b. (15 points) In the 1930s-1960s, experiments were done in which green algae were exposed to flashes of light of different energies and mole O_2 was measured. Using the data below and linear least-squares fitting, determine the experimental number of 540 nm photons required to generate one molecule of O_2.

Flash energy (millijoule)	O_2 generated (nanomole)
5	2.1
10	4.1
20	8.0
30	12.2

c. (10 points) Calculate the fraction of photon energy which is used for O_2 generation.
d. (10 points) In one or a few sentences, provide a hypothesis for the fate of the energy which is not used for O_2 generation.

Problem 1

ction) or chemical reactions. See the Animated Figures