

1. $\lambda_1 = 400 \text{ nm}$ to $\lambda_2 = 780 \text{ nm}$

$$E = h\nu = \frac{hc}{\lambda} \quad h = 6.63 \times 10^{-34} \text{ J-s}, c = 3 \times 10^8 \text{ m/s}, \lambda_1 = 400 \text{ nm}, \lambda_2 = 780 \text{ nm}$$

$$E_1 = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{400 \times 10^{-9}} = \frac{6.63 \times 3}{4} \times 10^{-19} = 5 \times 10^{-19} \text{ J}$$

$$E_2 = \frac{6.63 \times 3}{7.8} \times 10^{-19} = 2.55 \times 10^{-19} \text{ J}$$

So, the range is $5 \times 10^{-19} \text{ J}$ to $2.55 \times 10^{-19} \text{ J}$.

2. $\lambda = h/p$

$$\Rightarrow P = h/\lambda = \frac{6.63 \times 10^{-34}}{500 \times 10^{-9}} \text{ J-S} = 1.326 \times 10^{-27} = 1.33 \times 10^{-27} \text{ kg-m/s.}$$

3. $\lambda_1 = 500 \text{ nm} = 500 \times 10^{-9} \text{ m}$, $\lambda_2 = 700 \text{ nm} = 700 \times 10^{-9} \text{ m}$

$$E_1 - E_2 = \text{Energy absorbed by the atom in the process.} = hc [1/\lambda_1 - 1/\lambda_2]$$

$$\Rightarrow 6.63 \times 3 [1/5 - 1/7] \times 10^{-19} = 1.136 \times 10^{-19} \text{ J}$$

4. $P = 10 \text{ W} \quad \therefore E \text{ in 1 sec} = 10 \text{ J} \quad \% \text{ used to convert into photon} = 60\%$

$$\therefore \text{Energy used} = 6 \text{ J}$$

$$\text{Energy used to take out 1 photon} = hc/\lambda = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{590 \times 10^{-9}} = \frac{6.633}{590} \times 10^{-17}$$

$$\text{No. of photons used} = \frac{6}{\frac{6.63 \times 3}{590} \times 10^{-17}} = \frac{6 \times 590}{6.63 \times 3} \times 10^{17} = 176.9 \times 10^{17} = 1.77 \times 10^{19}$$

5. a) Here intensity = $I = 1.4 \times 10^3 \text{ W/m}^2$

$$\text{Intensity, } I = \frac{\text{power}}{\text{area}} = 1.4 \times 10^3 \text{ W/m}^2$$

$$\text{Let no. of photons/sec emitted} = n$$

$$\therefore \text{Power} = \text{Energy emitted/sec} = nhc/\lambda = P$$

$$\text{No. of photons/m}^2 = nhc/\lambda = \text{intensity}$$

No. of photons/m² = nhc/λ = intensity

$$n = \frac{\text{intensity} \times \lambda}{hc} = \frac{1.9 \times 10^3 \times 5 \times 10^{-9}}{6.63 \times 10^{-34} \times 3 \times 10^8} = 3.5 \times 10^{21}$$

b) Consider no. of two parts at a distance r and $r + dr$ from the source.

The time interval 'dt' in which the photon travel from one point to another = $dv/c = dt$.

$$\text{In this time the total no. of photons emitted} = N = n dt = \left(\frac{p\lambda}{hc} \right) \frac{dr}{C}$$

These points will be present between two spherical shells of radii ' r ' and $r+dr$. It is the distance of the 1st point from the sources. No. of photons per volume in the shell

$$(r + r + dr) = \frac{N}{2\pi r^2 dr} = \frac{P\lambda dr}{hc^2} = \frac{1}{4\pi r^2 ch} = \frac{p\lambda}{4\pi hc^2 r^2}$$

In the case = 1.5×10^{11} m, $\lambda = 500$ nm, = 500×10^{-9} m

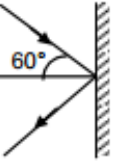
$$\frac{P}{4\pi r^2} = 1.4 \times 10^3, \therefore \text{No. of photons/m}^3 = \frac{P}{4\pi r^2} \frac{\lambda}{hc^2}$$

$$= 1.4 \times 10^3 \times \frac{500 \times 10^{-9}}{6.63 \times 10^{-34} \times 3 \times 10^8} = 1.2 \times 10^{13}$$

c) No. of photons = (No. of photons/sec/m²) \times Area

$$= (3.5 \times 10^{21}) \times 4\pi r^2$$

$$= 3.5 \times 10^{21} \times 4(3.14)(1.5 \times 10^{11})^2 = 9.9 \times 10^{44}.$$



