

GENERAL CHEMISTRY STANDARD 2.5

2.5: Calculate the speed, wavelength, and frequency of electromagnetic radiation

ELECTROMAGNETIC RADIATION

- Radiation consisting of electromagnetic waves originating from varying electrical and magnetic fields that include visible light, ultraviolet light, radio waves, and many other types of waves characterized by their ability to progress in the absence of a medium
 - Waves are massless
 - Waves transfer energy
 - Radiation – form of heat transfer that does not require a medium
 - Transverse waves
- ALL electromagnetic waves travel with the same velocity
 - Speed of light (c) = 3.0×10^8 m/s
 - Frequency and wavelength are inversely related
 - As frequency increases, wavelength decreases
 - As frequency decreases, wavelength increases

WAVE EQUATION

$$c = f \times \lambda$$

c = speed of light – 3.0×10^8 (m/s)

f = frequency (Hz = 1/sec)

λ = wavelength (m)

USING THE WAVE EQUATION

Compute the frequency of a 635 nm photon of red light.

Step 1

$$\begin{aligned}\lambda &= 635 \text{ nm} = 6.35 \times 10^{-7} \text{ m} \\ f &= ? \\ c &= 3.0 \times 10^8 \text{ m/s}\end{aligned}$$

Step 2

$$c = f \times \lambda$$

Step 3

$$f = c / \lambda$$

Step 4

$$f = 3.0 \times 10^8 / 6.35 \times 10^{-7}$$

Step 5

$$f = 4.72 \times 10^{14} \text{ Hz}$$

USING THE WAVE EQUATION

Graphing Calculator Tip - Dividing with Scientific Notation

Be sure when you divide numbers in scientific notation on a calculator to recognize that the calculator will use the order of operations exactly...whether you intend to or not! You can estimate your answer when dividing numbers in scientific notation by subtracting your exponents...in the example above, $8 - (-7) = 15$, so the answer should be in the neighborhood of 15, and 14 certainly is. If you don't input this problem correctly on the calculator you will get an answer in the vicinity of 1 for your exponent. Here are your options to ensure you input the problem into the calculator the correct way:

1. Use parenthesis. For example, looking at the example above, you would put step 4 into the calculator as $(3.00 \times 10^8)/(6.35 \times 10^{-7})$.
2. Alternatively, use the EE button on the calculator (if your calculator has it) to represent numbers in scientific notation. ON the TI-84+ Graphing Calculators, the EE button is found by using 2ND-, (comma). Using the EE button, you would input the above problem as $3.00\text{E}8/4.10\text{E}-7$. The E symbol represents "x 10[^]" for the calculator. Do not confuse the E button with Euler's Number, e (2.718...). The scientific notation E is always capitalized.