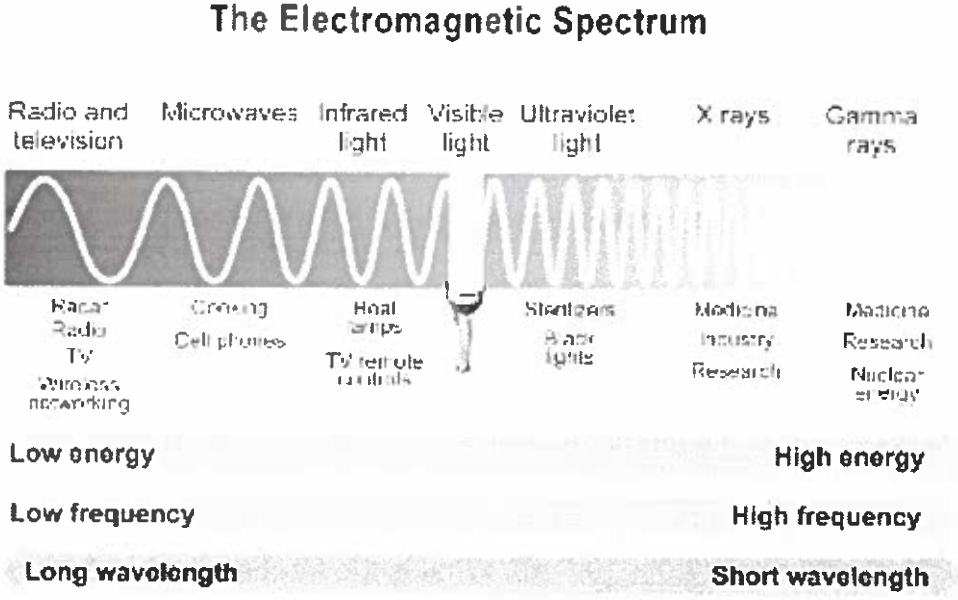
HPS Electromagnetic Spectrum 2020 Name Key 2020

Objective: Compare and contrast regions of the electromagnetic spectrum based on frequency, wavelength, and energy. (Obj 4)

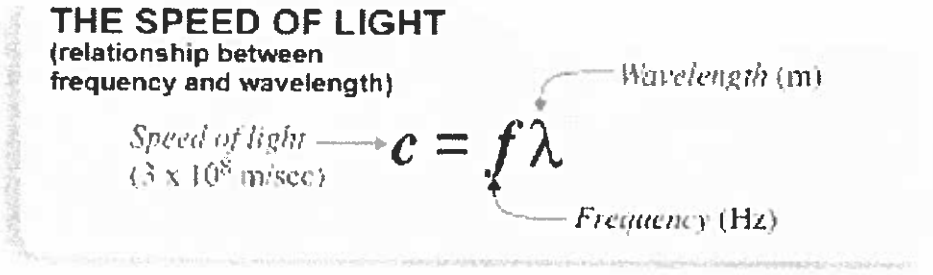
**Background Information**: Radio waves, microwaves, visible light, and x-rays are familiar kinds of electromagnetic waves. All of these waves have characteristic wavelengths and frequencies. *Wavelength* is measured in meters. It describes the length of one complete oscillation. *Frequency* describes the number of complete oscillations per second. It is measured in hertz, which is another way of saying "cycles per second." The higher the wave's frequency, the more energy it carries.




## Frequency, wavelength, and speed

In a vacuum, all electromagnetic waves travel at the same speed: $3.0 \times 10^8$ m/sec. This quantity is often called "the speed of light" but it really refers to the speed of all electromagnetic waves, not just visible light. It is such an important quantity in physics that it has its own symbol, *c*.

The speed of light is related to frequency *f* and wavelength λ by the formula.




The different colors of light that we see correspond to different frequencies. The frequency of red light is lower than the frequency of blue light. Because the speed of both kinds of light is the same, a lower frequency wave has a longer wavelength. A higher frequency wave has a shorter wavelength. Therefore, red light's wavelength is longer than blue light's.

When we know the frequency of light, the wavelength is given by: $\lambda = c/f$
When we know the wavelength of light, the frequency is given by: $f = c/\lambda$


$C = \lambda \cdot f$

$C = 3.00 \times 10^{8}$ m/s

$\times 10^{-9}$ = nanometer

Answer the following problems and show your work. $1.0 \times 10^{-11}$ m, $3.0 \times 10^{19}$ Hz

1. Yellow light has a longer wavelength than green light. Which color of light has the higher frequency? GREEN

2. Green light has a lower frequency than blue light. Which color of light has a longer wavelength? GREEN

3. Calculate the wavelength of violet light with a frequency of $750 \times 10^{12}$ Hz. $\frac{3.00 \times 10^{8}}{750 \times 10^{12}} = 4.0 \times 10^{-7}$ m ($400 \times 10^{-9}$ m)

4. Calculate the frequency of yellow light with a wavelength of $580 \times 10^{-9}$ m. $\frac{3.00 \times 10^{8}}{580 \times 10^{-9}} = 5.2 \times 10^{14}$ Hz ($520 \times 10^{12}$ Hz)

5. The waves used by a microwave oven to cook food have a frequency of 2.45 gigahertz ($2.45 \times 10^{9}$ Hz). Calculate the wavelength of this type of wave. $\frac{3.00 \times 10^{8}}{2.45 \times 10^{9}} = .122$ m

6. A radio station has a frequency of 90.9 megahertz ($9.09 \times 10^{7}$ Hz). What is the wavelength of the radio waves the station emits from its radio tower? $\frac{3.00 \times 10^{8}}{9.09 \times 10^{7}} = 3.30$ m

7. An x-ray has a wavelength of 5 nanometers ($5.0 \times 10^{-9}$ m). What is the frequency of x-rays? $\frac{3.00 \times 10^{8}}{5.0 \times 10^{-9}} = 6.0 \times 10^{16}$ Hz

8. The ultraviolet rays that cause sunburn are called UV-B rays. They have a wavelength of approximately 300 nanometers ($3.0 \times 10^{-7}$ m). What is the frequency of a UV-B ray? $\frac{3.00 \times 10^{8}}{3.0 \times 10^{-7}} = 1.0 \times 10^{15}$ Hz

9. Infrared waves from the sun are what make our skin feel warm on a sunny day. If an infrared wave has a frequency of $3.0 \times 10^{12}$ Hz, what is its wavelength? $\frac{3.00 \times 10^{8}}{3.0 \times 10^{12}} = 1.0 \times 10^{-4}$ m

10. Electromagnetic waves with the highest amount of energy are called gamma rays. Gamma rays have wavelengths of less than 10-trillionths of a meter ($1.0 \times 10^{-11}$ m). (Longest/Biggest λ)
    1. Determine the frequency that corresponds with this wavelength. $\frac{3.00 \times 10^{8}}{1.0 \times 10^{-11}} = 3.0 \times 10^{19}$ Hz
    2. Is this the minimum or maximum frequency of a gamma ray?

11. Use the information from this sheet to order the following types of waves from lowest to highest frequency: visible light, gamma rays, x-rays, infrared waves, ultraviolet rays, microwaves, and radio waves.
    Radio — Micro — IR — Vis light — UV — X Rays — Gamma

12. Use the information from this sheet to order the following types of waves from shortest to longest wavelength: visible light, gamma rays, x-rays, infrared waves, ultraviolet rays, microwaves, and radio waves.
    Gamma - X Rays — UV - Vis light - IR - Micro - Radio