6. $\lambda = 663 \times 10^{-9} \text{ m}$, $\theta = 60^\circ$, $n = 1 \times 10^{19}$, $\lambda = h/p$
 $\Rightarrow P = p/\lambda = 10^{-27}$

Force exerted on the wall = $n(mv \cos \theta - (-mv \cos \theta)) = 2n mv \cos \theta$.
 $= 2 \times 1 \times 10^{19} \times 10^{-27} \times \frac{1}{2} = 1 \times 10^{-8} \text{ N}$.

7. Power = 10 W $P \rightarrow$ Momentum

$$\lambda = \frac{h}{p} \quad \text{or, } P = \frac{h}{\lambda} \quad \text{or, } \frac{P}{t} = \frac{h}{\lambda t}$$

$$E = \frac{hc}{\lambda} \quad \text{or, } \frac{E}{t} = \frac{hc}{\lambda t} = \text{Power (W)}$$

$$W = Pc/t \quad \text{or, } P/t = W/c = \text{force.}$$

or Force = $7/10$ (absorbed) + $2 \times 3/10$ (reflected)

$$= \frac{7}{10} \times \frac{W}{C} + 2 \times \frac{3}{10} \times \frac{W}{C} \Rightarrow \frac{7}{10} \times \frac{10}{3 \times 10^8} + 2 \times \frac{3}{10} \times \frac{10}{3 \times 10^8}$$

$$= 13/3 \times 10^{-8} = 4.33 \times 10^{-8} \text{ N}$$

8. $m = 20 \text{ g}$

The weight of the mirror is balanced. Thus force exerted by the photons is equal to weight

$$P = \frac{h}{\lambda} \quad E = \frac{hc}{\lambda} = PC$$

$$\Rightarrow \frac{E}{t} = \frac{P}{t} C$$

$$\Rightarrow \text{Rate of change of momentum} = \text{Power}/C$$

30% of light passes through the lens.

Thus it exerts force. 70% is reflected.

$$\therefore \text{Force exerted} = 2(\text{rate of change of momentum})$$

$$= 2 \times \text{Power}/C$$

$$30\% \left(\frac{2 \times \text{Power}}{C} \right) = mg$$

$$\Rightarrow \text{Power} = \frac{20 \times 10^{-3} \times 10 \times 3 \times 10^8 \times 10}{2 \times 3} = 10 \text{ w} = 100 \text{ MW.}$$

9. Power = 100 W

Radius = 20 cm

60% is converted to light = 60 w

$$\text{Now, Force} = \frac{\text{power}}{\text{velocity}} = \frac{60}{3 \times 10^8} = 2 \times 10^{-7} \text{ N.}$$



$$\begin{aligned} \text{Pressure} &= \frac{\text{force}}{\text{area}} = \frac{2 \times 10^{-7}}{4 \times 3.14 \times (0.2)^2} = \frac{1}{8 \times 3.14} \times 10^{-5} \\ &= 0.039 \times 10^{-5} = 3.9 \times 10^{-7} = 4 \times 10^{-7} \text{ N/m}^2. \end{aligned}$$

10. We know,

If a perfectly reflecting solid sphere of radius 'r' is kept in the path of a parallel beam of light of large aperture if intensity is I,

$$\text{Force} = \frac{\pi r^2 I}{C}$$

$$I = 0.5 \text{ W/m}^2, r = 1 \text{ cm}, C = 3 \times 10^8 \text{ m/s}$$

$$\begin{aligned} \text{Force} &= \frac{\pi \times (1)^2 \times 0.5}{3 \times 10^8} = \frac{3.14 \times 0.5}{3 \times 10^8} \\ &= 0.523 \times 10^{-8} = 5.2 \times 10^{-9} \text{ N.} \end{aligned}$$

11. For a perfectly reflecting solid sphere of radius 'r' kept in the path of a parallel beam of light of large aperture with intensity 'I', force exerted = $\frac{\pi r^2 I}{C}$

12. If the e undergoes an elastic collision with a photon. Then applying energy conservation to this collision. We get, $hC/\lambda + m_0 c^2 = mc^2$
and applying conservation of momentum $h/\lambda = mv$

$$\text{Mass of e} = m = \frac{m_0}{\sqrt{1 - v^2/c^2}}$$

from above equation it can be easily shown that

$$v = C \quad \text{or} \quad v = 0$$

both of these results have no physical meaning hence it is not possible for a photon to be completely absorbed by a free electron.

