Name: ____ **Date:** __________________ **Class:** _______________

Energy Homework Answer Key

Helpful Hints: 1 meter = 10^9 nanometers
Assume all waves are traveling in a vacuum, unless otherwise noted.

1. List the electromagnetic spectrum from highest to lowest energy.

   Gamma rays, x-rays, ultraviolet rays, visible light, infrared, microwaves, radio waves

2. List the electromagnetic spectrum from longest to shortest wavelength.

   Radio waves, microwaves, infrared, visible light, ultraviolet rays, x-rays, gamma rays

3. Calculate the frequency of ultraviolet A with a wavelength of 350 nm.

   $c=\lambda\upsilon$ so **$\upsilon = c/\lambda$**

   First, change 350 nanometers to meters.

   350 nm $\times$ 1 meter / 10^9 nanometers = 3.5×10^{-7} meters

   $\upsilon = 3.0 \times 10^8$ m/s / 3.5×10^{-7} meters = 8.6×10^{14} s^{-1}

4. Calculate the energy, in quanta, of the ray above.

   $E = h\upsilon$

   $E = 6.626 \times 10^{-34}$ J · S $\times$ 8.6×10^{14} s^{-1} = 5.7×10^{-19} Joules

5. Calculate the frequency of a wave traveling with a wavelength of 1.2 meters.
   What type of ray would this most likely be?

   $c=\lambda\upsilon$ so $\upsilon = c/\lambda$

   $\upsilon = 3.00 \times 10^8$ m/s / 1.2 meters = 2.5×10^8 s^{-1}

   radio wave

6. Calculate the energy of a photon traveling with a frequency of 1.0×10^5 s^{-1}.

   $E = h\upsilon$

   $E = (6.626 \times 10^{-34}$ J · S) (1.0×10^5 s^{-1}) = 6.6×10^{-29} Joules

7. Copper absorbs energy with a wavelength of 510 nm. If 2.20×10^4 J of energy is emitted, calculate the number of copper atoms that were present. Assume 1 atom emits 1 quantum.

$c = \lambda \upsilon$ $E = h \upsilon$

$\upsilon = 3.00 \times 10^8 / 1.5 \times 10^{-7}$ meters $= 2.0 \times 10^{15}$ 1/s

$E_{photon} = (2.0 \times 10^{15}$ 1/S$)(6.626 \times 10^{-34}$ J · S$) = 1.3 \times 10^{-18}$ Joules

Since 1 photon emits 1.3×10^{-18} Joules and 1 atom emits 1 photon then:

2.20×10^4 Joules / 1.3×10^{-18} Joules $= 1.7 \times 10^{22}$ atoms Cu

8. In problem 7, how many grams of copper were present?

1.7×10^{22} atoms Cu $\times$ 1 mole Cu/6.022×10^{23} atoms $\times$ 63.55 g Cu/1 mole Cu

= 1.8 grams Cu

9. Calculate the frequency of a wave of wavelength 1.50×10^2 centimeters traveling at 80 % of the speed of light in a vacuum?

$c = \lambda\upsilon$, so $\upsilon = c/\lambda$

$\upsilon = (3.00 \times 10^8$ m/s $\times$ .80) / (.015 meters) $= 1.6 \times 10^{10}$ 1/s

10. Calculate the energy for visible light of wavelength 400 nm, 550 nm and 700 nm. Graph energy vs. wavelength. What can be said about the relationship of energy to wavelength?

$c = \lambda\upsilon$ $E = h\upsilon$

Energy for 400 nm = 4.97×10^{-19}

Energy for 550 nm = 3.61×10^{-19}

Energy for 700 nm = 2.84×10^{-19}

Energy increases with decreasing wavelength