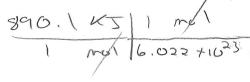
| Sample | Photon   | Energy  | <b>Problems</b> |
|--------|----------|---------|-----------------|
| Sample | FIIOCOII | Lileigy | 1 1 Obicins     |

1) If it takes 3.36 x 10<sup>-19</sup> 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.

E = 
$$\frac{L}{2}$$

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  $\lambda$  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.

UV light will break DNA bunds (violet is about 400 nm)

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  $3.14 \times 10^{-19}$  J and an intensity of 13 W (J/s).

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

$$7 = \frac{LC}{E}$$

$$7 = \frac{(6.626 + 10^{-34} \%)(2.998 + 10^{8} \%)}{3.14 + 10^{-19} \%} [6.33 + 10^{-7} m]$$

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

6.33+10-7 m -> 633 nm

Tes, 633 nm falls between 620. and 674 nm.