13. $r = 1 \text{ m}$

$$\text{Energy} = \frac{kq^2}{R} = \frac{kq^2}{1}$$

$$\text{Now, } \frac{kq^2}{1} = \frac{hc}{\lambda} \quad \text{or } \lambda = \frac{hc}{kq^2}$$

For max ' λ ', 'q' should be min,
For minimum 'e' = $1.6 \times 10^{-19} \text{ C}$

$$\text{Max } \lambda = \frac{hc}{kq^2} = 0.863 \times 10^3 = 863 \text{ m.}$$

$$\text{For next smaller wavelength} = \frac{6.63 \times 3 \times 10^{-34} \times 10^8}{9 \times 10^9 \times (1.6 \times 2)^2 \times 10^{-38}} = \frac{863}{4} = 215.74 \text{ m}$$

14. $\lambda = 350 \text{ nm} = 350 \times 10^{-9} \text{ m}$
 $\phi = 1.9 \text{ eV}$

$$\text{Max KE of electrons} = \frac{hC}{\lambda} - \phi = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{350 \times 10^{-9} \times 1.6 \times 10^{-19}} - 1.9$$

$$= 1.65 \text{ eV} = 1.6 \text{ eV.}$$

15. $W_0 = 2.5 \times 10^{-19} \text{ J}$

a) We know $W_0 = h\nu_0$

$$\nu_0 = \frac{W_0}{h} = \frac{2.5 \times 10^{-19}}{6.63 \times 10^{-34}} = 3.77 \times 10^{14} \text{ Hz} = 3.8 \times 10^{14} \text{ Hz}$$

b) $eV_0 = h\nu - W_0$

$$\text{or, } V_0 = \frac{h\nu - W_0}{e} = \frac{6.63 \times 10^{-34} \times 6 \times 10^{14} - 2.5 \times 10^{-19}}{1.6 \times 10^{-19}} = 0.91 \text{ V}$$

16. $\phi = 4 \text{ eV} = 4 \times 1.6 \times 10^{-19} \text{ J}$

a) Threshold wavelength = λ

$$\phi = hc/\lambda$$

$$\Rightarrow \lambda = \frac{hC}{\phi} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{4 \times 1.6 \times 10^{-19}} = \frac{6.63 \times 3}{6.4} \times \frac{10^{-27}}{10^{-9}} = 3.1 \times 10^{-7} \text{ m} = 310 \text{ nm.}$$

b) Stopping potential is 2.5 V

$$E = \phi + eV$$

$$\Rightarrow hc/\lambda = 4 \times 1.6 \times 10^{-19} + 1.6 \times 10^{-19} \times 2.5$$

$$\Rightarrow \lambda = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{\lambda \times 1.6 \times 10^{-19}} = 4 + 2.5$$

$$\Rightarrow \frac{6.63 \times 3 \times 10^{-26}}{1.6 \times 10^{-19} \times 6.5} = 1.9125 \times 10^{-7} = 190 \text{ nm.}$$

17. Energy of photoelectron

$$\Rightarrow \frac{1}{2}mv^2 = \frac{hc}{\lambda} - hv_0 = \frac{4.14 \times 10^{-15} \times 3 \times 10^8}{4 \times 10^{-7}} - 2.5 \text{ eV} = 0.605 \text{ eV.}$$

$$\text{We know } KE = \frac{P^2}{2m} \Rightarrow P^2 = 2m \times KE.$$

$$P^2 = 2 \times 9.1 \times 10^{-31} \times 0.605 \times 1.6 \times 10^{-19}$$

$$P = 4.197 \times 10^{-25} \text{ kg} \cdot \text{m/s}$$

18. $\lambda = 400 \text{ nm} = 400 \times 10^{-9} \text{ m}$

$$V_0 = 1.1 \text{ V}$$

$$\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + eV_0$$

$$\Rightarrow \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{400 \times 10^{-9}} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{\lambda_0} + 1.6 \times 10^{-19} \times 1.1$$

$$\Rightarrow 4.97 = \frac{19.89 \times 10^{-26}}{\lambda_0} + 1.76$$

$$\Rightarrow \frac{19.89 \times 10^{-26}}{\lambda_0} = 4.97 - 1.76 = 3.21$$

$$\Rightarrow \lambda_0 = \frac{19.89 \times 10^{-26}}{3.21} = 6.196 \times 10^{-7} \text{ m} = 620 \text{ nm.}$$

