

The Electromagnetic Spectrum and Astronomy

Formulas & Theorems Covered Today:



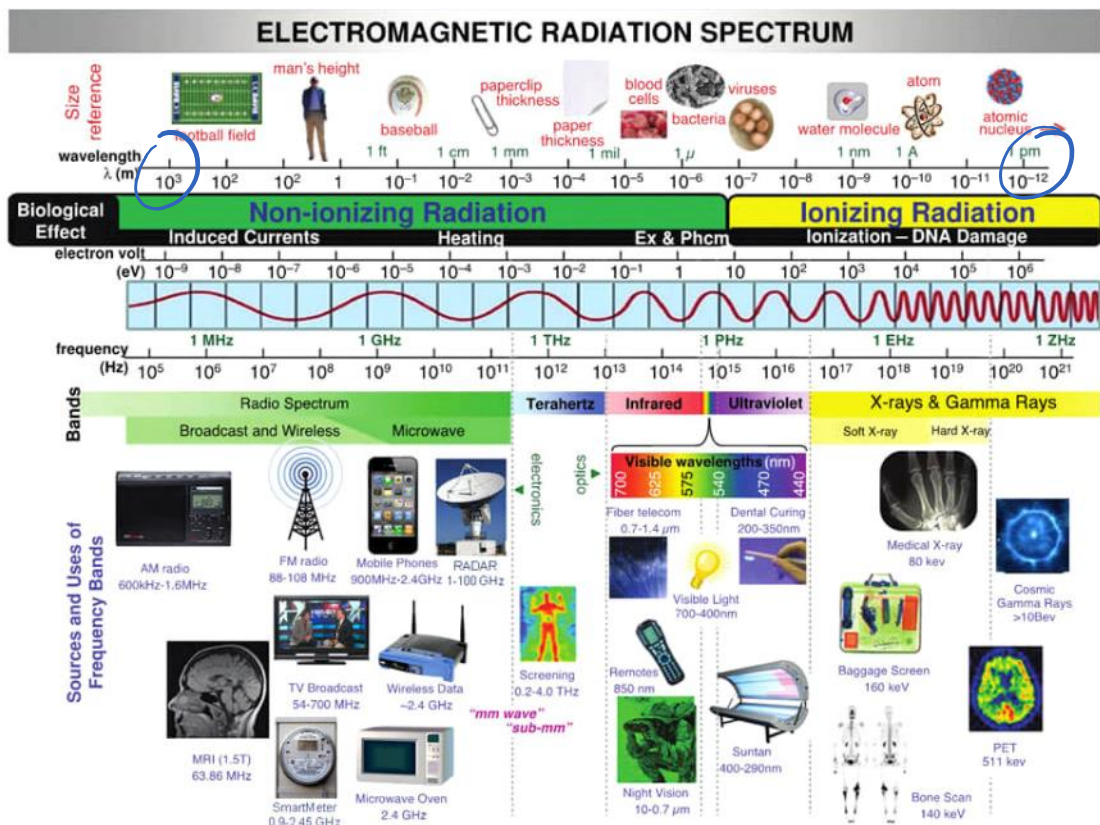
Homework:

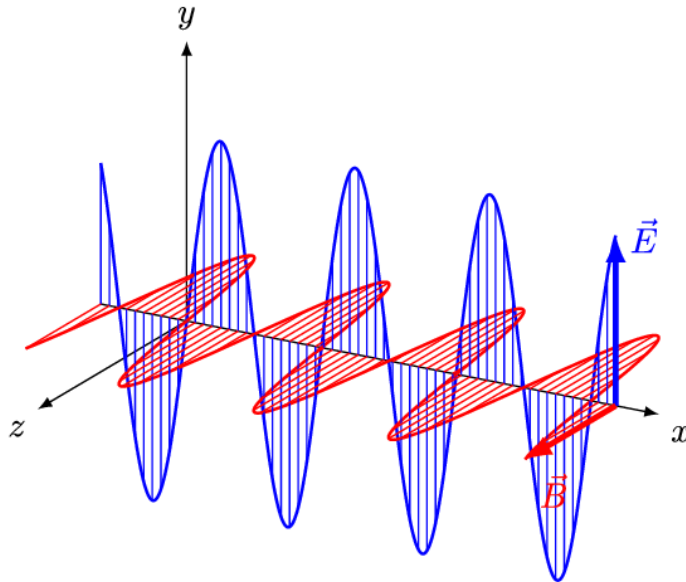


Notes:

The Electromagnetic Spectrum and the Tools of Astronomy

- The Radiation from distant bodies throughout the universe that scientists study is called electromagnetic radiation
- This include two components, the magnetic component and the electric component.





