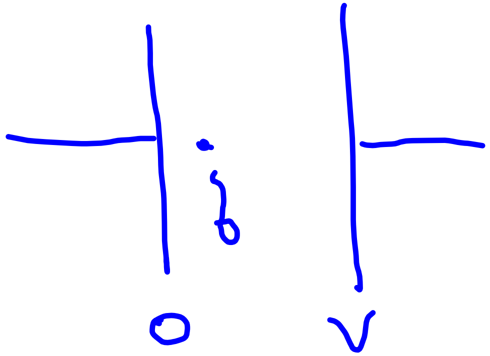
Reminders 4-23-07:

-Exam 4 May 7 Chapters 38-39.
-We will only cover two chapter in the next two weeks.

Objectives:

-Blackbody Radiation
-Photoelectric Effect
-Compton Scattering
-Line Spectra
-Bohr Atom



$$\Delta U = q\Delta V$$

$$W = -q\Delta V = \Delta K$$

$$\boxed{\Delta K = -q\Delta V}$$

$$|q| = 1.6\times10^{-19}\,C$$

$$(1.6\times10^{-19}\,C)(1\,V)$$

$$= 1.6\times10^{-19}\,J$$

$$1\,eV = 1.6\times10^{-19}\,J$$

Why must the absorbed energy depend on time?

Assume a point source gives 1W of light energy and emitting radiation uniformly in all directions, find the light intensity at a distance 1m from the source?

Assume a reasonable size for an atom (10^{-10}m), find the energy per unit time incident on this atom.
If 2eV of energy are required to remove an electron from the atom, how long does it take to eject it?
Theoretically can we control this lag time?

$$I = \frac{1}{4\pi(1)^2} = \frac{1}{4\pi}\frac{W}{m^2}$$

$$IA = \frac{1}{4\pi}\pi(10^{-10})^2 = .25\times10^{-20}\,\frac{J}{s}$$

$$\frac{(2eV)(1.6\times10^{-19}\,J/s)}{25\times10^{-20}\,J/s} = 128s$$

$$KE = hf - \phi \qquad \phi = \text{work function}$$

$$eV_s = hf - \phi$$

$$f = \frac{c}{\lambda}$$

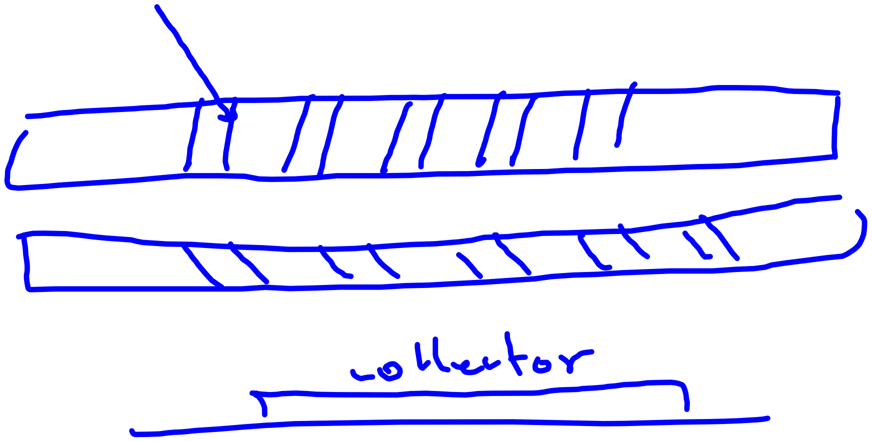
$$eV_s = \frac{hc}{\lambda} - \phi$$

$$hc = \frac{(6.626 \times 10^{-34}\,J s)(3 \times 10^{8})}{1.6 \times 10^{-19}\,J/eV} \cdot 10^{9}$$

