Chem 1
Dr. Casagrande / Mrs. Rinaldi

Name: Answer Key
Period: ____ Date: _____

Light & Waves

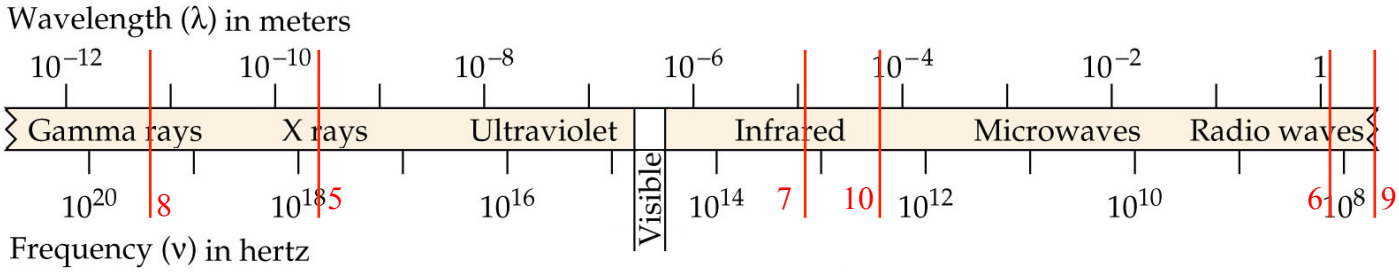
1. What is the cause of all electromagnetic radiation?
   EM radiation is caused by electrons or other charged particles losing energy.

2. What is wavelength? What symbol is used to represent it? What are its units?
   Wavelength is the distance between successive wave crests (or any equivalent point). It is represented by the Greek letter λ, lambda. Since it is a distance, its units are generally meters (m), or any related unit such as mm, μm, nm (used commonly for visible light) or pm.

3. What is frequency? What symbol do we use to represent it? What are its units?
   Frequency is the number of waves passing a given point in 1 second. It is represented by the Greek letter ν, nu. Its units are s^{-1} ("per second"), 1/s, or Hz. Radio waves are typically given in units of megahertz (MHz) for FM or kilohertz (KHz) for AM stations.

4. What is the type of relationship between wavelength and frequency? Describe it.
   Wavelength and frequency have an inverse relationship. As one quantity increases, the other decreases. Thus, long wavelength corresponds to low frequency, and short wavelength is high frequency.

Use the Reference Packet and the EM spectrum below to solve the following problems:



5. What is the frequency, in Hz, of an electromagnetic wave with a wavelength of 3.5×10^{-10} m? Draw a line at this wavelength/frequency on the EM spectrum above and state which region this is in.

$$c = \lambda\nu : 3.00\times10^{8}\ \text{m/s} = \left(3.5\times10^{-10}\ \text{m}\right)\nu \Rightarrow \nu = \frac{3.00\times10^{8}\ \cancel{\text{m}}/\text{s}}{3.5\times10^{-10}\ \cancel{\text{m}}} = 8.6\times10^{17}/\text{s} = \boxed{8.6\times10^{17}\ \text{Hz}}$$

This is in the **x - ray** region of the spectrum (see above)

6. What is the wavelength, in m, of an electromagnetic wave with a frequency of 2.29×10^{8} Hz? Draw a line at this wavelength/frequency on the EM spectrum above and state which region this is in.

$$c = \lambda\nu : 3.00\times10^{8}\ \text{m/s} = \lambda\left(2.29\times10^{8}/\text{s}\right) \Rightarrow \lambda = \frac{c}{\nu} = \frac{3.00\times10^{8}\ \text{m}/\cancel{\text{s}}}{2.29\times10^{8}\ /\cancel{\text{s}}} = \boxed{1.31\ \text{m}}$$

This is a **radio wave**.

7. Calculate the wavelength of electromagnetic radiation, in nm, with a frequency of 2.50×10^{13} Hz [hint: calculate m first then convert.]. Draw a line at this wavelength/frequency on the EM spectrum above and state which region this is in.

$$3.00\times10^{8}\ \text{m/s}=\lambda\left(2.50\times10^{13}/\text{s}\right)\Rightarrow\lambda=\frac{c}{\nu}=\underbrace{\frac{3.00\times10^{8}\ \cancel{\text{m}}/\cancel{\text{s}}}{2.50\times10^{13}\ \cancel{\text{s}^{-1}}}}_{1.20\times10^{-5}\ \text{m}}\times\frac{1\ \text{nm}}{1\times10^{-9}\ \cancel{\text{m}}}=\boxed{1.20\times10^{4}\ \text{nm}}$$; **infrared (IR)**

8. Calculate the frequency, in Hz, of electromagnetic radiation that has a wavelength of 9.35 pm (convert to m—Chart A!). Draw a line at this wavelength/frequency on the EM spectrum above and state which region this is in.

$$\lambda=9.35\ \text{pm}\times\frac{1\times10^{-12}\ \text{m}}{1\ \text{pm}}=9.35\times10^{-12}\ \text{m};\ 3.00\times10^{8}\ \text{m/s}=\left(9.35\times10^{-12}\ \text{m}\right)\nu\Rightarrow$$

$$\nu=\frac{c}{\lambda}=\frac{3.00\times10^{8}\ \cancel{\text{m}}/\text{s}}{9.35\times10^{-12}\ \cancel{\text{m}}}=\boxed{3.21\times10^{19}\ \text{Hz}}$$; **Gamma rays**

9. A popular radio station broadcasts with a frequency of 94.7 MHz. What is the wavelength of the broadcast, in m? (You must first convert MHz to Hz—Chart A!) Draw a line at this wavelength/ frequency on the EM spectrum above and state which region this is in.

$$\nu=94.7\ \text{MHz}\times\frac{1\times10^{6}\ \text{Hz}}{1\ \text{MHz}}=9.47\times10^{7}\ \text{Hz};\ 3.00\times10^{8}\ \text{m/s}=\lambda\left(9.47\times10^{7}/\text{s}\right)$$

$$\lambda=\frac{c}{\nu}=\frac{3.00\times10^{8}\ \text{m}/\cancel{\text{s}}}{9.47\times10^{7}\ \cancel{/\text{s}}}=\boxed{3.17\ \text{m}}$$; **Radio waves** (as would be expected for a radio station!)

10. What is the speed of an electromagnetic wave with frequency 4.87×10^{12} Hz? What region of the EM spectrum is this in?

All electromagnetic radiation, regardless of frequency or wavelength, has speed $c=3.00\times10^{8}$ m/s.

This is in the **Infrared (IR)** region.