LECTURE 4

1. In the video on her research in the Bawendi lab, Darcy discusses properties and applications of quantum dots. Consider a quantum dot that emits yellow light with a wavelength of 537 nm.
(a) If 1.00 mol of photons are emitted at this wavelength, what is the total energy emitted?
(b) A different quantum dot emits 187 kJ per mol of photons released. Without performing any additional calculations, would you expect this quantum dot to produce red light or green light? Briefly explain your answer.

(a) 2.23 x 10^5 J•mol^{-1} or 2.23 x 10^5 J or 223 kJ/mol or 223 kJ
(b) Red

2. A single photon of UV light has enough energy to mutate human DNA.
(a) Calculate the wavelength (in nm) of a UV photon with a per mol energy of 4,990 kJ. Provide your answer with two significant figures.
(b) Calculate the minimum integer number of 500.0-nm photons that would be required to add up to or exceed the same total energy as a single UV photon from part (a).
(c) Briefly explain the following: Irradiation of a strand of DNA with 25 photons of 500-nm green light will *not* result in DNA mutation.

(a) 24 nm
(b) 21
(c) The per photon energy is insufficient for DNA mutation.

3. Electrons with a kinetic energy of 3.61 x 10^{-19} J are ejected from the surface of a metal plate upon irradiation by light with a frequency of 1.71 x 10^{15} s^{-1}.
(a) Calculate the workfunction of the metal.
(b) Calculate the minimum intensity of light in Watts (J/s) required to eject 1.40 x 10^{11} electrons (each with a kinetic energy of 3.61 x 10^{-19} J) using a 0.20 second pulse of light.

(a) workfunction = 7.7 x 10^{-19} J
(b) 7.9 x 10^{-7} J/s

4. In a photoelectric effect experiment, electrons are ejected from a titanium surface (work function, Φ, = 4.33 eV) following irradiation with UV light. The energy of the incident UV light is 7.2 x 10^{-19} J per photon.
(a) Calculate the wavelength of the ejected electrons.
(b) Calculate the wavelength of the incident photons.
(c) Would an iron surface (Φ = 4.7 eV) require *longer* or *shorter* wavelength photons to eject electrons with the same wavelength as calculated in part (a)? Briefly explain.

(a) λ = 3.0 x 10^{-9} m
(b) λ = 280 nm
(c) Iron has a larger work function, so it would require more energy and thus *shorter* wavelength photons.