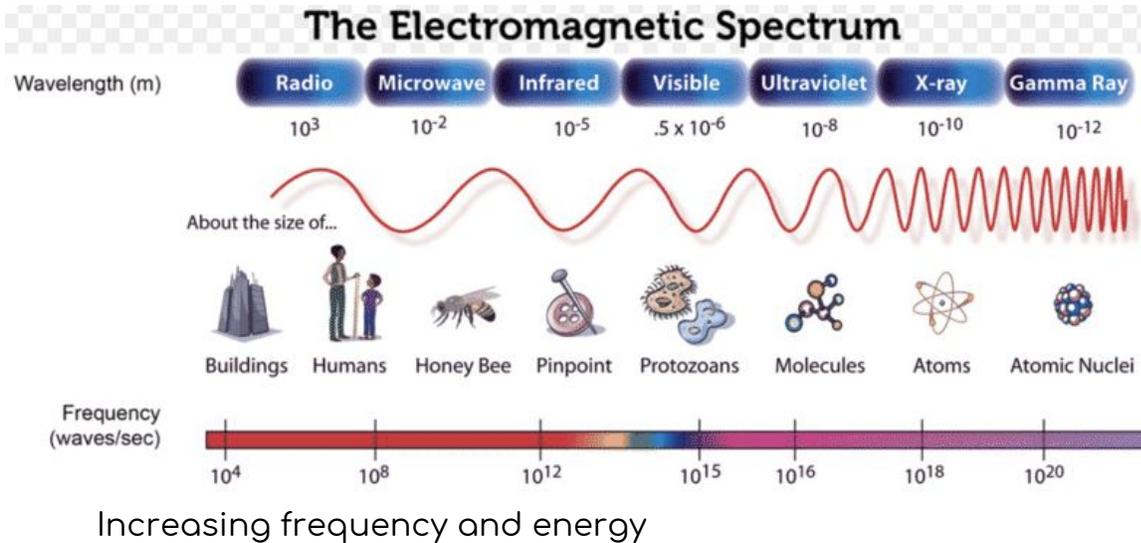


Electromagnetic Radiation

He will make your innocence radiate like the dawn, and the justice of your cause will shine like the noonday sun." Psalm 37:6

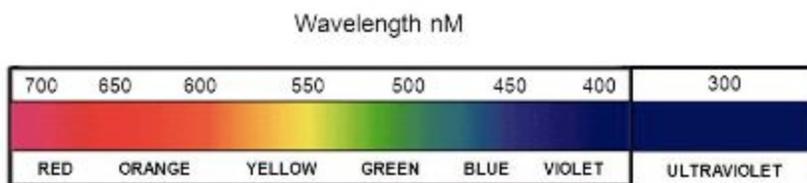
- Electromagnetic spectrum: arrangement of all forms of electromagnetic radiation in order of frequency and wavelength:



- Radio waves: widely used for communication (television, FM radio, cellular)
- Microwaves: microwave ovens, radar (Radio Detection And Ranging) which uses reflected microwaves to measure the distance and direction of far away objects, emitting a brief pulse and listening for echoes
- Infrared rays: just below red in visible spectrum; also called "heat rays" because they transmit radiant heat effectively