19. a) When $\lambda = 350$, $V_s = 1.45$
and when $\lambda = 400$, $V_s = 1$

$$\therefore \frac{hc}{350} = W + 1.45 \quad \dots(1)$$

$$\text{and } \frac{hc}{400} = W + 1 \quad \dots(2)$$

Subtracting (2) from (1) and solving to get the value of h we get
 $h = 4.2 \times 10^{-15}$ ev-sec

b) Now work function = $w = \frac{hc}{\lambda} = \text{ev} - s$

$$= \frac{1240}{350} - 1.45 = 2.15 \text{ ev.}$$

c) $w = \frac{hc}{\lambda} = \lambda_{\text{there cathod}} = \frac{hc}{w}$

$$= \frac{1240}{2.15} = 576.8 \text{ nm.}$$

20. The electric field becomes 0.12×10^{45} times per second.

$$\therefore \text{Frequency} = \frac{1.2 \times 10^{15}}{2} = 0.6 \times 10^{15}$$

$$h\nu = \phi_0 + kE$$

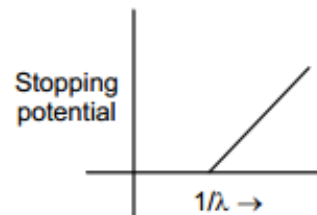
$$\Rightarrow h\nu - \phi_0 = KE$$

$$\Rightarrow KE = \frac{6.63 \times 10^{-34} \times 0.6 \times 10^{15}}{1.6 \times 10^{-19}} - 2$$

$$= 0.482 \text{ ev} = 0.48 \text{ ev.}$$

21. $E = E_0 \sin[(1.57 \times 10^7 \text{ m}^{-1})(x - ct)]$

$$W = 1.57 \times 10^7 \times C$$



$$\Rightarrow f = \frac{1.57 \times 10^7 \times 3 \times 10^8}{2\pi} \text{ Hz} \quad W_0 = 1.9 \text{ eV}$$

$$\text{Now } eV_0 = hf - W_0$$

$$= 4.14 \times 10^{-15} \times \frac{1.57 \times 3 \times 10^{15}}{2\pi} - 1.9 \text{ eV}$$

$$= 3.105 - 1.9 = 1.205 \text{ eV}$$

$$\text{So, } V_0 = \frac{1.205 \times 1.6 \times 10^{-19}}{1.6 \times 10^{-19}} = 1.205 \text{ V.}$$

$$22. E = 100 \sin[(3 \times 10^{15} \text{ s}^{-1})t] \sin [6 \times 10^{15} \text{ s}^{-1}t]$$

$$= 100 \frac{1}{2} [\cos[(9 \times 10^{15} \text{ s}^{-1})t] - \cos [3 \times 10^{15} \text{ s}^{-1}t]]$$

The ω are 9×10^{15} and 3×10^{15}

for largest K.E.

$$f_{\text{max}} = \frac{\omega_{\text{max}}}{2\pi} = \frac{9 \times 10^{15}}{2\pi}$$

$$E - \phi_0 = \text{K.E.}$$

$$\Rightarrow hf - \phi_0 = \text{K.E.}$$

$$\Rightarrow \frac{6.63 \times 10^{-34} \times 9 \times 10^{15}}{2\pi \times 1.6 \times 10^{-19}} - 2 = \text{KE}$$

$$\Rightarrow \text{KE} = 3.938 \text{ eV} = 3.93 \text{ eV.}$$

$$23. W_0 = hf - eV_0$$

$$= \frac{5 \times 10^{-3}}{8 \times 10^{15}} - 1.6 \times 10^{-19} \times 2 \quad (\text{Given } V_0 = 2\text{V, No. of photons} = 8 \times 10^{15}, \text{Power} = 5 \text{ mW})$$

$$= 6.25 \times 10^{-19} - 3.2 \times 10^{-19} = 3.05 \times 10^{-19} \text{ J}$$

$$= \frac{3.05 \times 10^{-19}}{1.6 \times 10^{-19}} = 1.906 \text{ eV.}$$

24. We have to take two cases :

Case I ... $v_0 = 1.656$
 $\nu = 5 \times 10^{14}$ Hz

Case II... $v_0 = 0$
 $\nu = 1 \times 10^{14}$ Hz

We know ;

a) $ev_0 = h\nu - w_0$
 $1.656e = h \times 5 \times 10^{14} - w_0$... (1)

