CHEM 105 – Dr. Lammi

Name: _____

Quiz 2 – Sept. 4, 2019

$c = 2.9979 \times 10^{8}$ m/s $h = 6.626 \times 10^{-34}$ J · s $E_{photon} = h\nu$ $\nu = \frac{c}{\lambda}$

$\Delta E = -2.178 \times 10^{-18} \text{J}\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$ $E_{photon} = |\Delta E|$ $E_{K,\ ejected\ e^-} = E_{photon} - \phi$ $E_K = \frac{1}{2}mv^2$ $\lambda_{matter} = \frac{h}{mv}$

1. (7 pts) Planck showed that energy is ***quantized*** (forming the basis for our modern understanding of electrons). Explain **in a few words** what this term means and **give the equation** that is associated with Planck's work. "Quantized" means that only certain values are allowed.

   $E = h\nu$

2. (18 pts) Suppose that you want to build a new device that functions on the basis of the photoelectric effect. You have a green laser pointer with a wavelength of 543.0 nm and are looking for a suitable metal from which your laser photons will eject electrons.

   $\lambda = 543.0 nm$

   a. (8 pts) What is the **energy of each photon** emitted by the laser?

   $$E = h\nu = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34} Js)(2.9979 \times 10^{8} \frac{m}{s})}{(543.0 nm)(\frac{1\ m}{1 \times 10^{9} nm})}$$

   $E_{photon} = 3.658 \times 10^{-19}$ J

   b. (3 pts) Several metals and their work functions are listed below. Please fill in the element names corresponding to the symbols provided.

Element symbol	**Element Name??**	Work Function (J) ← Φ
Cs	cesium	3.124×10^{-19}
Rb	rubidium	3.621×10^{-19}
Sm	samarium	4.325×10^{-19}

   c. (7 pts) **Which of the metals above could you use in your device?** (That is, from which one(s) can your laser eject electrons?) Be sure to **show your work and/or explain** your reasoning.

   $E_K = E_{photon} - \Phi$

   In order for an e^- to be ejected, $E_{photon} \geq \Phi$, resulting in $E_K \geq 0$.

   Comparing E_{photon} to the Φ values given, the photon can eject e^- from Rb and Cs, but not Sm.

   ($3.658 \times 10^{-19} > 3.621 \times 10^{-19}$ for Rb ✓
   $3.658 \times 10^{-19} > 3.124 \times 10^{-19}$ for Cs ✓)

   The photon does not have enough energy to overcome the work function of Sm.