Max Planck

- Planck studied the radiation emitted by heated metals
- Called ***"black body radiation"***
- He plotted intensity vs. λ and postulated that electromagnetic waves (like light) travel in ***"packets"*** of energy rather than as continuous waves
- These packets were called ***"quanta"***
- He stated that the energy of a quantum is proportional to its frequency:

$$\mathbf{E = hf}$$

Or, since $\mathbf{v = f\lambda}$,

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

E = energy (J)
H = planck's constant (6.626×10^{-34} J·s)
f = frequency (Hz)

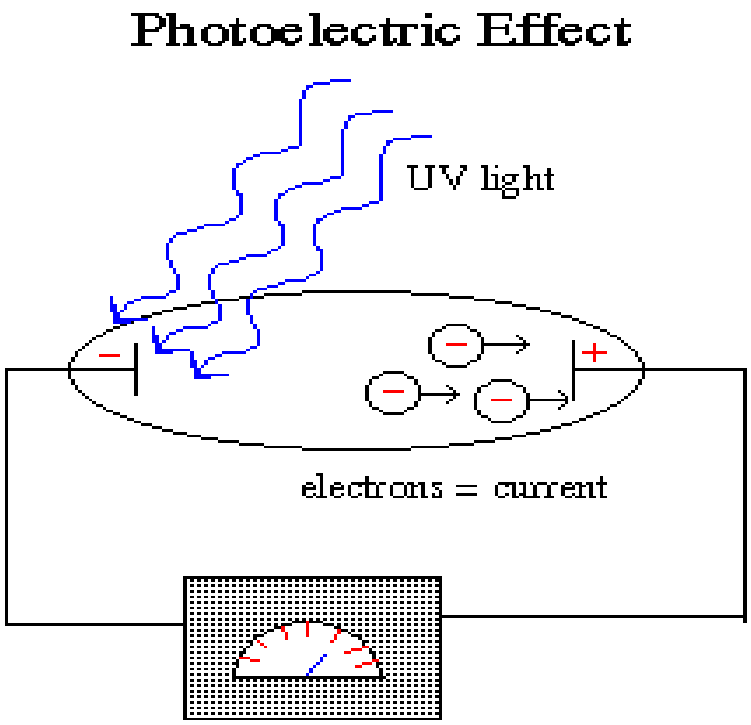
- So for ***"n"*** quanta:

$$\mathbf{E = nhf}$$

- Planck won the Nobel prize in 1918 for his work

The Photoelectric Effect

- When light (or other e-m radiation) strikes certain metals, electrons are emitted (current)
- The light ***must*** have $\mathbf{f > f_o}$, where $\mathbf{f_o}$ is the ***"threshold frequency"***
- (Current) α (intensity of light)



