EM Radiation & Photoelectric Effect • Chem 210

1. A dance radio station broadcasts at a frequency of 92.7 MHz. What is the wavelength associated with the radio waves?

$$c = \lambda \nu$$

$$\lambda = \frac{c}{\nu} = \frac{3.00 \times 10^8 \text{ m/s}}{92.7 \times 10^6 \text{ 1/s}} = 3.23 \text{ m}$$

2. What is the energy of a photon of EM radiation if its wavelength is 195 nm? What is the energy of a mole of these photons?

$E = h\nu$ $\quad c = \lambda\nu$

$E = \frac{hc}{\lambda}$ $\quad \nu = \frac{c}{\lambda}$

$$E = \frac{(6.626 \times 10^{-34} \text{ J·s})(3.00 \times 10^8 \text{ m/s})}{195 \times 10^{-9} \text{ m}} = 1.02 \times 10^{-18} \text{ J/photon}$$

$$\frac{1.019 \times 10^{-18} \text{ J}}{1 \text{ photon}} \left| \frac{6.022 \times 10^{23} \text{ photons}}{1 \text{ mol}} \right. = 614{,}000 \text{ J/mol} = 614 \text{ kJ/mol}$$

3. What is the maximum wavelength of EM radiation that can cause electrons to be ejected from the surface of lithium metal in a photoelectric cell? The ionization energy for lithium is 513.3 kJ/mol.

$$\frac{513.3 \text{ kJ}}{1 \text{ mol}} \left| \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ photons}} \right| \frac{1000 \text{ J}}{1 \text{ kJ}} = 8.524 \times 10^{-19} \text{ J/photon}$$

$$E = \frac{hc}{\lambda}$$

$$\lambda = \frac{hc}{E} = 2.33 \times 10^{-7} \text{ m} = 233 \text{ nm}$$

4. The threshold frequency that will allow electrons to be ejected from the surface of beryllium metal is 2.25×10^{15} Hz. What is the ionization energy (in kJ/mol) for Be?

$$E = h\nu = 1.491 \times 10^{-18} \text{ J/photon}$$

$$\frac{1.491 \times 10^{-18} \text{ J}}{1 \text{ photon}} \left| \frac{6.022 \times 10^{23} \text{ photons}}{1 \text{ mol}} \right| \frac{1 \text{ kJ}}{1000 \text{ J}} = 898 \text{ kJ/mol}$$

5. What is the minimum uncertainty in the position of an electron traveling at $8.4 \times 10^4 \pm 0.6 \times 10^4$ km/s ?

→ $\Delta u = 1.2 \times 10^7$ m/s

Notes: 1 Joule (J) = 1 kg•m^2/s^2 $\quad m_{electron} = 9.11 \times 10^{-31}$ kg

$$\Delta x \cdot_m \Delta u \leq \frac{h}{4\pi}$$

$$\Delta x \cdot (9.11 \times 10^{-31}\,\text{kg})(1.2 \times 10^7\,\text{m/s}) \leq \frac{6.626 \times 10^{-34}\ \frac{\text{kg}\cdot\text{m}^2}{\text{s}^2} \cdot \text{s}}{4\pi}$$

$$\boxed{\Delta x = 4.8 \times 10^{-12}\ \text{m} = 4.8\ \text{pm}}$$