- Electromagnetic radiation is classified in multiple ways such as wavelength which represents the distance between peaks (or troughs) on a wave as shown below or frequency which represents the number of oscillations that pass a given point in any second.
- There also exists mathematical relationships between frequency and wavelength as well as energy and frequency as shown by the equations below.
- Frequency and wavelength are inversely proportional to one another
- Energy and frequency are directly proportional to one another
- The h in the second equation is Planck's constant which is a fundamental constant of quantum theory which sets the scale of the quantization and represents the energy that is carried by photons (quanta).

Equations	Constants
$C = \lambda\nu$	$C = 3 \times 10^8 \frac{m}{s}$ $m \times \frac{1}{s} = \text{m/s}$
$E = h\nu$	$h = 6.626 \times 10^{-34} \text{J} \cdot \text{s}$

$\lambda = \text{wavelength (m)}$
 $\nu = \text{frequency (Hz) (s}^{-1}\text{)}$

- Ex. 1 Calculate the frequency of light that has a wavelength 326nm?

$$c = \lambda\nu$$

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

$$\frac{3 \times 10^8 \frac{m}{s}}{3.26 \times 10^{-7} m} = 9.2 \times 10^{14} \frac{1}{s}$$

- Ex. 2 Calculate the wavelength of light given that the quantum of light possesses $2.87 \times 10^{-17} \text{J}$

$$2.87 \times 10^{-17} \text{ J}$$

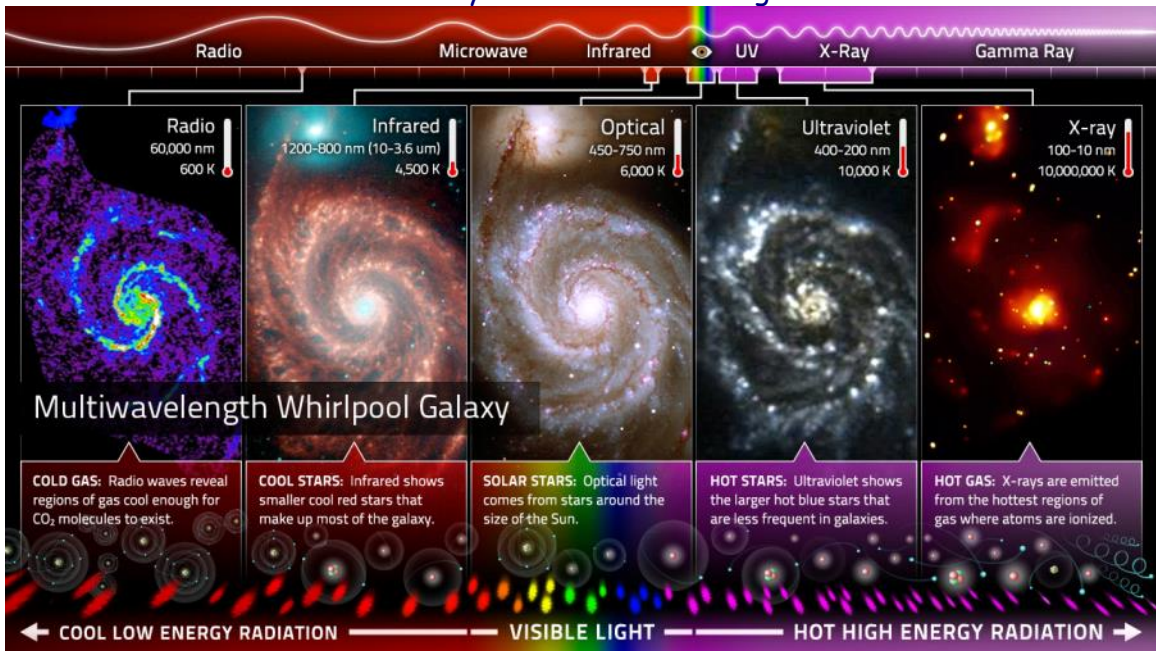
$$c = \lambda \nu \rightarrow \left(\frac{c}{\lambda} = \nu \right)$$

$$E = h \nu$$

$$E = \frac{hc}{\lambda} \rightarrow \lambda = \frac{hc}{E} = \frac{(6.626 \times 10^{-34} \text{ J}\cdot\text{s}) (3 \times 10^8 \frac{\text{m}}{\text{s}})}{2.87 \times 10^{-17} \text{ J}}$$

$$= 6.97 \times 10^{-9} \text{ m}$$

- Up until recent times, only the visible part of the spectrum was used in astronomy which was between wavelengths $\sim 700\text{nm}$ to $\sim 400\text{nm}$ and a frequency of $4.3 \times 10^{14}\text{Hz}$ to $7.5 \times 10^{14}\text{Hz}$
- Part of the reason for this is that there was a lapse in technological advancements of instruments to see these other parts of the spectrum and a second reason is that many of these types of radiation don't penetrate the atmosphere.
- Each one has its uses to astronomy as shown in the image below



- The tools of astronomy have gone one step further and are now using other methods of discovering the wonders of the universe like LIGO (Laser Interferometry Gravitational-Wave Observatory)

