Name: KEY Period: ____________ Date: ______________

Problem Set #16 – Light Quantum Mechanics

Solve the following problems and report your final answer using the correct number of significant figures. Show all work!

1. What is the wavelength of light, in mm, with a frequency of $2.04 \times 10^{12}\ s^{-1}$?

$C = \lambda \nu$

$\lambda = \frac{c}{\nu}$

$\frac{2.99 \times 10^{8}\ m}{s} \times \frac{1000\ mm}{1\ m} \times \frac{1\ s}{2.04 \times 10^{12}} = \boxed{0.147\ mm}$

2. The frequency of "middle C" on the musical scale is $262\ s^{-1}$, and the wavelength is 132 cm. What is the speed of a sound wave, in m/s?

$u = \lambda \nu = \frac{132\ cm}{} \bigg| \frac{1\ m}{100\ cm} \times \frac{262}{s} = \boxed{345\ m/s}$

3. Calculate the energy of a photon in the following light waves:
   a. An FM radio wave with a frequency of 92.5 MHz

   $E = h\nu = 6.626 \times 10^{-34}\ Js \times \frac{92.5\ MHz}{} \bigg| \frac{1 \times 10^{6}\ s^{-1}}{1\ MHz} = \boxed{6.13 \times 10^{-26}\ J}$

   b. A blue light wave with a frequency of 4.85×10^{14} Hz

   $E = h\nu = 6.626 \times 10^{-34}\ Js \times \frac{4.85 \times 10^{14}\ Hz}{} \bigg| \frac{1\ s^{-1}}{1\ Hz} = \boxed{3.21 \times 10^{-19}\ J}$

   c. A Gamma ray with a wavelength of 1.83 picometers (1 meter = 1×10^{12} picometers)

   $E = h\nu$

   $c = \lambda \nu$

   $\nu = \frac{c}{\lambda}$

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

   $6.626 \times 10^{-34}\ Js \times \frac{2.99 \times 10^{8}\ m}{s} \cdot \frac{1}{1.83\ pm} \bigg| \frac{1 \times 10^{12}\ pm}{1\ m}$

   $\boxed{1.08 \times 10^{-13}\ J}$

4. It takes 6.89×10^{-19} J to remove an electron from Zn. Calculate the minimum frequency of light that can cause this to happen.

$E = h\nu$

$\nu = \frac{E}{h} = \frac{6.89 \times 10^{-19}\ J}{6.626 \times 10^{-34}\ Js} = \boxed{1.04 \times 10^{15}\ J}$

5. Solar panels utilize the photoelectric effect to create a current when the sunlight pops an electron off the silicon. If violet visible light waves hit a solar panel with wavelengths of 314 nm, will an electric current be produced? 7.61×10^{-19} J of energy are required to remove an electron from silicon.

$E = h\nu$

$c = \lambda\nu$

$\nu = \frac{c}{\lambda}$

$E = \frac{hc}{\lambda} = 6.626 \times 10^{-34}\ Js \times \frac{2.99 \times 10^{8}\ m}{s} \times \frac{1}{314\ nm} \times \frac{1 \times 10^{9}\ nm}{1\ m}$

$E = 6.31 \times 10^{-19}\ J$

No - not enough energy to pop the electrons off