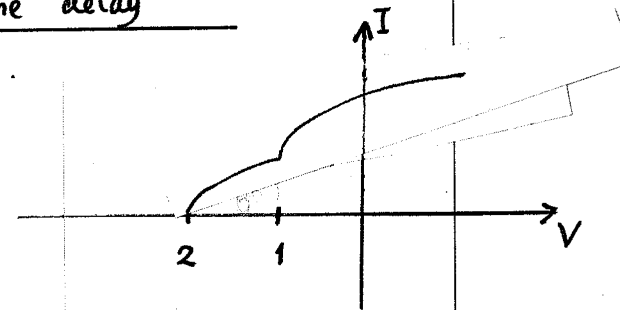
	long wave length		short wavelength
propagator	wave	$\longrightarrow$	particle like
energy momentum transfer	continuous	$\longleftarrow$	quantized.

Photo Electric Effect

Dependence	Independence
I versus light intensity	V_s versus intensity
V_s versus f	no time delay

$$eV_0 = hf - \phi$$



A photo electric effect Experiment uses a light source of 2 spectrum lines of 400 nm and 600 nm. Without the filter, one obseves I versus V as shown. Explain the phenomenon.

Possible explanation: The light source is of 2 colors.

The first stopping potential at 1 volt for a longer wavelength, and the last stopping potential at 2 volt for a shorter wavelength.

$$\left.\begin{aligned} 1\ eV &= hf_1 - \phi \\ 2\ eV &= hf_2 - \phi \end{aligned}\right\} \quad 1\ eV = hf_2 - hf_1$$

$$h = \frac{1\ eV}{f_2 - f_1}$$

$$f_1 = \frac{c}{\lambda_1} = \frac{3\times10^8\ m/s}{600\times10^{-9}\ m} = 5\times10^{14}\ Hz$$

$$f_2 = \frac{c}{\lambda_2} = \frac{3\times10^8\ m/s}{400\ nm} = 7.5\times10^{14}\ Hz$$

$$h = \frac{1\ eV}{2.5\times10^{14}/s} = 4\times10^{-15}\ eV.s = 6.4\times10^{-34}\ J.s. \checkmark$$

We can find ϕ too: $1\ eV = hf_1 - \phi$; $\phi = hf_1 - 1\ eV = 4\times10^{-15}\ eV.s \times 5\times10^{14} - 1$

$= 2 - 1 = 1\ eV.$

Photon flux of 100W light bulb of $\lambda = 600$ nm. at $r = 1.5\ m$

$hf = hc/\lambda$; therefore, to find energy quantum, it is useful to know hc

$$hc = 4.136\times10^{-15}\ eV\cdot s \cdot 3\times10^8\ m/s = 12.4\times10^{-7}\ m\cdot eV$$
$$= 1240\ nm\cdot eV$$

$$hf = \frac{1240\ nm\cdot eV}{600\ nm}$$

$= 2.07\ eV$; $\quad 100\ joules = 100/1.602\times10^{-19}\ eV = 0.624\times10^{21}\ eV$

$= 3\times10^{20}\ hf$ or 3×10^{20} photon.

$$\text{Photon flux} = \frac{\#\ \text{photon}}{\text{area}} = \frac{\#\ \text{photon}}{4\pi\times r^2} = \frac{3\times10^{20}}{4\pi\times1.5^2} = 1.1\times10^{19}\ \text{photon}/m^2 = 1.1\times10^{15}\ \text{phot}/cm^2$$