25.1

25.1 The Electromagnetic Spectrum

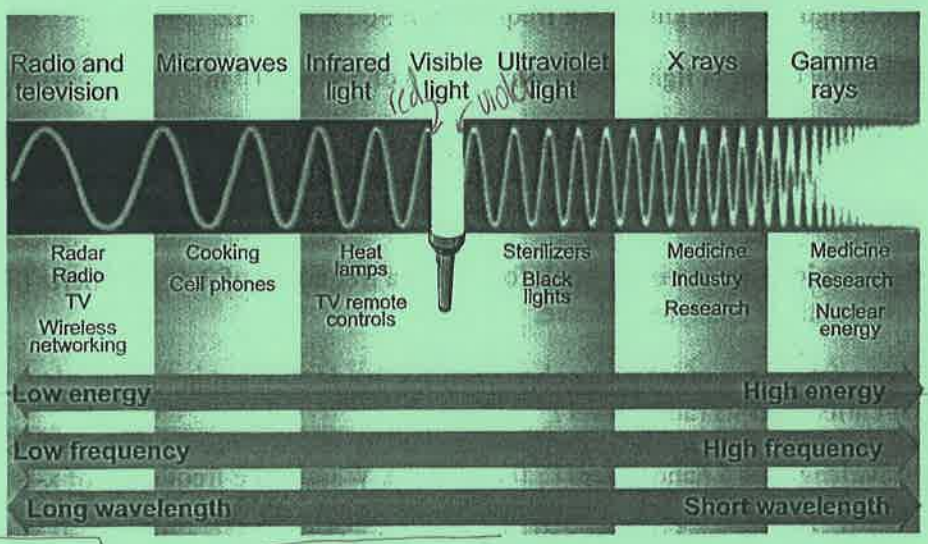
READ

A light year is the distance that light travels through space in a year = 9.46×10^{12} km = ≈ 6 trillion miles

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.

8 min. + 20 sec for light from Sun to reach Earth

The Electromagnetic Spectrum



speed of light = "c" = 3.0×10^8 m/s in a vacuum ≈ 186,000 miles/s

$c = 300{,}000{,}000 \frac{m}{s}$

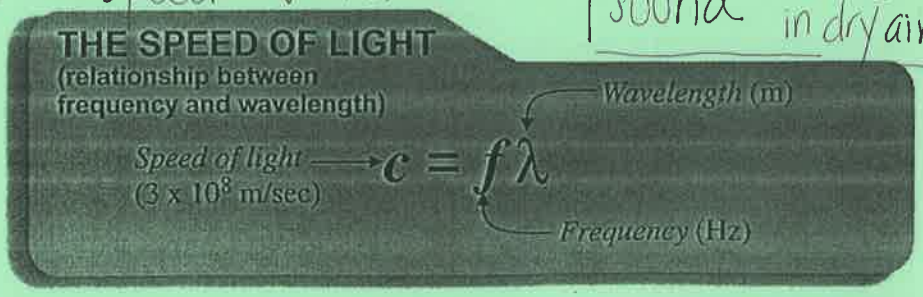
Frequency, wavelength, and speed

In a vacuum, all electromagnetic waves travel at the same speed: 3.0×10^8 m/s. 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*.

Wave speed = $v = \lambda f$

Speed of sound = 343 m/s in dry air

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



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: $\lambda = \frac{c}{f}$

$c = f\lambda$

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