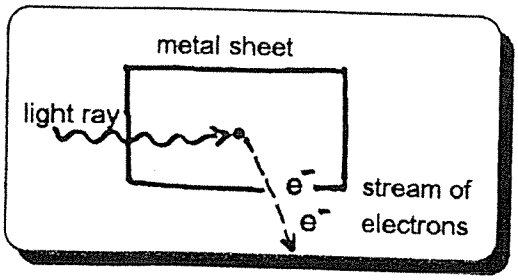
Photoelectric Effect

Name _____



photoelectric effect when light falls on a metal surface, electrons are ejected

photoelectrons the ejected electron

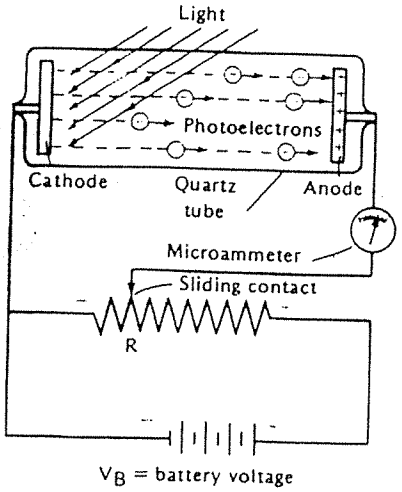


Fig. 29-1. Arrangement for measuring the rate of emission of photoelectrons from the cathode.

Light has frequency

below f_o no e^- are ejected

at f_o threshold f, different for each metal

above f_o photo electrons are ejected with greater KE

Light has energy

$E = h f$

E = energy of incident light
h = Plank's constant
f = frequency of light in Hz

remember $v = f\lambda$

$h = 6.6 \times 10^{-34}$ J·S

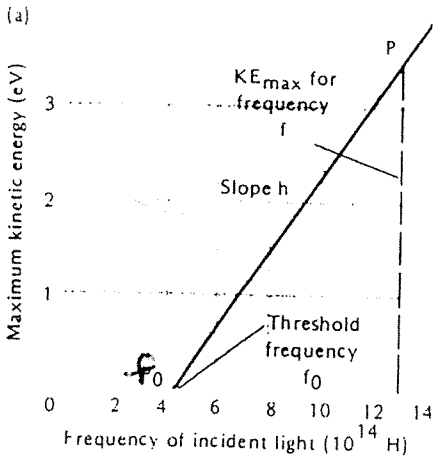
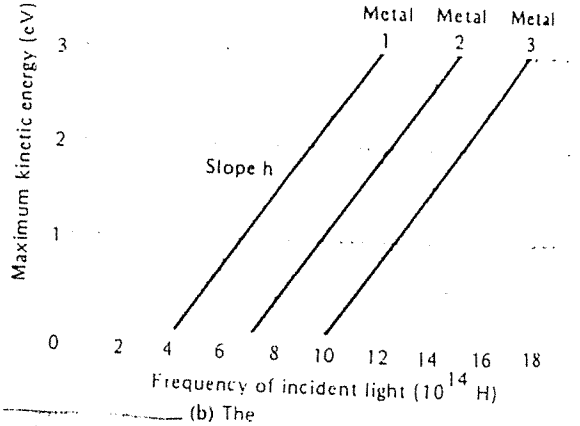


Fig. 29-3. (a) The maximum kinetic energy of the photoelectrons ejected from sodium, a typical metal, is proportional to the frequency of the incident light.



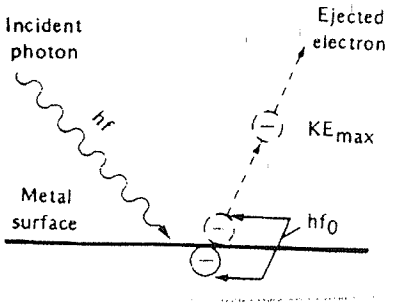
(b) The photoelectric effect for three metals. The graphs have the same slope (h) but different threshold frequencies, f_0.

What is the f_o for each metal?

1 4×10^{14} Hz
2 7×10^{14} Hz
3 10×10^{14} Hz

Use Analogy stone thrown against a wall

Photoelectric Effect (page 2)



W_o = work function = energy needed to free a surface e⁻

$KE_{max} = E_{photon} - W_o$

$KE_{max} = hf - hf_o$

Conservation of energy!

Increased frequency of incident light results in increased KE_{max} of photoelectrons (below f_o no e⁻ are ejected)

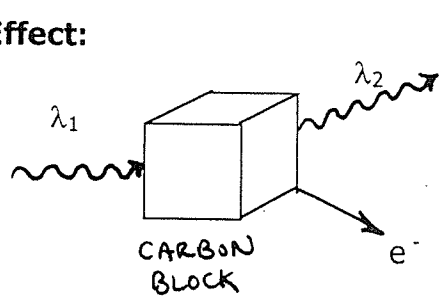
Increased intensity of incident light results in an increased number of photoelectrons but KE_{max} does not change

above f_o

What did we learn from the photoelectric effect? Light behaves like matter (particles) in this situation.

Compton Effect:

X rays



$\lambda_1 < \lambda_2$

$v = f\lambda$ $\quad f_1 > f_2$

$E = hf$ $\quad E_1 > E_2$

Observed: $\lambda_1 < \lambda_2$

What happened to the energy? $E_1 > E_2$, measured KE of the e⁻ $KE = \frac{1}{2}mv^2$

What did we learn from the Compton effect? Again Light is behaving like matter (particles).

wave 1 = wave out + KE_{e^-}

$hf_1 = hf_2 + \frac{1}{2}mv^2$

Energy is conserved also momentum is conserved.

Next -
Dual Nature of Light
define Photon
Photon momentum