The Electromagnetic Spectrum and Astronomy

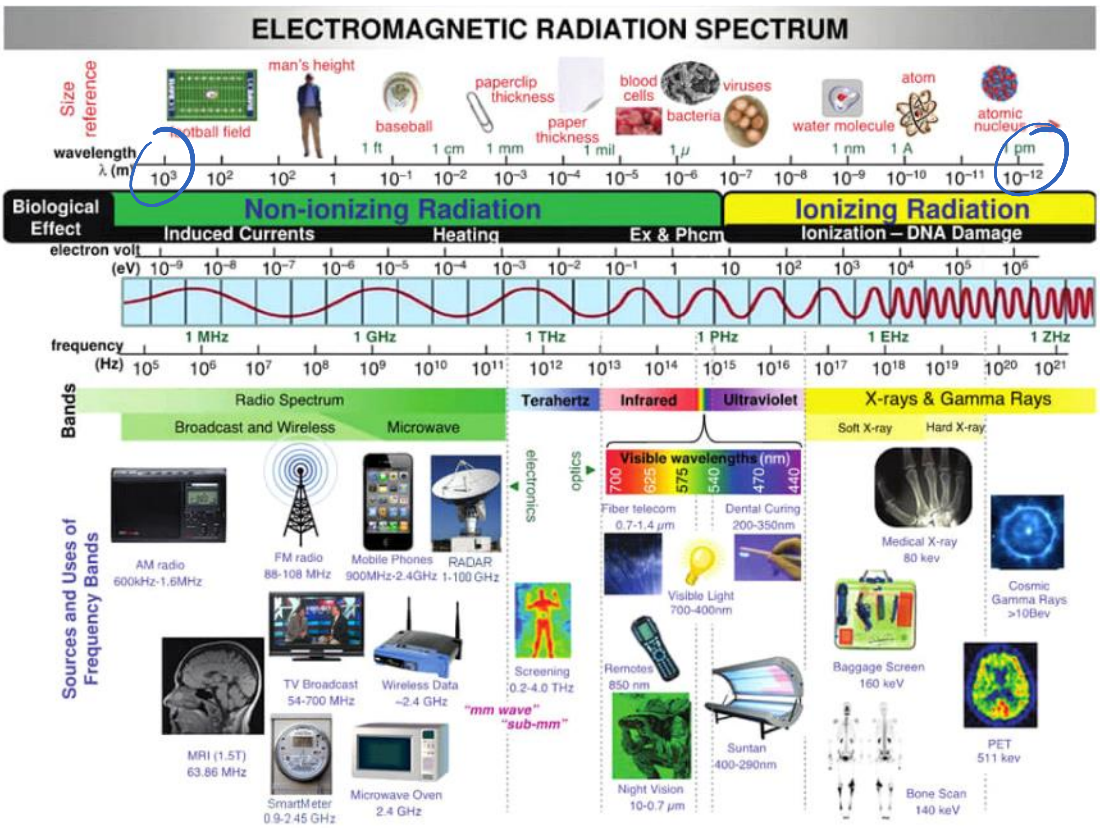
Formulas & Theorems Covered Today:

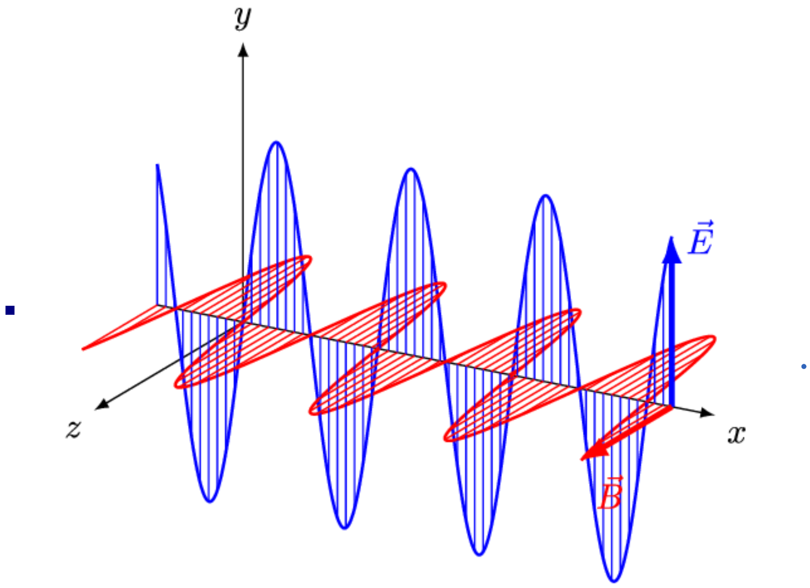
Homework:

