

short trick

$$F = \frac{I}{c} \times \text{projected area } a$$

for any value of  $a$  and  $I$

$$f = \frac{I}{c} \cdot h \cdot a$$

Photo-electric effect  $\Rightarrow$

$$\phi = \text{work function} = \frac{hc}{\lambda_0} = \frac{12400 \text{ eV}}{\lambda}$$

$\uparrow \lambda$   $\downarrow$  then at  $\lambda$  when  $e^-$  starts coming out is known as threshold wavelength ( $\lambda_0$ )

threshold frequency ( $\nu_0$ )

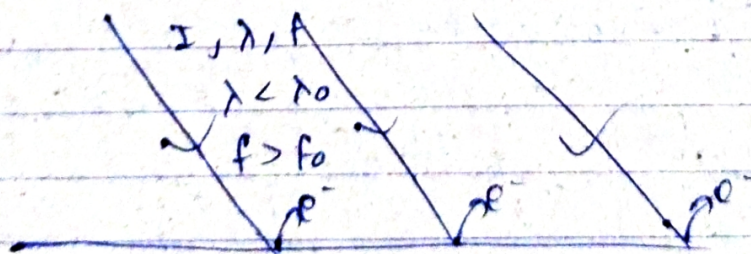
experimental observation and conclusion  $\Rightarrow$

suppose we have taken a light of wavelength  $\lambda$  and frequency  $f$  and we are not getting any electron from the surface. now we started increasing ~~wavelength~~ intensity of light keeping  $f$  and  $\lambda$  constant. we found that electron ~~are~~ will

no come out for any increment value of intensity so we concluded that electrons  $e^-$   $\frac{dE}{dt}$  does not depend on intensity. now we started increasing frequency or we can say starting decreasing wavelength. we found that at a particular value of  $f_0$ , and  $\lambda$  electron start coming out <sup>from</sup> the surface as we further increase or decrease frequency or decrease wavelength electron emission continues so we concluded that  $e^-$   $\frac{dE}{dt}$  depends on frequency and wavelength.

Threshold frequency  $\Rightarrow$  Min<sup>m</sup> frequ. of light required for a particular surface to get electron is known as threshold frequency of surface.

Threshold  $\lambda$   $\Rightarrow$  Max<sup>m</sup> possible value of  $\lambda$  for which electron will come out from the surface is known as threshold wavelength ( $\lambda_0$ )



so we concluded that ejection of  $e^-$  depends on energy of one photon. (not on total energy) i.e. intensity) because process

depends on  $h\nu$

min<sup>m</sup> energy of one photon required to take out the  $e^-$  from the metal surface is  $W_0$  work function for that particular surface

\* work function, threshold frequency and threshold wavelength depends on metal surface and these values changes with changing the metal surface.

The process of ejection  $e^-$  from metal surface on incident of light (photons) is  $W_0$  photoelectric surface effect.

photoelectric effect can be explained only using particle nature of light (not by wave nature, if we consider wave nature then for every intensity electron बहार आने चाहिए थे पर experimentally ऐसा होता नहीं है (It is found that electron ejection is independent of intensity)

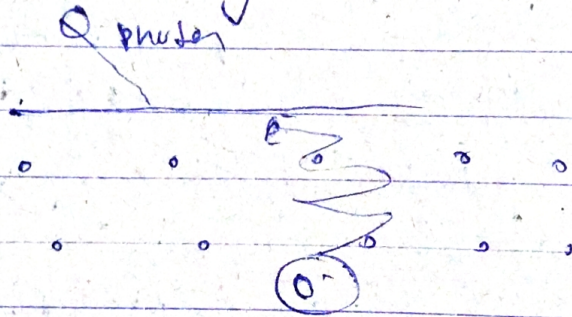
(ii) अगर हम wave nature मानें तो electron को बहार आने में कुछ समय लाना चाहिए कि electron emission is a instantaneous process which can be explained only using particle nature

अगर हम wave nature मान लें तो electron को बहार आना frequency और wavelength से Depend होगा परन्तु यह सही नहीं है • Intensity Depend नहीं है but experimentally इसका उल्टा होता है

लाभक photons  $\equiv$  capable of taking out electron  
 नालाभक photons  $\equiv$  not " " " "