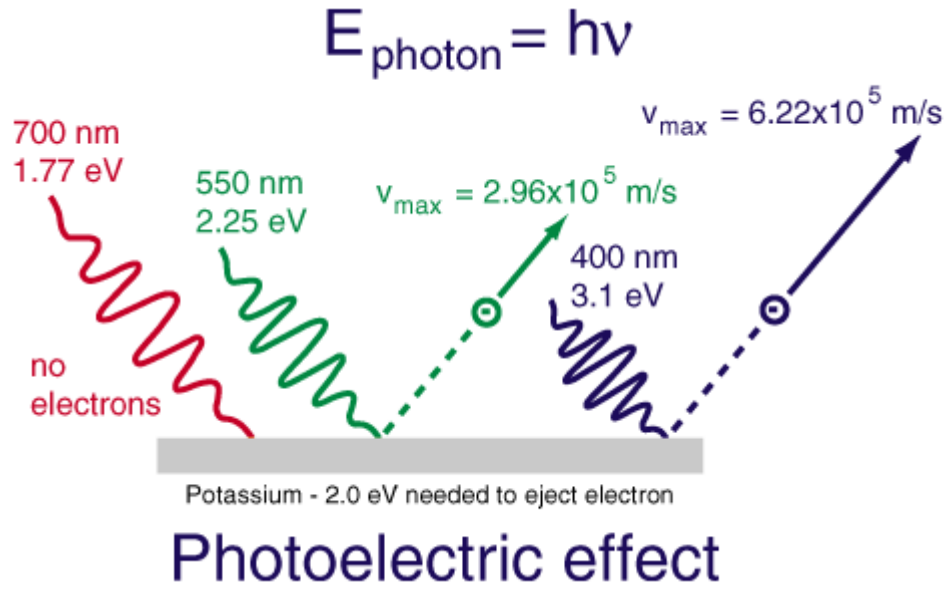
photon = wave particle of light

- ***Stopping potential*** **(V)** is increased up to $\mathbf{V_o}$, the ***cut-off potential***
- When **V** reaches $\mathbf{V_o}$, photocurrent is zero
- $\mathbf{V_o} \alpha$ f
- The maximum $\mathbf{E_k}$ of photoelectrons can be found:

$$\mathbf{E_k = eV_o}$$

$\mathbf{E_k}$ = kinetic energy of electron

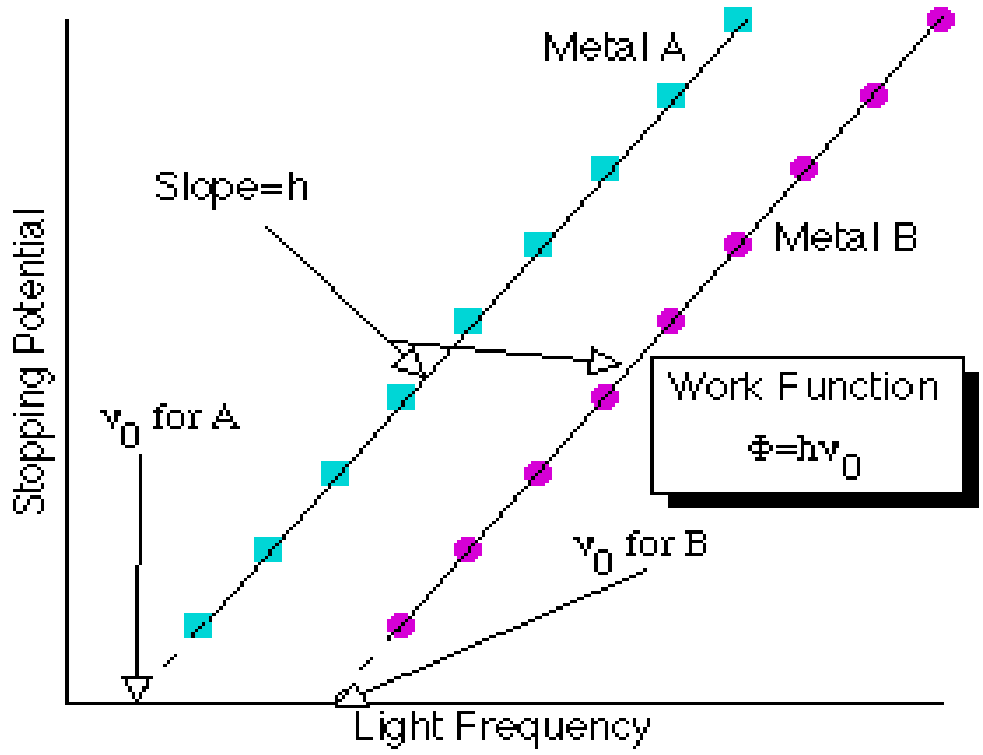
e = elementary charge (1.602×10^{-19} C)
V_o = cut-off voltage (V)



- Einstein expanded on Planck's work, calling quanta ***"photons"***
- Developed the photoelectric equation:

$$\mathbf{E_k = hf - W}$$

- W is called the work function
- W is the energy required to free the electron from the metal (J)
- W is different for each metal



Examples:

1. A metal with a work function of 2.3 eV is illuminated with light of wavelength 632 nm.

a) Will this light liberate photoelectrons?
b) If not, then what maximum wavelength of light will cause the photoelectric effect?

2. If the headlight of a van radiates 30 W and the peak wavelength of emitted light is 540 nm, how many photons per second does the headlight radiate?