Name: _____ Date: _____ Period: ____

Grade problems are worth 2 points each. This assignment is graded out of **18** points.

Planck's constant = $6.626 \times 10^{-34}\ J \cdot s$
You may assume that the EM waves are all traveling through space.

1) An EM wave has a frequency of 2.5×10^{8} Hz. How much energy does a photon of this wave have?

2) An EM wave has a frequency of 9.5×10^{18} Hz. How much energy does a photon of this wave have?

3) **Graded.** An EM wave has a frequency of 1.1×10^{11} Hz. How much energy does a photon of this wave have?

4) **Graded.** An EM wave has a frequency of 7.5×10^{13} Hz. How much energy does a photon of this wave have?

5) A photon of an EM wave has 6.5×10^{-16} J. What is its frequency?

6) A photon of an EM wave has 2.3×10^{-21} J. What is its frequency?

7) **Graded.** A photon of an EM wave has 8.5×10^{-17} J. What is its frequency?

8) **Graded.** A photon of an EM wave has 6.9×10^{-25} J. What is its frequency?

9) Green light has a wavelength of $4.9 \times 10^{-7}\ m$. How much energy does a photon of this wave have? (***Hint****: you'll want to check out the answer to this one.*)

10) **Graded.** Red light has a wavelength of $6.9 \times 10^{-7}\ m$. How much energy does a photon of this wave have?

11) **Graded.** Violet light has a wavelength of $3.9 \times 10^{-7}\ m$. How much energy does a photon of this wave have?

12) A photon of an EM wave has 2.9×10^{-19} J. What color of light is this?

13) A photon of an EM wave has 3.31×10^{-19} J. What color of light is this?

14) **Graded.** A photon of an EM wave has 3.9×10^{-19} J. What color of light is this?

15) **Graded.** A photon of an EM wave has 3.43×10^{-19} J. What color of light is this?

16) **Graded.** A photon of an EM wave has 4.85×10^{-19} J. What color of light is this?

Selected Answers

1) An EM wave has a frequency of 2.5×10^8 Hz. How much energy does a photon of this wave have?

$$E = h \times \nu$$
$$E = (2.5 \times 10^8 Hz) \times (6.626 \times 10^{-34} J \cdot s)$$
$$E = 1.66 \times 10^{-25}\ J$$

2) An EM wave has a frequency of 9.5×10^{18} Hz. How much energy does a photon of this wave have?

$$E = h \times \nu$$
$$E = (9.5 \times 10^{18} Hz) \times (6.626 \times 10^{-34} J \cdot s)$$
$$E = 6.29 \times 10^{-15}\ J$$

5) A photon of an EM wave has 6.5×10^{-16} J. What is its frequency?

$$h = \frac{E}{\nu}$$
$$h = \frac{6.5 \times 10^{-16} J}{6.626 \times 10^{-34}\ J \cdot s}$$
$$h = 9.81 \times 10^{17}\ Hz$$

6) A photon of an EM wave has 2.3×10^{-21} J. What is its frequency?

$$h = \frac{E}{\nu}$$
$$h = \frac{2.3 \times 10^{-21} J}{6.626 \times 10^{-34}\ J \cdot s}$$
$$h = 3.47\ \times 10^{12}\ Hz$$

9) Green light has a wavelength of $4.9 \times 10^{-7}\ m$. How much energy does a photon of this wave have?

First, find the frequency of the light wave. Since may assume that the light is traveling through space, we know that the velocity of the waves will be $3.0 \times 10^8 \frac{m}{s}$.

$$frequency = \frac{velocity}{wavelength}$$
$$h = \frac{3.0 \times 10^8 \frac{m}{s}}{4.9 \times 10^{-7}\ m} = 6.12 \times 10^{14}\ Hz$$

Now that you have frequency, you can use it to find the energy:

$$E = h \times \nu$$
$$E = (6.12 \times 10^{14} Hz) \times (6.626 \times 10^{-34} J \cdot s)$$
$$E = 4.06\ \times 10^{-19}\ J$$

12) A photon of an EM wave has 2.9×10^{-19} J. What color of light is this?

The general strategy for this is to solve for the wavelength of the EM wave, and then figure out from the wavelength what color the light is. To solve for the wavelength, you need to find the frequency first using the wave energy equation, and then use the frequency to solve for the wavelength using the wave velocity equation. Once you know the wavelength, you look up the color based on the wavelength, doing conversion of units, if necessary.

First, solve for the frequency of the wave:

$$h = \frac{E}{\nu}$$

$$h = \frac{2.9 \times 10^{-19}\, J}{6.626 \times 10^{-34}\, J \cdot s} = 4.37 \times 10^{14}\, Hz$$

Now, find the wavelength of the wave:

$$\lambda = \frac{v}{f}$$

$$v = 3.0 \times 10^{8}\, m;\ \ f = h = 4.37 \times 10^{14}\, Hz$$

$$\lambda = \frac{3.0 \times 10^{8} m}{4.37 \times 10^{14} Hz} = 6.86 \times 10^{-7} m$$

Now, convert the wavelength to a unit that you can compare with what you have in your notes. Alternately, you could convert the values in your notes from nm to m.

$$6.86 \times 10^{-7} m = 686\, nm$$

*The photon is a photon of **red** light.*

13) A photon of an EM wave has 3.31×10^{-19} J. What color of light is this?

Use the same technique as above.

$$h = \frac{E}{\nu}$$

$$h = \frac{3.31 \times 10^{-19}\, J}{6.626 \times 10^{-34}\, J \cdot s} = 5.00 \times 10^{14}\, Hz$$

Now, find the wavelength of the wave:

$$\lambda = \frac{v}{f}$$

$$v = 3.0 \times 10^{8}\, m;\ \ f = h = 5.00 \times 10^{14}\, Hz$$

$$\lambda = \frac{3.0 \times 10^{8} m}{5.00 \times 10^{14} Hz} = 6.0 \times 10^{-7} m$$

Convert the wavelength from m to nm:

$$6.0 \times 10^{-7} m = 600\, nm$$

*The photon is a photon of **orange** light.*