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
$C = \lambda v$	$C = 3x10^{8}\frac{m}{s}$ $m \times \frac{1}{s} = \frac{m}{s}$
$E = hv$	$h = 6.626x10^{-34} J \cdot s$

λ = wavelength (m)
ν = frequency (Hz) (s^{-1})

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

$$C = \lambda v$$

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

$$\frac{3\times10^{8}\,\frac{\cancel{m}}{s}}{3.26\times10^{-7}\,\cancel{m}} = 9.2\times10^{14}\ \frac{1}{s}$$

- Ex. 2 Calculate the wavelength of light given that the quantum of light possesses 2.87x10^{-17}J

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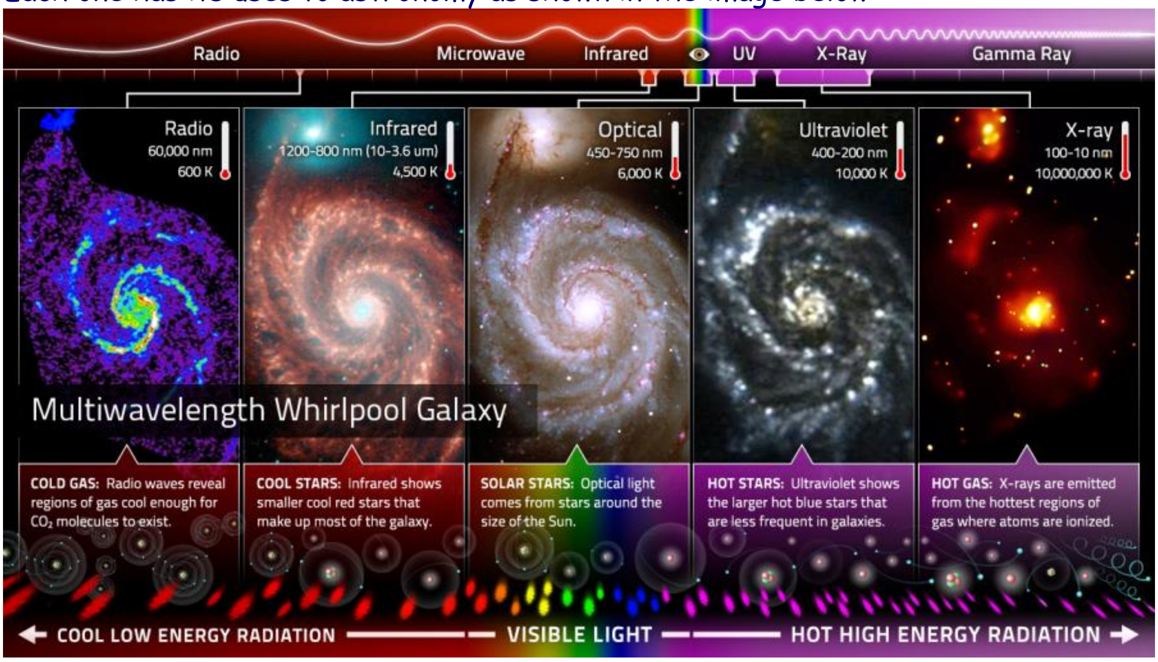
$$c = \lambda v \rightarrow \frac{c}{\lambda} = v$$

$$E = hv$$

$$E = \frac{hc}{\lambda} \rightarrow \lambda = \frac{hc}{E} = \frac{(6.626\times10^{-34}\ \cancel{J}\cdot\cancel{s})(3\times10^{8}\ \frac{m}{\cancel{s}})}{2.87\times10^{-17}\ \cancel{J}}$$

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

- Up until recent times, only the visible part of the spectrum was used in astronomy which was between wavelengths ~700nm to ~400nm and a frequency of 4.3x1014Hz to 7.5x1014Hz
- 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)