हमने पाया कि जितने लाभक photons ( $\frac{IA}{hc}$ ) per second  
 गिरते हैं उससे बहुत कम electron बाहर आते हैं (1/10)

इसका मतलब  $\text{Max}^m$  लाभक photons waste  
 हो जाते हैं only .2 and .1 % ही काम कर पाते हैं



photoelectric effect में हम ये मानते हैं कि  
 एक photon एक ही electron को energy  
 दे सकता है and 1 electron 1 ही photon से  
 ले सकता है जब 1 electron 1 लाभक  
 photon को लेता है तो वह हमेशा surface के पास  
 ही यह जरूरी नहीं है surface तक पहुंचने तक  
 वह कई electrons and nuclei से टकराता  
 है। अगर surface तक पहुंचते - उसकी energy  
 work function से ज्यादा बच जाए तो वह  
 बाहर आता है otherwise धर में ही रह जाता है  
 and probability of above event is very-very less  
 that is why we get very less no. of electrons  
 ejected as compare to no. of लाभक photons  
 falling

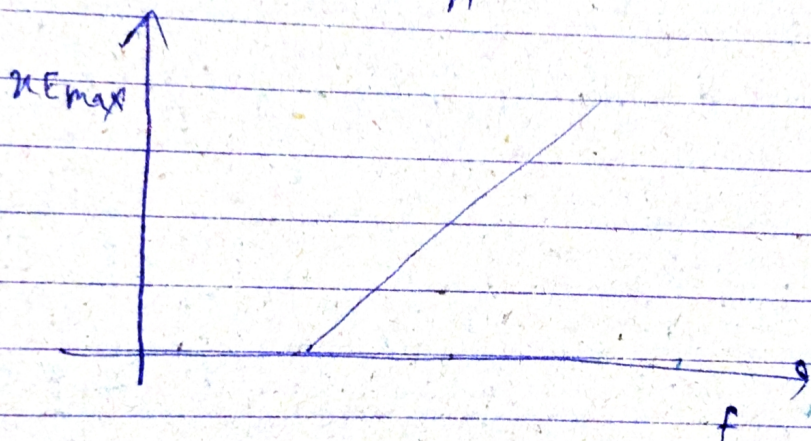
main eqn solving numerical problem

$$hf = hf_0 + KE_{max}$$

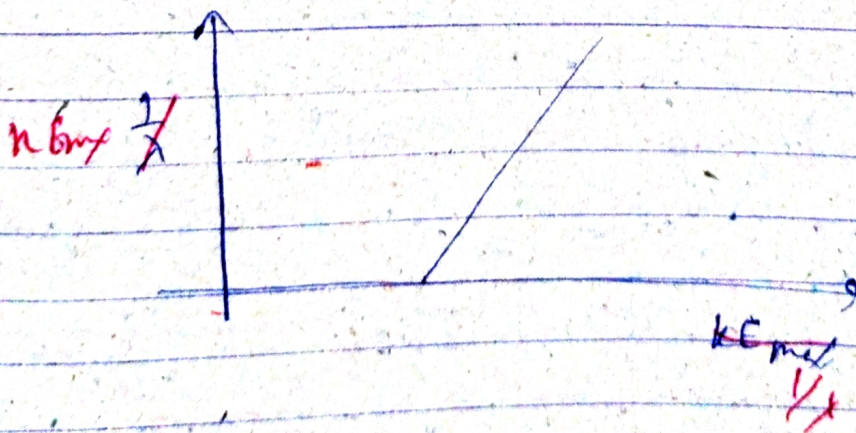
$$\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + KE_{max}$$

