Unit 3A Practice: Calculating Frequency & Wavelength of EM radiation

Show your work! Use a calculator and do the actual math – answer should have units and correct significant figures.

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

$v =$ *frequency*
$c =$ *speed of light*
$\lambda =$ *wavelength*

1. Violet light has a wavelength of 4.10×10^{-7} m. What is the frequency?

   7.32×10^{14} Hz

2. Green light has a frequency of 5.60×10^{14} Hz. What is the wavelength?

   5.36×10^{-7} m or 536 nm

3. What is the wavelength (in meters) of the electromagnetic carrier wave transmitted by The Sports Fan radio station at a frequency of 640 kHz? (*Hint: convert kHz into Hz by multiplying by 10^3.*)

$$v = \frac{640\ kHz}{1}\left|\frac{1\ Hz}{1000\ kHz}\right| = 6.4 \times 10^5\ Hz$$

$$\lambda = \frac{c}{v} = \frac{3 \times 10^8 m/s}{6.4 \times 10^5\ /s} = 468.75\ m \sim \mathbf{470\ m}$$

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

$$\lambda = \frac{c}{v} = \frac{3 \times 10^8 m/s}{8.0 \times 10^{14}\ /s} = 3.75 \times 10^{-7}\ m\ \ or\ \ 375\ nm$$

Calculating Energy and Frequency (*f*)

E=hv

- E = energy of a particle of light
- h = Planck's Constant (6.626×10^{-34} J•s)
- v = frequency of radiation

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

$$\boldsymbol{E = hv = (8.5 \times 10^{14}/s)(6.626 \times 10^{-34}\ J \cdot s)}$$

$$\boldsymbol{E = hv = 5.6 \times 10^{-19}\ Joules}$$

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

$$\boldsymbol{E = hv = (5.02 \times 10^{20}/s)(6.626 \times 10^{-34}\ J \cdot s)}$$

$$\boldsymbol{E = hv = 3.33 \times 10^{-13}\ Joules}$$

3. Calculate the energy of a photon of radiation with a wavelength of 6.4×10^{-7} m.

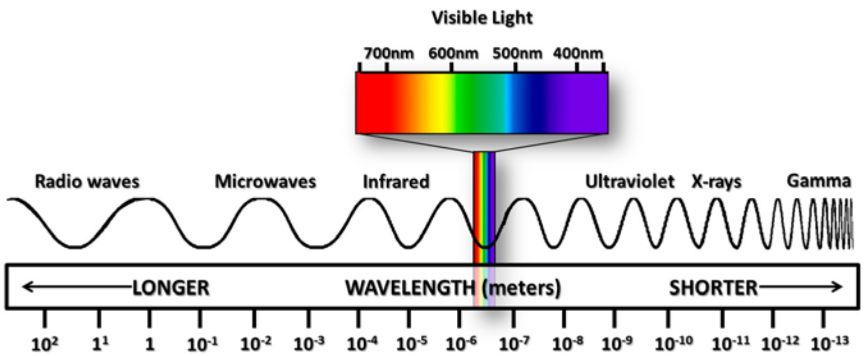
$$\boldsymbol{E = hv = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34}\ J \cdot s)(3 \times 10^8 m/s)}{6.4 \times 10^{-7} m} = 3.1 \times 10^{-19}\ Joules}$$

4. What is the energy of light whose wavelength is 4.06×10^{-11} m?

$$\boldsymbol{E = hv = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34}\ J \cdot s)(3 \times 10^8 m/s)}{4.06 \times 10^{-11}\ m} = 4.90 \times 10^{-15}\ Joules}$$

EM Spectrum

1. Draw the EM spectrum labeling the different types of EM radiation.



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

Energy is inversely proportional to wavelength, so when ↑ Energy, ↓ Wavelength.

1. Radio waves – Lowest Energy
2. Microwaves
3. Infrared
4. Visible Light
5. Ultraviolet
6. X-rays
7. Gamma Radiation – Highest Energy

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

Frequency is inversely proportional to wavelength, so when ↑ Frequency, ↓ Wavelength.

1. Radio waves – Lowest Frequency
2. Microwaves
3. Infrared
4. Visible Light
5. Ultraviolet
6. X-rays
7. Gamma Radiation – Highest Frequency

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

Gamma has the shortest waves and Radio waves are the longest.

5. What is the relationship between frequency and wavelength?

Frequency is **inversely** proportional to wavelength, so when ↑ Frequency, ↓ Wavelength.

6. What is the relationship between frequency and energy?

Frequency is **directly** proportional to energy, so when ↑ Frequency, ↑ Energy.