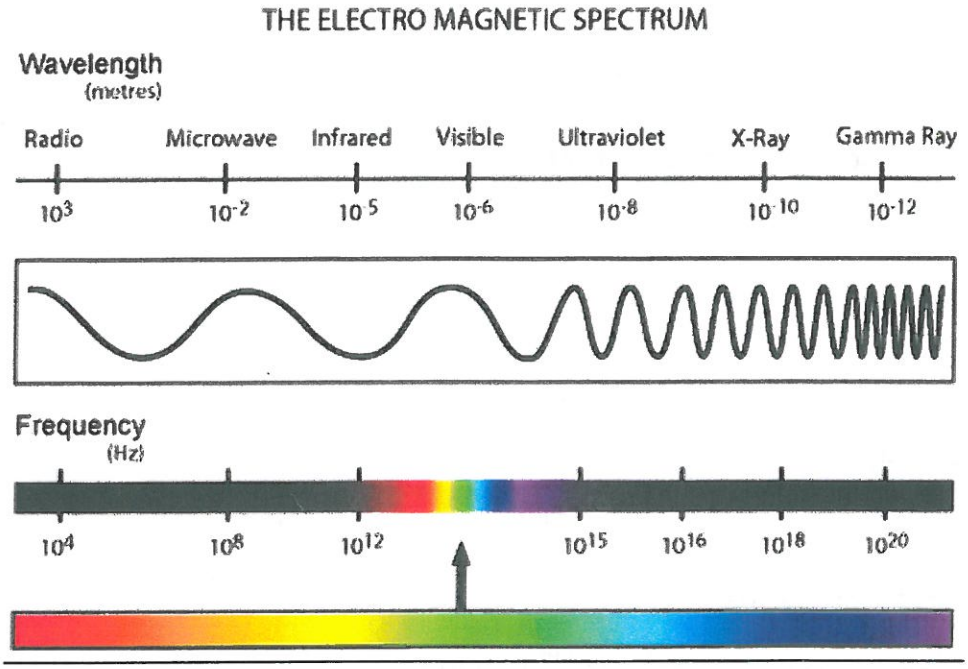
Name: Key

Electromagnetic Radiation Problems



***Directions*: Solve the following problems. Show your work and units for full credit. Box in or circle your final answer.**

1. A wave has a frequency of 22 Hz and a wavelength of 4.0 m. What is its velocity?

$$v = 22\,Hz(4.0\,m) = \boxed{88\,\frac{m}{s}}$$

2. What is the frequency of a wave if its wavelength is 3.6×10^{-9} m and its velocity is 3.0×10^{8} m/s?

$$3.0\times10^{8}\,\frac{m}{s} = (3.6\times10^{-9}\,m)\,\nu$$

$$\nu = \boxed{8.3\times10^{16}\,Hz}$$

3. As you move across the continuous visible spectrum from red to violet, what happens to…

   a. wavelength (increase or decrease)? decrease

   b. frequency (increase or decrease)? increase

4. A beam of microwaves has a frequency of 1.0×10^{9} Hz. A radar beam has a frequency of 5×10^{11} Hz. Which type of radiation…

   a. has the longer wavelength?

$\uparrow\lambda\ \downarrow\nu$ microwave

b. is nearer to visible light in the electromagnetic spectrum?

radar

c. is closer to X-rays in frequency value?

radar

5. A bright line spectrum contains a line with a wavelength of 518 nm. Determine...

a. the wavelength, in meters. (Hint: 1 x 10^9 nm = 1 m)

$518\ nm \times \frac{1\ m}{1\times10^9\ nm} =$ 5.18×10^{-7} m or 518×10^{-9} m

b. the frequency.

$3.0\times10^8 \frac{m}{s} = (5.18\times10^{-7} m)\nu$ $\quad \nu =$ 5.79×10^{14} Hz

c. the energy.

$E = (6.63\times10^{-34} J\cdot s)(5.79\times10^{14} Hz) =$ 3.84×10^{-19} J

d. the color of the line. green

6. A photon has an energy of 4.00 x 10^{-19} J. Find...

a. the frequency of the radiation.

$4.00\times10^{-19} J = (6.63\times10^{-34})\nu$

$\nu =$ 6.03×10^{14} Hz

b. the wavelength of the radiation.

$3\times10^8 \frac{m}{s} = \lambda (6.03\times10^{14} Hz)$

$\lambda =$ 4.97×10^{-7} m

c. the region of the electromagnetic spectrum that this radiation represents.

visible (497 nm)

7. A photon of light has a wavelength of 3.20 x 10^5 m. Find...

a. the frequency of the radiation.

$3\times10^8 = 3.2\times10^5 (\nu)$

$\nu =$ 938 Hz

b. the energy of the photon.

$E = (6.63\times10^{-34})(938) =$ 6.21×10^{-31} J

c. the region of the electromagnetic spectrum that this radiation represents.

radio

$4.257\times10^{-7}\,cm \times \frac{}{100\,cm}$

8. Determine the frequency of light with a wavelength of 4.257×10^{-7} cm.

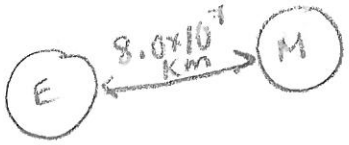
$3\times10^{8}\frac{m}{s} = (4.257\times10^{-9}\,m)(\nu)$

$\nu = 7.047\times10^{16}\,Hz$

9. How many minutes would it take a radio wave with a frequency of 7.25×10^{5} Hz to travel from Mars to Earth if the distance between the two planets is approximately 8.0×10^{7} km?

$\nu = 7.25\times10^{5}\,Hz$ light moves $3\times10^{8}\frac{m}{s}$

convert distance to time



$8.0\times10^{7}\,km \times \frac{1000m}{1\,km} \times \frac{1s}{3\times10^{8}m} \times \frac{1min}{60s} = 4.4\,min$

10. Cobalt-60 is an artificial radioisotope that is produced in a nuclear reactor for use as a gamma-ray source in the treatment of certain types of cancer. If the wavelength of the gamma radiation from a cobalt-60 source is 1.00×10^{-3} nm, calculate the energy of a photon of this radiation.

$\lambda = 1.00\times10^{-3}\,nm \times \frac{1m}{1\times10^{9}\,nm} = 1\times10^{-12}\,m$

$3\times10^{8} = 1\times10^{-12}(\nu)$

$\nu = 3\times10^{20}$

$E = (6.63\times10^{-34})(3\times10^{20}) = 1.99\times10^{-13}\,J$