



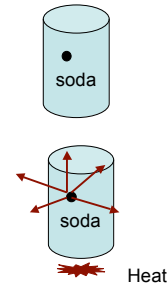
Chapter 27 Early Quantum Physics and the Photon

- Blackbody radiation
- Photoelectric effect
- X-ray production
- Absorption and Emission Spectra
- Bohr model of the atom



Black body radiation

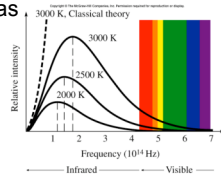
- An ideal **blackbody** absorbs all of the radiation incident on the body. A simple way to make a **blackbody** is to put a small hole in a hollow object (like a soda can) The hole is black because all of the light that falls on it is absorbed. A **blackbody** also emits radiation in a well defined way that depends on the temperature of the body.



Ultra-Violet Catastrophe

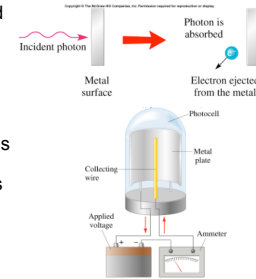
- Classical theory predicted that the energy emitted from a blackbody should increase exponentially for short wavelengths (**UV**). This was not observed!
- Solution: Planck tried quantizing the light energy

$$E=hf$$

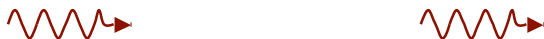


Photoelectric effect

- Brighter light-->increased light intensity but NO increase in KE of ejected electrons
- Max KE of electrons depends on frequency
- For a given metal, there is a threshold frequency below which no electrons are ejected
- Electrons are ejected instantaneously--expect some time for energy to build up.

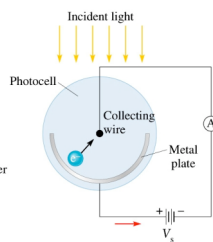


NO CLASSICAL EXPLANATION

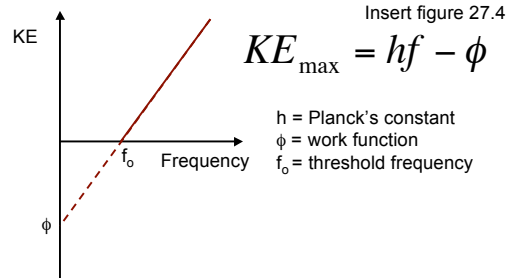


Photoelectric effect--the photon

- Brighter light \rightarrow more photons \rightarrow more electrons
- Each photon has an energy= hf , so Max KE of electrons depends on frequency
- For a given metal, there is a threshold frequency below which no electrons are ejected. This makes sense if a photon does not have enough energy it can't remove an electron
- Each photon gives up its energy to an electron. No need for energy to build up.



Photoelectric effect--the photon



Photoelectric Effect example

- What is the work function of a metal if green light of wavelength 514.5 nm causes electrons to be ejected with a maximum KE of 1.25eV?

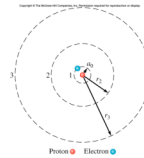
Early Model of the Atom

- JJ Thomson
– Plum Pudding



Inconsistent With Rutherford scattering

- Rutherford
– Planetary or solar



Electrons moving in orbits are constantly accelerating. Therefore they are losing energy. They will spiral into the nucleus and self destruct.

Bohr Model

- Stationary states--electrons can only occupy discrete orbits

$$L_n = n \frac{h}{2\pi} = n\hbar$$

$$L = I\omega = mr^2\omega = mvr_n$$

$$mvr = n\hbar$$

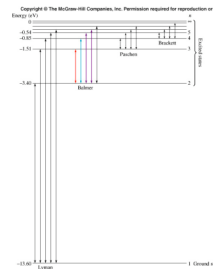
$$r_n = \frac{n^2\hbar^2}{mke^2} = n^2 a_0, \text{ where } a_0 = 5.29 \times 10^{-11} \text{ m}$$



Quantized Energy levels

$$E = K + U = \frac{1}{2}mv^2 - \frac{ke^2}{r}$$

$$E_n = -\frac{mk^2e^4}{2n^2\hbar^2} = \frac{-E_1}{n^2} = \frac{-13.6}{n^2}$$



Emission and Absorption Spectra

