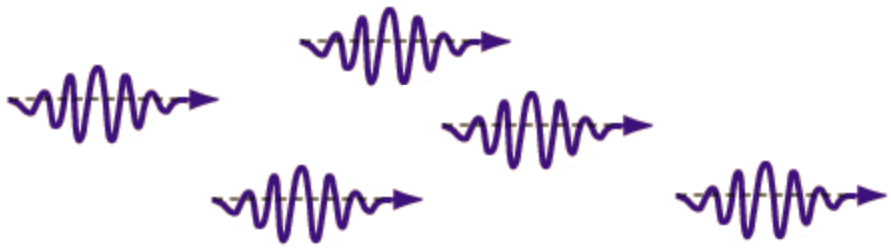
Photons & Production of Light

Einstein's work on the photoelectric affect coupled with Planck's work with blackbody radiation and quantization of energy led to the Photon Theory of Light. Further work by Bohr and other physicists created a model for the atom that offered an explanation as to how photons of light could be emitted from atoms and a way to determine the amount of energy the light would have as well as the frequency of the light.

Photon Theory of Light

Under the photon theory of light, a ***photon* is a discrete bundle** (or ***quantum***) of electromagnetic (or light) energy.



Photons are sometimes described as wave-packets. They travel at the speed of light and carry discrete amounts of energy related to their frequency as per Planck's work.

Energy of a Photon

$$E = hf$$

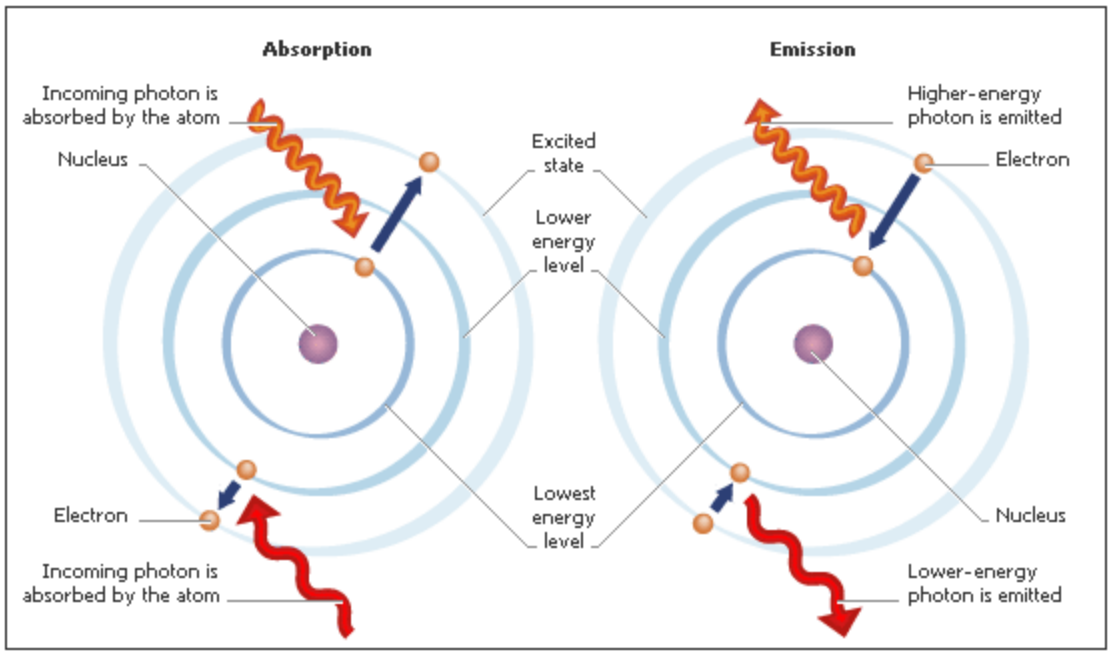
, where h is Planck's Constant ($h = 6.63 \times 10^{-34} J \cdot s$)

Photons of light carry discrete amounts of energy or "lumps of energy." This means that the energy of a vibrating atom that is emitting the light is also quantized and the energy can only exist in discrete bundles.

Producing Photons

Photons of light are produced by **energizing** electrons in an atom. A simplified view of the atom has electrons orbiting the nucleus in defined and quantized energy levels. All of the electrons occupy specific "energy levels" when the atom is at its **lowest energy level** (ground state). When you energize the atom you give electrons enough energy to jump up and momentarily occupy higher energy levels. This is similar to adding gravitational potential energy to a rock by lifting it from the ground to a height

above your head. The strange thing is that only specific, quantized energy levels are allowed. A photon of light is emitted whenever an electron that has been energized from a higher-than-normal energy level (orbit) falls back to its original energy level (or some intermediate energy level/orbit). Analogous to the kinetic energy gained by dropping the rock from above your head. During the fall from the higher orbit a photon of light is emitted. The photon has a frequency proportional to the energy difference between the two energies of the orbits that the electron "fell" from.



Questions

1. A certain quantum of energy is measured to be $7.5 \times 10^{-22} Joules$. Calculate the frequency and the wavelength of the light.
2. For each of the following frequencies, calculate the corresponding wavelength and energy in joules; a) $95.3 \times 10^{7} Hz$ b) $2.0 \times 10^{10} Hz$
3. How is the wavelength of a photon related to the energy the photon is carrying?
4. Calculate the energy emitted from ultraviolet radiation with a wavelength of 200 nm.