

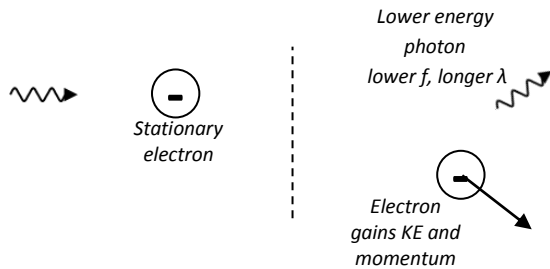
Modern Physics Review Map

6.1.1A-B

Photons

- Einstein explained the Photoelectric Effect using the photon concept.
- Photons have the following properties:
 - o Travel at the speed of light
 - o Have no mass
 - o Carry energy and momentum
 - o Undergo particle-like collisions (Compton Effect)

$$E_{\text{photon}} = hf = \frac{hc}{\lambda}$$



6.1.1C-D **Energy/Mass and Wave/Particle Duality**

Light has both a wave nature (diffraction and interference) and a particle nature (Photoelectric Effect)

Just as light has a particle nature, matter has a wave nature (deBroglie waves)

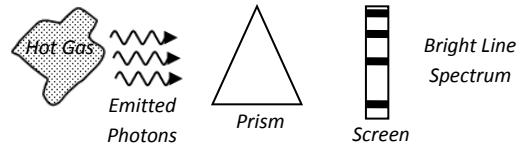
Special Relativity: energy and mass are the same thing $E = mc^2$

6.1.2D

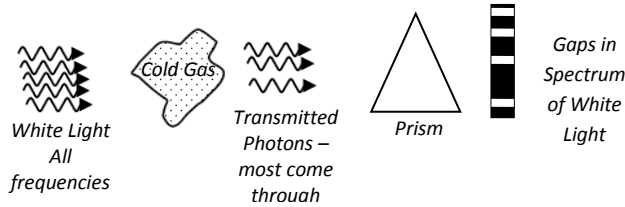
Atomic Spectrum

- Only certain energies are allowed in atoms, so only certain photons can be emitted or absorbed

Emission Spectrum – photons emitted from a heated source will only have certain frequencies



Absorption Spectrum – photons are absorbed by a cold gas so that only certain frequencies do NOT pass through

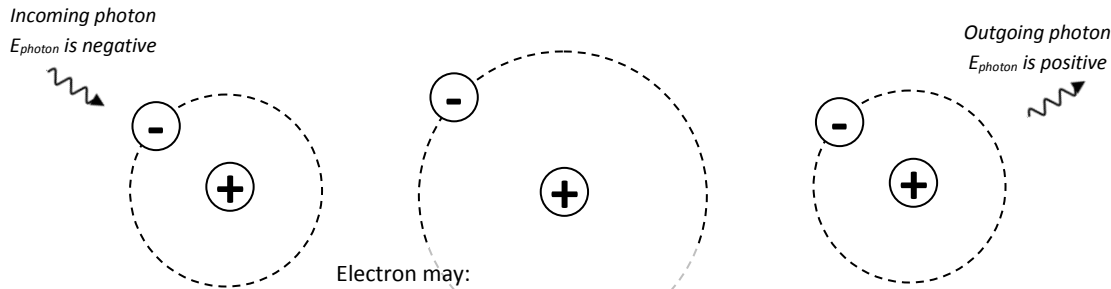


6.1.2A-C

Atomic Energy Levels

- Photons can be absorbed or emitted by atoms.

$$E_{\text{photon}} = E_i - E_f$$



Electron may:

- Be liberated if $E_{\text{photon}} \geq$ ionization energy
- Jump to higher level i if $E_{\text{photon}} =$ difference in levels
- Do nothing if neither condition is met

6.1.3A-C

Standard Model

Explains the operation of three of the four fundamental forces and predicts the existence of various particles and carriers that make up the Universe.

Families of Particles

Hadrons	Leptons
Baryons – 3 quarks -1, 0, +1, +2	<i>Do not experience the strong force</i>
Mesons – quark plus anti-quark -1, 0, +1	Electron (-1) Muon (-1) Tau (-1)
	Neutrinos (0)

Every particle has an anti-particle of equal mass and opposite charge

Most of the Universe is composed of up and down quarks.

Proton = uud
Neutron = udd

6.1.3-E

Fundamental Forces

Strong (Nuclear) Force – holds nuclei together

Weak (Nuclear) Force – involved in beta decay

neutron \rightarrow proton + electron + neutrino
one down quark \rightarrow up quark
baryon \rightarrow baryon and two leptons

Charge, energy, and mass are conserved (neutron is more massive than proton!)

Electromagnetic Force – gives matter its shape due to attraction of electrons and protons

Gravitation – not accounted for by the Standard Model