$$hf = hf_0 + KE_{max}$$

$$f = \frac{KE_{max}}{h} + f_0$$

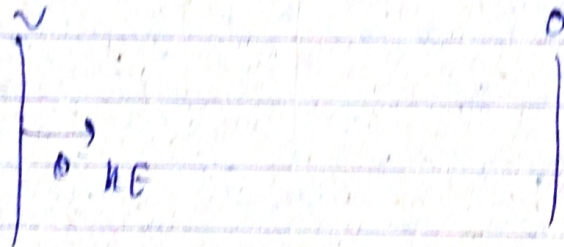


$$\frac{1}{\lambda} = \frac{KE_{max}}{hc} + \frac{1}{\lambda_0}$$



## Stopping Potential & $K.E_{max}$

अगर हम Potential के magnitude को धीरे-धीरे side में बढ़ाते हैं हम पाएंगे कि current बढ़ रहा है. मतलब electron reaching the other plate decreases. सबसे-से एक value ऐसी है जहाँ potential की قيم पर current = 0 मतलब वह electron जो  $Max KE$  के साथ निकला था वह दूसरी plate पर Just पहुँचते-से रह जाता



$$-eV + K.E = 0 + 0$$

$$K.E_{max} = eV$$

so we can say that  $Max^{th}$   $V.G.$  of electron ejected from surface is  $eV$ . where  $V$  is known as stopping potential. जब भी experiment में stopping potential दिया है तो होता है  $K.E_{max}$  दिया है

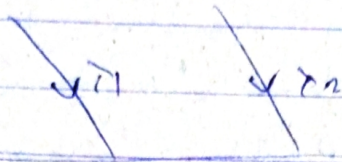
ex stopping  $P.E = 4V \Rightarrow K.E_{max} = 4eV$

$$hf = hf_0 + eV_s$$

$$\frac{12000}{\lambda(A)} = \frac{10000}{\lambda_0(A)} + V_s$$

$$\lambda(A) \quad \lambda_0(A)$$

Ques 2 diff wavelengths  $\lambda_1$  and  $\lambda_2$  falls on a surface of substance of max<sup>m</sup> possible  $KE$  is  $n$  find  $\phi$  (w.f.) of surface.



$$\frac{hc}{\lambda_1} = \phi + KE_{max1} \Rightarrow KE_{max1} = \frac{hc}{\lambda_1} - \phi$$

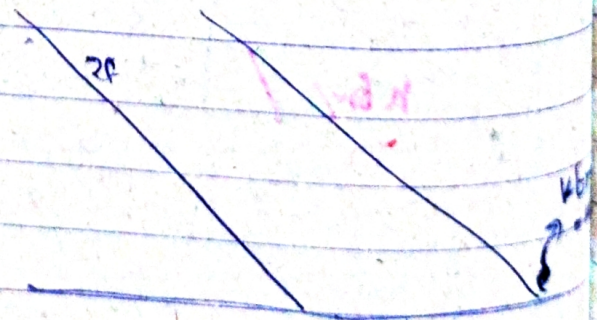
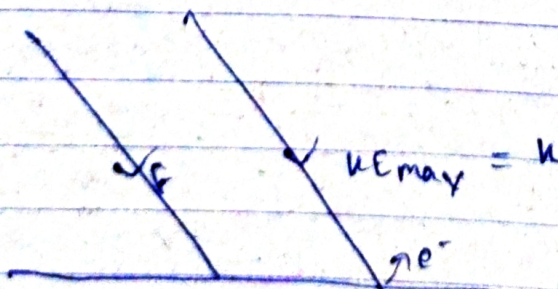
$$\frac{hc}{\lambda_2} = \phi + KE_{max2} \Rightarrow KE_{max2} = \frac{hc}{\lambda_2} - \phi$$

$$\frac{\frac{hc}{\lambda_1} - \phi}{\frac{hc}{\lambda_2} - \phi} = n \Rightarrow \frac{hc}{\lambda_1} - \phi = n \frac{hc}{\lambda_2} - n\phi$$

