**Sample Photon Energy Problems Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**1)** If it takes 3.36 x 10-19 J of energy to eject an electron from the surface of a certain metal, calculate the longest possible wavelength, in nanometers, of light that can ionize the metal.

**2)** The ionization energy of gold is 890.1 kJ/mol. Is light with a wavelength of 240. nm capable of ionizing a gold atom (removing an electron) in the gas phase?

**3)** What is the energy per photon of the lowest frequency of electromagnetic radiation that can be used to observe a gold atom with a diameter of 280. picometers? (the λ of light must be equal to or smaller than the atom)

**4)** DNA consists mainly of (C-H), (C-C), and bonds which have bond energies 413, 348, and 308 kJ/mol, respectively. What is the lowest energy light wave that will break the weakest bond? Determine its wavelength.

**5)** Fluorescent molecules (known as fluorophores) are widely used by chemists and biologists to study sub-cellular molecules, including proteins, DNA, and RNA. In the most straightforward applications, fluorophores are appended to a bio-molecule of interest and used to image the bio-molecule’s cellular location. The fluorescence imaging process involves the excitation of a fluorophore with a photon of energy, resulting in a brief (1-10 ns) excited state that is followed by the release of a photon with a second, lower energy.

Imagine that you are studying a protein involved in tumor metastasis (spreading). Based on previous studies, you hypothesize that the protein localizes to the nucleus in tumor cells. To determine the sub-cellular location of your protein, you label it with a fluorophore that can be excited by light in the range of 620. to 674 nm.

The lab’s fluorescent microscope is currently set up with a He-Ne laser for excitation. The laser produces a beam of light with a per-photon energy of 3.14 x 10-19 J and an intensity of 13 W (J/s).

(a) Calculate the wavelength of the light emitted by the He-Ne laser.

(b) Does the He-Ne laser beam have an appropriate energy to excite your fluorophore (does it fall within the excitation range)?

(c) Calculate the number of photons emitted by the laser per second.