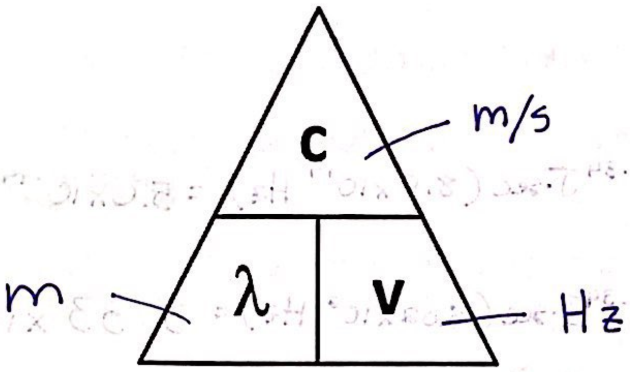
Name: Key Date: 19-20 Pd: 1,3,5

Honors Chemistry – Calculations Practice: Wavelength, Frequency, and Energy of a Photon

Calculating Wavelength and Frequency Formulas:

Speed of Electromagnetic Waves (c) = 2.998 x 10⁸ m/s - When using c, confirm wavelength is in meters



1. Violet light has a wavelength of 4.10 x 10^{-6} nm. What is the frequency?

$\frac{4.10\times10^{-6}\ nm}{} \cdot \frac{1\ m}{10^9\ nm} = 4.1\times10^{-15}\ m$ $\nu = \frac{2.998\times10^{8}\ m/s}{4.1\times10^{-15}\ m} = 7.31\times10^{22}\ Hz$

2. Green light has a frequency of 6.01 x 10^{14} Hz. What is the wavelength in meters?

$\lambda = \frac{2.998\times10^{8}\ m/s}{6.01\times10^{14}\ Hz} = 4.99\times10^{-7}\ m$

3. What is the wavelength (in meters) of the electromagnetic carrier wave transmitted by The Sports Fan radio station at a frequency of 640 kilohertz (kHz)? **(Hint: Check your units!!)**

$640\ KHz \cdot \frac{1000\ Hz}{1\ KHz} = 640{,}000\ Hz$ $\lambda = \frac{2.998\times10^{8}\ m/s}{640{,}000\ Hz} = 470\ m$

4. Calculate the wavelength in nanometers of radiation with a frequency of 8.0 x 10^{14} Hz.

$\lambda = \frac{2.998\times10^{8}\ m/s}{8.0\times10^{14}\ Hz} = 3.7475\times10^{-7}\ m \cdot \frac{10^9\ nm}{1\ m} = 374.75 \rightarrow 370\ nm$

5. A helium laser emits light with a wavelength of 633 nm. What is the frequency of the light?

$633\ nm \cdot \frac{1\ m}{10^9\ nm} = 6.33\times10^{-7}\ m$ $\nu = \frac{2.998\times10^{8}\ m/s}{6.33\times10^{-7}\ m} = 4.74\times10^{14}\ Hz$

6. What is the wavelength in nanometers of X-rays having a frequency of 4.80 x 10^{17} Hz?

$\lambda = \frac{2.998\times10^{8}\ m/s}{4.80\times10^{17}\ Hz} = 6.2458\overline{3}\times10^{-10}\ m \cdot \frac{1\ nm}{10^{-9}\ m} = 0.625\ nm$

7. An FM radio station broadcasts at a frequency of 107.9 Megahertz (MHz). What is the wavelength in meters of the radio signal? **(Hint: Check your units!!)**

$107.9\ MHz \cdot \frac{10^6\ Hz}{1\ MHz} = 1.079\times10^{-4}\ Hz$ $\lambda = \frac{2.998\times10^{8}\ m/s}{1.079\times10^{-4}\ Hz} = 2.778\times10^{12}\ m$

8. If the limits of human hearing are 20 Hz to 20,000 Hz, what are the sound wavelengths in meters that are associated with both of these two extremes, assuming the speed of sound is 345 m/s.

- Frequency = 20 Hz : Wavelength =

$\lambda = \frac{345\ m/s}{20\ Hz} = 17.25\ m \rightarrow 20\ m$

- Frequency = 20,000 Hz : Wavelength =

$\lambda = \frac{345\ m/s}{20{,}000\ Hz} = 0.01725\ m \rightarrow 0.02\ m$

Name: Date: Pd:

Energy of a Photon Formulas:

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

Planck's Constant (h) - 6.626 x 10^{-34} J · sec

9. Calculate the energy of a photon of radiation with a frequency of 8.5 x 10^{14} Hz.

$E = h\nu = 6.626\times10^{-34}$ J·sec $(8.5\times10^{14}$ Hz$) = 5.6\times10^{-19}$ J

10. Calculate the energy of a gamma ray photon whose frequency is 5.02 x 10^{20} Hz?

$E = h\nu = 6.626\times10^{-34}$ J·sec $(5.02\times10^{20}$ Hz$) = 3.33\times10^{-13}$ J

11. Calculate the energy of a photon of radiation with a wavelength of 0.64 nm (convert to m).

$\frac{0.64 \text{ nm}}{} \cdot \frac{1 \text{ m}}{10^9 \text{ nm}} = 6.4\times10^{-10}$ m

$E = \frac{hc}{\lambda} = \frac{(6.626\times10^{-34} \text{ J·sec})(2.998\times10^8 \text{ m/s})}{6.4\times10^{-10} \text{ m}} = 3.1\times10^{-16}$ J

12. What is the energy of light whose wavelength is 4.06 x 10^{-5} nm (convert to m)?

$\frac{4.06\times10^{-5} \text{ nm}}{} \cdot \frac{1 \text{ m}}{10^9 \text{ nm}} = 4.06\times10^{-14}$ m

$E = \frac{hc}{\lambda} = \frac{(6.626\times10^{-34} \text{ J·sec})(2.998\times10^8 \text{ m/s})}{4.06\times10^{-14} \text{ m}} = 4.89\times10^{-12}$ J

13. Rank these parts of the electromagnetic spectrum from lowest energy (1) to highest (7):

7	3	2	1	4	5	6
Gamma	Infrared	Microwave	Radio	Visible	Ultraviolet	X-ray

14. Rank these parts of the electromagnetic spectrum from lowest frequency (a) to highest (g):

g	c	b	a	d	e	f
Gamma	Infrared	Microwave	Radio	Visible	Ultraviolet	X-ray

15. Rank these parts of the electromagnetic spectrum from shortest wavelength (A) to longest (G):

A	E	F	G	D	C	B
Gamma	Infrared	Microwave	Radio	Visible	Ultraviolet	X-ray