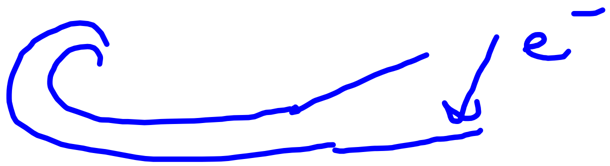
$$hc = 1240\,eV\text{-}nm$$

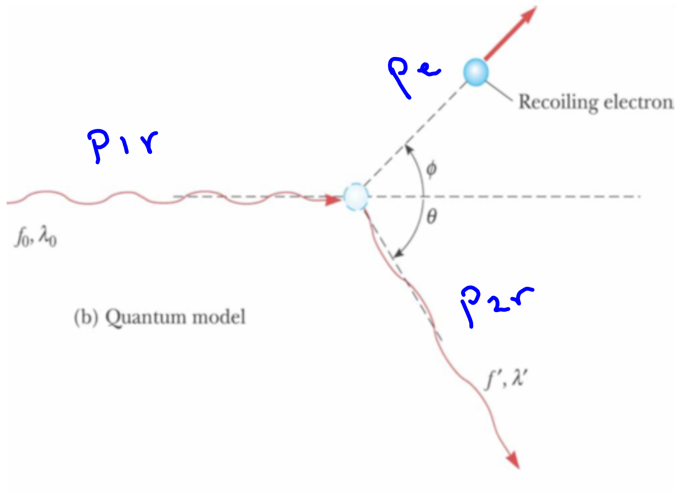
$$hc = 12400\,eV\text{-}\mathring{A}$$

MCP



Channeltron





$\vec{p}_{1r} = \vec{p}_{2r} + \vec{p}_e$

$\vec{p}_{1r} - \vec{p}_{2r} = \vec{p}_e$ square both sides

$p_{1r}^2 + p_{2r}^2 - 2\vec{p}_{1r}\cdot\vec{p}_{2r} = p_e^2$

$p_{1r}^2 + p_{2r}^2 - 2p_{1r}p_{2r}\cos\theta = p_e^2$

$E_0 + E_{1r} = E_{2r} + E_e$

$E_0 =$ rest mass of electron mc^2

Energy of photon $hf = \frac{hc}{\lambda} = pc$

$E_0 + p_{1r}c = p_{2r}c + (E_0^2 + p_e^2c^2)^{1/2}$

$E_0 + (p_{1r} - p_{2r})c = (E_0^2 + p_e^2c^2)^{1/2}$

$$E_0 + (p_{1r} - p_{2r})c = (E_0^2 + p_e^2 c^2)^{1/2}$$

$$\cancel{E_0^2} + (p_{1r} - p_{2r})^2 c^2 + 2E_0(p_{1r} - p_{2r})c$$
$$= \cancel{E_0^2} + p_e^2 c^2$$

$$(p_{1r} - p_{2r})^2 c^2 + 2E_0(p_{1r} - p_{2r})c$$
$$= p_e^2 c^2$$

$$(p_{1r} - p_{2r})^2 c^2 + 2E_0 c(p_{1r} - p_{2r}) =$$
$$(p_{1r}^2 + p_{2r}^2 - 2p_{1r}p_{2r}\cos\theta)c^2$$

$$-\cancel{2}p_{1r}p_{2r}c^2 + \cancel{2}E_0 c(p_{1r} - p_{2r})$$
$$= -2p_{1r}p_{2r}\cos\theta\, c^2$$

$$-p_{1r}p_{2r}c + E_0(p_{1r} - p_{2r}) = -p_{1r}p_{2r}\cos\theta\, c$$

$$E_0(p_{1r} - p_{2r}) = p_{1r}p_{2r}(1 - \cos\theta)c$$

$$\frac{p_{1r} - p_{2r}}{p_{1r}p_{2r}} = \frac{c}{E_0}(1 - \cos\theta)$$

$$\frac{\frac{h}{\lambda_1} - \frac{h}{\lambda_2}}{\frac{h^2}{\lambda_1\lambda_2}} = \frac{c}{E_0}(1 - \cos\theta)$$

$$\frac{\frac{1}{\lambda_1} - \frac{1}{\lambda_2}}{\lambda_1\lambda_2} = \frac{hc}{E_0}(1 - \cos\theta)$$

$$\lambda_2 - \lambda_1 = \frac{hc}{E_0}(1 - \cos\theta)$$

$$\lambda_2 - \lambda_1 = \frac{hc}{mc^2}(1 - \cos\theta)$$

$$\lambda_2 - \lambda_1 = \frac{h}{mc}(1 - \cos\theta)$$

What should the energy of photons be be so that the maximum change in wavelength due to Compton scattering by electrons is 1%?

Using these photons, what is in angstroms for

Compton scattered photons at 60?

What is the energy of the recoil electrons in this case?