$$\phi (n-1) = \frac{nhc}{\lambda_2} - \frac{hc}{\lambda_1}$$

$$\phi = \frac{hc(n-1)}{n-1 \lambda_2 \lambda_1}$$

Ques



- ①  $k' = 2k$
- (✓) ②  $k' > 2k$
- ③  $k' < 2k$
- ④ Depend on  $\phi$

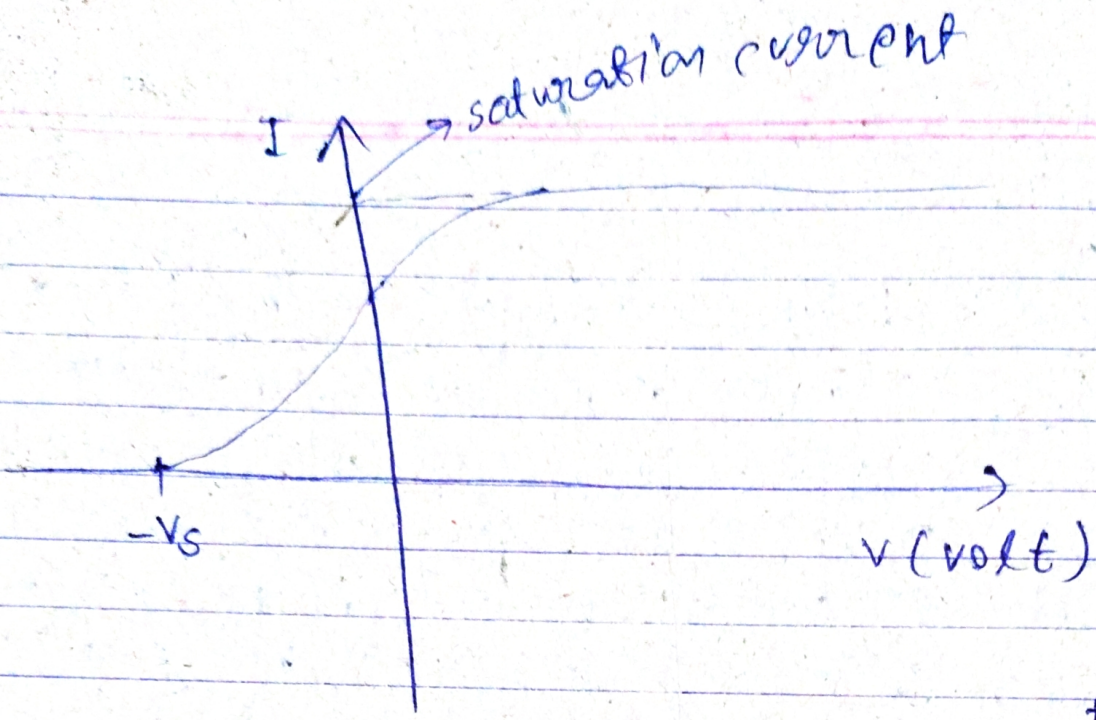
$$hf = \phi + KE_{max}$$

$$KE_{max} = hf - \phi = k \quad (hf > k)$$

$$k' = 2hf - \phi$$

$$k' = hf + k$$

$$k' = 2.1k$$

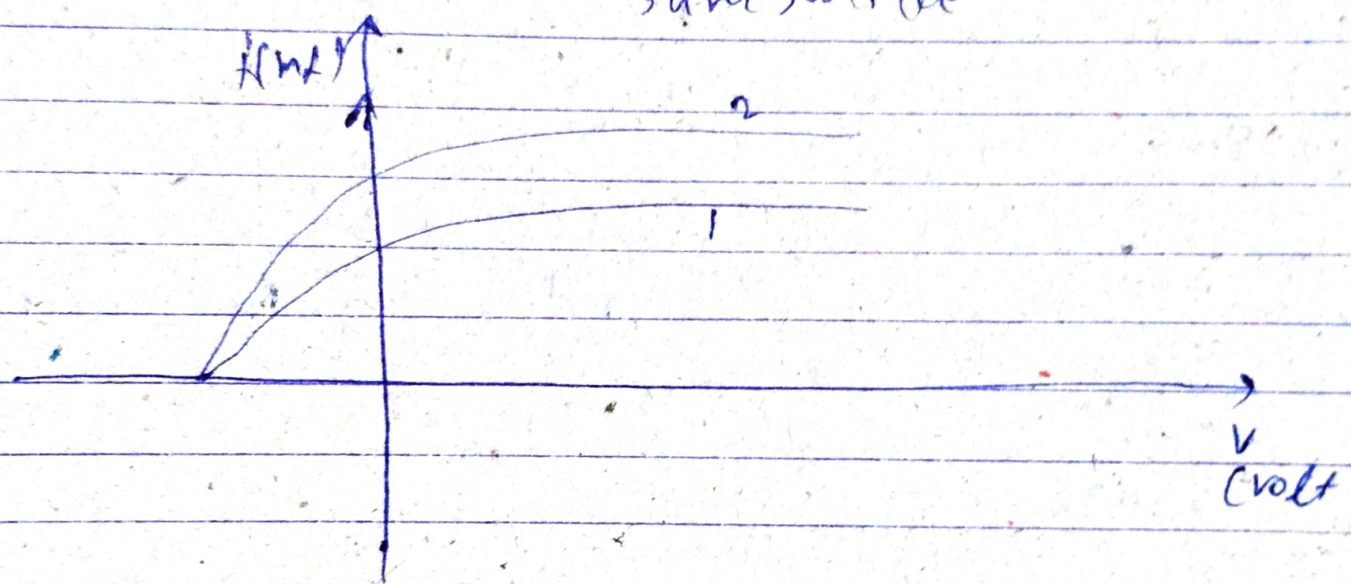
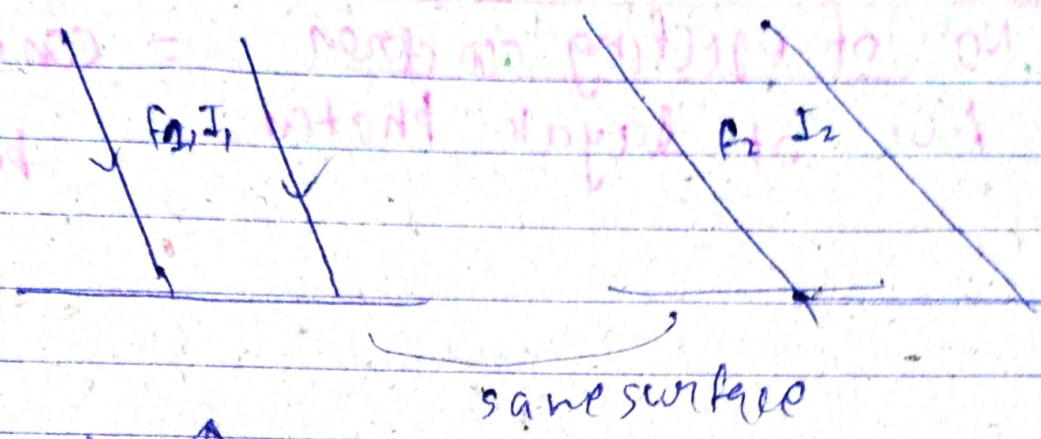


+ve side

saturation current! अगर हम potential को बढ़ाते चलाते हैं तो हम देखते हैं कि current बढ़ने लगता है और a certain value के बाद potential जितना भी बढ़ाओ current बढ़ना बंद हो जाता है इस limiting value of current को saturation current कहते हैं। ऐसा इसलिए होता है कि जितने electron निकल रहे थे उनके में कुछ other plate पर पहुँच रहे थे और कुछ नहीं पहुँच रहे थे जब हमने potential बढ़ाया तो धीरे-2 वह electron भी पहुँचने लगे जो नहीं पहुँच रहे थे ऐसा करके करके जब सारे electron दूसरी ~~plate~~ plate पर पहुँचने लगे रहे थे उसके साथ जितने भी electron थे जितना भी potential बढ़ाओ No. of electron reaching to other plate remain same और current become constant and that is max/ or saturation current



Q1



comment on  $F_1$  &  $F_2$

comment on  $I_1$  and  $I_2$

- |     |                         |     |                 |
|-----|-------------------------|-----|-----------------|
| (a) | $F_1 > F_2$             | (1) | $I_1 > I_2$     |
| (b) | $F_2 > F_1$             | (2) | $I_2 > I_1$ (✓) |
| (c) | $F_1 = F_2$ (✓)         | (3) | $I_1 = I_2$     |
| (d) | Not possible to comment | (4) |                 |

\*\*\*\* stopping potential depends on frequency and wavelength of the incident light and work function

\*\*\*\* stopping potential does not depend on intensity.

\*\*\*\* saturation current depends on intensity of light as intensity increases saturation current increases.  $e\vec{v} + m\vec{v} = \vec{p}$  of electron  $\vec{p} = \vec{p}$