Chemistry: Light Problems

- Violet: 400-430 nm
- Indigo: 430-450 nm
- Blue: 450-500 nm
- Green: 500-570 nm
- Yellow: 570-590 nm
- Orange: 590-610 nm
- Red: 610-700 nm

\[ E = h \nu \]
\[ c = \lambda \nu \]

Directions: Solve the following problems. Show proper set-up, work, and units for full credit. Box in your final answer.

1. A wave has a frequency of 22 Hz. Find its wavelength.
   \[ \frac{c}{\lambda} = \nu \]
   \[ 3.00 \times 10^8 \text{ m/s} = \lambda (22 \text{ Hz}) \]
   \[ \lambda = 1.4 \times 10^7 \text{ m} \]

2. What is the frequency of a wave if its wavelength is 3.6 \times 10^{-9} \text{ m} and its velocity is 3.0 \times 10^8 \text{ m/s}?
   \[ \frac{c}{\lambda} = \nu \]
   \[ 3.00 \times 10^8 \text{ m/s} = \lambda (\nu) \]
   \[ \nu = 8.3 \times 10^{14} \text{ Hz} \]

3. As you move across the continuous spectrum from red to violet, what happens to...
   a. wavelength? it decreases
   b. frequency? it increases

4. A beam of microwaves has a frequency of 1.0 \times 10^9 \text{ Hz}. A radar beam has a frequency of 5 \times 10^{11} \text{ Hz}. Which type of radiation... (you will need to calculate the wavelength and compare to the chart at the top of the page)
   a. has the longer wavelength?
      \[ \frac{\text{microwaves}}{3.00 \times 10^8 \text{ m/s}} = \lambda (1.0 \times 10^9 \text{ Hz}) \]
      \[ \lambda = 0.30 \text{ m} \]
   b. is nearer to visible light in the electromagnetic spectrum?
      \[ \frac{\text{radar}}{3.00 \times 10^8 \text{ m/s}} = \lambda (5 \times 10^{11} \text{ Hz}) \]
      \[ \lambda = 0.00006 \text{ m} \]
   c. is closer to X-rays in frequency value?

5. A bright line spectrum contains a line with a wavelength of 518 nm. Determine...
   a. the wavelength, in meters. (Hint: 1 \times 10^9 \text{ nm} = 1 \text{ m})
      \[ \frac{518 \text{ nm}}{1 \times 10^9 \text{ nm}} = 5.18 \times 10^{-7} \text{ m} \]
   b. the frequency.
      \[ \frac{c}{\lambda} = \nu \]
      \[ 3.00 \times 10^8 \text{ m/s} = \lambda (5.18 \times 10^{-7} \text{ m}) \]
      \[ \nu = 5.79 \times 10^{14} \text{ Hz} \]
   c. the energy.
      \[ E = h \nu \]
      \[ E = 6.626 \times 10^{-34} \text{ J s} (5.79 \times 10^{14} \text{ Hz}) \]
      \[ E = 3.84 \times 10^{-19} \text{ J} \]
   d. the color of the line.
      Green
6. A photon has an energy of $4.00 \times 10^{-19}$ J. Find...
   a. the frequency of the radiation.
      
      \[
      E = h\nu \\
      4.00 \times 10^{-19} \text{J} = 6.626 \times 10^{-34} \text{J} \cdot \text{s} (\nu) \\
      \]
      
      $E = 6.04 \times 10^{14} \text{Hz}$
   
   b. the wavelength of the radiation.
      
      \[
      \frac{c}{\lambda} = \nu \\
      3.00 \times 10^{8} \text{m/s} = \lambda (6.04 \times 10^{14} \text{Hz}) \\
      \]
      
      $\lambda = 4.97 \times 10^{-7} \text{m}$
   
   c. the region of the electromagnetic spectrum that this radiation represents.
      
      \[
      4.97 \times 10^{-7} \text{m} \times \frac{1 \times 10^{9} \text{mm}}{1 \text{m}} = 497 \text{nm} \\
      \]
      
      visible light - blue

7. A photon of light has a wavelength of $3.20 \times 10^{5}$ m. Find...
   a. the frequency of the radiation.
      
      \[
      \frac{c}{\lambda} = \nu \\
      3.00 \times 10^{8} \text{m/s} = 3.20 \times 10^{5} \text{m} (\nu) \\
      \]
      
      $\nu = 9.38 \times 10^{2} \text{Hz}$
   
   b. the energy of the photon.
      
      \[
      E = h\nu \\
      E = 6.626 \times 10^{-34} \text{J} \cdot \text{s} (9.38 \text{Hz}) \\
      \]
      
      $E = 6.22 \times 10^{-21} \text{J}$
   
   c. the region of the electromagnetic spectrum that this radiation represents.
      
      Long Radio Waves

8. Determine the frequency of light with a wavelength of $4.257 \times 10^{-7}$ m.
   
   \[
   \frac{c}{\lambda} = \nu \\
   3.00 \times 10^{8} \text{m/s} = 4.257 \times 10^{-7} \text{m} (\nu) \\
   \]
   
   $\nu = 7.05 \times 10^{14} \text{Hz}$