BLACKBODY RADIATION & PLANK'S HYPOTHESIS

- The black body is an ideal absorber of incident radaition.

- The emitted "thermal" radiation from a black body characterizes the equilibrium temperature of the black-body.

- Emitted radiation from a blackbody does not depend on the material of which the walls are made.

BLACKBODY RADIATION & PLANK'S HYPOTHESIS

The Planck Law gives a distribution that peaks at a certain wavelength, the peak shifts to shorter wavelengths for higher temperatures, and the area under the curve grows rapidly with increasing temperature. In short the law fitted the experimental data for all wavelength regions and at all temperatures.

But for this to happen, Plank made two bold and controversial assumptions concerning the nature of the oscillators in the cavity walls.

BLACKBODY RADIATION & PLANK'S HYPOTHESIS

Planck's restriction of the available energies for radiation gets around the ultraviolet catastrophe in the following way: the short wavelength/high frequency modes are now limited in the energy they can have to either zero, or $E \geq hf$; in the calculation of the average energy, these modes with high energy are cut off by the Boltzmann factor $\exp(-E/k_B T)$, *i.e.* these modes are rarely excited and, therefore, contribute nothing to the average energy in the limit $\lambda \to 0$.

BLACKBODY RADIATION & PLANK'S HYPOTHESIS

SJ: Section 40.1 P-1 The human eye is most sensitive to 560 nm light. What is the temperature of a black body that would radiate most intensely at this wavelength?

SJ: Section 40.1 P-3 A blackbody at 7500 K consists of an opening of diameter 0.050 mm, looking into an oven. Find the number of photons per second escaping the hole and having wavelengths between 500 nm and 501 nm.

THE PHOTOELECTRIC EFFECT

Summary

Einstein successfully extended Plank's quantum hypothesis to explain photoelectric effect.

In Einstein's model, light is viewed as a stream of particles, or photons, each having energy $E = hf$, where h is Plank's constant and f is the frequency.

The maximum kinetic energy K_{max} of the ejected photoelectron is

$$K_{max} = hf - \phi$$

Where ϕ is the work function of the photocathode.

THE PHOTOELECTRIC EFFECT

SJ: P-SE 40.3 The Photoelectric Effect for Sodium

A sodium surface is illuminated with light having a wavelength of 300 nm. The work function for sodium metal is 2.46 eV. Find

A. The maximum kinetic energy of the ejected photoelectrons and

B. The cutoff wavelength for sodium.

SJ: Section 40.2 P-13. Molybdenum has a work function of 4.2eV. (a) Find the cut off wavelength and cut off frequency for the photoelectric effect. (b) What is the stopping potential if the incident light has wavelength of 180 nm?

THE PHOTOELECTRIC EFFECT

SJ: Section 40.2 P-14. Electrons are ejected from a metallic surface with speeds up to 4.60×10^5 m/s when light with a wavelength of 625 nm is used. (a) What is the work function of the surface? (b) What is the cut-off frequency for this surface?

SJ: Section 40.2 P-16. The stopping potential for photoelectrons released from a metal is 1.48 V larger compared to that in another metal. If the threshold frequency for the first metal is 40.0 % smaller than for the second metal, determine the work function for each metal.

THE COMPTON EFFECT

- Introduction
- What is Compton Effect
- Schematic diagram of Compton's apparatus
- Experimental Observations
- Classical Predictions
- Explanation for Compton Effect
- Derivation of the Compton Shift Equation.
- Conclusion
- Summary

THE COMPTON EFFECT

Applying the law of conservation of energy to the process gives

$$\frac{hc}{\lambda_0} = \frac{hc}{\lambda'} + K_e$$

where

$hc/\lambda_0 = E_0$ is the energy of the incident photon,

$hc/\lambda' = E'$ is the energy of the scattered photon,

and K_e is the kinetic energy of the recoiling electron.

Substituting for K_e we get

$$\frac{hc}{\lambda_0} = \frac{hc}{\lambda'} + (\gamma - 1)\, m_e c^2$$