Chemistry Worksheet Name: _____

Quantum Concepts – Photoelectric Effect, etc. Block: _____

Answer each question in the space required. Show all work.

1. Einstein's explanation of the photoelectric effect (Nobel Prize) was an important development in the early advancement of quantum concepts. In short, when a metal surface is exposed to light that has a frequency above a *threshold* frequency, ν_o, electrons are ejected from the surface of the metal. If, however, the frequency of light is below the threshold frequency, then no electrons are ejected. One way to write the photoelectric effect mathematically is, $h\nu = W + KE$, where $h\nu$ is the energy of one quantum of incident light, W is the *work function* (the minimum amount of energy required to eject the electron), and KE is the kinetic energy of the ejected electron, known as a *photoelectron*.

   a. **Selenium** was one of the first elements used in the construction of "electric eyes", due to its photoconductive properties. The work function for selenium is 5.11 eV. What is the longest wavelength of light that will *just* cause electrons to be ejected from a surface coated with selenium? (Formally, the electrons leaves with no kinetic energy.)

   b. In what range of the electromagnetic spectrum does light of the wavelength from part a fall?

   c. When a particular monochromatic light source shines on a selenium surface, photoelectrons are ejected with a kinetic energy of 1.05 eV. What is the wavelength of the incident monochromatic light?

   d. Calculate the maximum velocity (m/s) of the ejected electrons from the previous question.

   e. What is the de Broglie wavelength (m) of electrons ejected at the maximum velocity from part c?

   f. Calculate the frequency associated with the de Broglie wavelength of the electron.

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2. The de Broglie wavelength of 18.35 angstrom (Å) is measured for a photoelectron that was ejected from the surface of sodium with incident light of wavelength 4540 Å.

   a. What is the energy per quantum of the incident light? Express your answer in both joules and eV.

   b. Calculate the frequency associated with the de Broglie wavelength of the electron.

   c. Calculate the momentum of the ejected electron.

   d. What is the kinetic energy of the ejected electron? Express your answer in joules and in eV.

   e. Use the information you have (including your answers so far!) to calculate the work function, *W*, for sodium. Express your answer in joules and in eV.

   f. What is the wavelength of light that will *just* cause the ejection of a photoelectron from sodium metal?