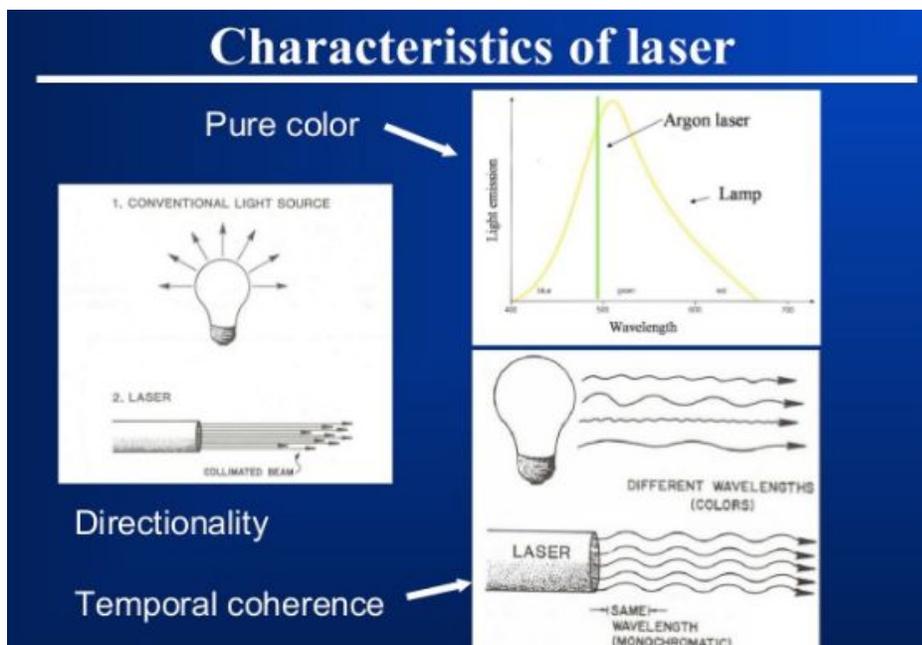


- Visible light: narrow band of frequencies perceived by the human eye (ROYGBIV)



- Ultraviolet: slightly higher than violet in visible spectrum; UVA in black lights; UVB dangerous to human cells, largely blocked by ozone layer; UVC most powerful form of UV radiation but short wavelengths completely blocked by ozone layer

- X-rays: easily penetrate many materials; used in medicine, airport security; prolonged exposure is harmful
- Gamma rays: most powerful form of electromagnetic radiation; penetrate even metals; used in radiotherapy and food sterilization
- Energy of a photon depends on its frequency
- When a photon of light strikes an atom, it may be absorbed by an electron → e- moves to a higher energy level → e- unstable at higher level so reverts to original level → energy released
- Stimulated emission (Einstein): if an e- already at a high energy level is struck by a photon, e- will emit two photons and then fall back down to a low energy level → two photons have same wavelength and frequency
- Laser: Light Amplification by Stimulated Emission of Radiation generates and amplifies high-energy beams of light (pic p.299)
 - monochromatic: light from a laser consists of a single frequency
 - coherent: all the light waves in a laser are in phase and move in one direction resulting in constructive interference
 - intense: entire light output from a laser is concentrated in a narrow, coherent beam



- Uses for lasers:
 - CD players use a small laser to scan microscopic depressions → special circuits convert pattern of the reflections into music or video
 - fiber optics: transmitting light through optical fibers; sounds travel by laser beams instead of electrical signals
 - lasers used for cutting metal, clothing and fabric
 - lasers in eye surgery
- Holograms: three-dimensional image produced by laser light; depends on principle of wave interference

Speed of Light

- Speed of light in a vacuum (c) = 3.00×10^8 m/s
Not affected by motion of the person or instrument doing the measuring; speed of light in a vacuum is always constant
- Special theory of relativity describes consequences of constancy of speed of light
- For objects traveling at high speeds:
 1. Time slows down/time dilation
 2. Objects become shorter to an outside observer; results from a slowdown of time
 3. Mass increases
- Speed of light in a vacuum (c) is thought of as the universal speed limit because it cannot be exceeded

Einstein's General Theory of Relativity/Time Dilation

- Video (<https://www.youtube.com/watch?v=yuD34tEpRFw&t=12s>)
- General theory of relativity (Einstein): gravity is a result of the geometry of space itself; a massive body such as earth "stretches" the space near it, causing the path of objects to be "bent" within the distorted area
→ time and length are affected by gravity; time runs more slowly and length contracts within a gravitational field from the perspective of an observer outside the field

