2012 APR 11



# PHOTONS

A PHOTON IS A LITTLE PIECE OF LIGHT WITH ENERGY

$$E = hf$$

WHERE $f$ IS THE FREQUENCY OF LIGHT.

WHAT IS THE RELATIONSHIP BETWEEN FREQUENCY AND WAVELENGTH?

$$v = \frac{\lambda}{T}$$

$\lambda$ ← WAVELENGTH

$v$ ← WAVE SPEED

$T$ ← PERIOD

$$f = \frac{1}{T}$$

(G6, Ch 27, Ex 27-3)

$$E = hf = \frac{hv}{\lambda} = \frac{hc}{\lambda}$$

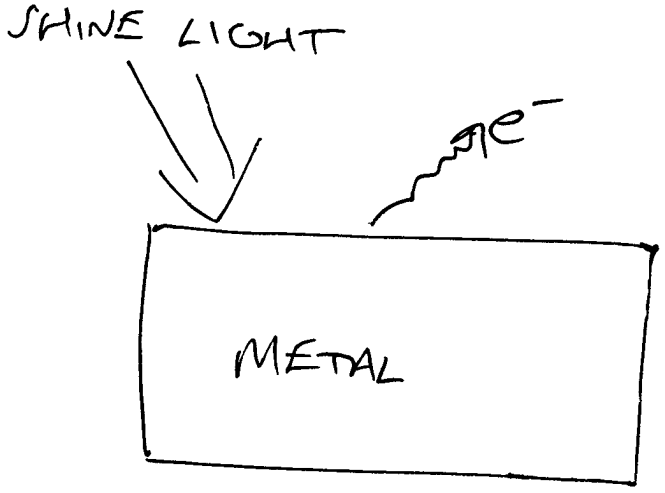
$$v = \lambda f \qquad f = \frac{v}{\lambda}$$

$$= \frac{(6.63 \times 10^{-34}\ J \cdot s)(3 \times 10^{8}\ m/s)}{450 \times 10^{-9}\ m}$$

$$= 4.4 \times 10^{-19}\ J$$

# PHOTOELECTRIC EFFECT






THE "WORK FUNCTION" IS THE AMOUNT OF ENERGY REQUIRED TO RELEASE AN ELECTRON FROM THE METAL.

$$hf = W_0 + \frac{1}{2}mv^2$$

- $hf$: ENERGY OF AN INCOMING PHOTON
- $W_0$: WORK FUNCTION
- $\frac{1}{2}mv^2$: KINETIC ENERGY OF RELEASED ELECTRON

THERE IS A THRESHOLD FREQUENCY ($hf_{th} = W_0$) BELOW WHICH NO ELECTRONS ARE FREED.

(GG, Ch 27, Ex 27-4)

$$hf = W_0 + \frac{1}{2}mv^2$$

$$\frac{hc}{\lambda} = W_0 + \frac{1}{2}mv^2$$

(a)

$$\frac{(6.63\times10^{-34}\ J\cdot s)(3\times10^{8}\ m/s)}{410\times10^{-9}\ m} = (2.28\ eV)\times\frac{1.602\times10^{-19}\ J}{1\ eV} + \frac{1}{2}mv^2$$

$$4.85\times10^{-19}\ J = 3.65\times10^{-19}\ J + \frac{1}{2}mv^2$$

$$KE = \frac{1}{2}mv^2 = 1.20\times10^{-19}\ J$$

$$v = \sqrt{\frac{2(1.20\times10^{-19}\ J)}{9.1\times10^{-31}\ kg}} = 5.1\times10^{5}\ m/s$$

(b)

$$\frac{(6.63\times10^{-34}\ J\cdot s)(3\times10^{8}\ m/s)}{550\times10^{-9}\ m} = 3.62\times10^{-19}\ J$$

NO ELECTRON GETS FREED

(GG, Ch 27, P 22)



$$hf = W_o + \frac{1}{2}mv^2$$

$$\frac{hc}{\lambda} = W_o + \frac{1}{2}mv^2$$

$$\frac{(6.63\times10^{-34}\ J\cdot s)(3\times10^{8}\ m/s)}{365\times10^{-9}\ m} = (2.48eV)\times\frac{1.602\times10^{-19}\ J}{1ev} + \frac{1}{2}mv^2$$

$$5.45\times10^{-19}\ J = 3.97\times10^{-19}\ J = \frac{1}{2}mv^2$$

$$KE = \frac{1}{2}mv^2 = 1.48\times10^{-19}\ J$$

$$v = 5.7\times10^{5}\ m/s$$