$0 = 5h \times 10^{14} - 5w_0$... (2)

$1.656e = 4w_0$

$\Rightarrow w_0 = \frac{1.656}{4} \text{ ev} = 0.414 \text{ ev}$

b) Putting value of w_0 in equation (2)

$\Rightarrow 5w_0 = 5h \times 10^{14}$

$\Rightarrow 5 \times 0.414 = 5 \times h \times 10^{14}$

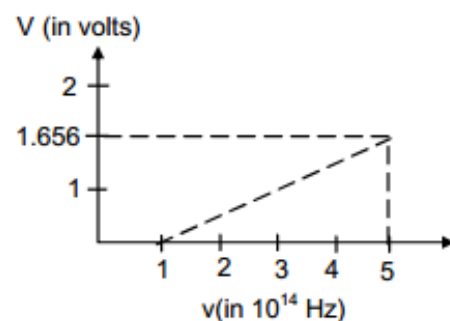
$\Rightarrow h = 4.414 \times 10^{-15} \text{ ev-s}$

25. $w_0 = 0.6 \text{ ev}$

For w_0 to be min ' λ ' becomes maximum.

$$w_0 = \frac{hc}{\lambda} \text{ or } \lambda = \frac{hc}{w_0} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{0.6 \times 1.6 \times 10^{-19}}$$

$= 20.71 \times 10^{-7} \text{ m} = 2071 \text{ nm}$



26. $\lambda = 400 \text{ nm}$, $P = 5 \text{ w}$

$$E \text{ of 1 photon} = \frac{hc}{\lambda} = \left(\frac{1242}{400} \right) \text{ eV}$$

$$\text{No. of electrons} = \frac{5}{\text{Energy of 1 photon}} = \frac{5 \times 400}{1.6 \times 10^{-19} \times 1242}$$

No. of electrons = 1 per 10^6 photon.

$$\text{No. of photoelectrons emitted} = \frac{5 \times 400}{1.6 \times 1242 \times 10^{-19} \times 10^6}$$

$$\text{Photo electric current} = \frac{5 \times 400}{1.6 \times 1242 \times 10^6 \times 10^{-19}} \times 1.6 \times 10^{-19} = 1.6 \times 10^{-6} \text{ A} = 1.6 \mu\text{A}.$$

27. $\lambda = 200 \text{ nm} = 2 \times 10^{-7} \text{ m}$

$$E \text{ of one photon} = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{2 \times 10^{-7}} = 9.945 \times 10^{-19}$$

$$\text{No. of photons} = \frac{1 \times 10^{-7}}{9.945 \times 10^{-19}} = 1 \times 10^{11} \text{ no.s}$$

$$\text{Hence, No. of photo electrons} = \frac{1 \times 10^{11}}{10^4} = 1 \times 10^7$$

Net amount of positive charge 'q' developed due to the outgoing electrons

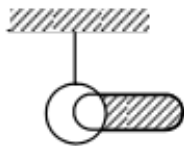
$$= 1 \times 10^7 \times 1.6 \times 10^{-19} = 1.6 \times 10^{-12} \text{ C}.$$

Now potential developed at the centre as well as at the surface due to these charger

$$= \frac{Kq}{r} = \frac{9 \times 10^9 \times 1.6 \times 10^{-12}}{4.8 \times 10^{-2}} = 3 \times 10^{-1} \text{ V} = 0.3 \text{ V}.$$

28. $\phi_0 = 2.39 \text{ eV}$

$$\lambda_1 = 400 \text{ nm}, \lambda_2 = 600 \text{ nm}$$



for B to the minimum energy should be maximum

$\therefore \lambda$ should be minimum.

$$E = \frac{hc}{\lambda} - \phi_0 = 3.105 - 2.39 = 0.715 \text{ eV.}$$

The presence of magnetic field will bend the beam there will be no current if the electron does not reach the other plates.

$$r = \frac{mv}{qB}$$

$$\Rightarrow r = \frac{\sqrt{2mE}}{qB}$$

$$\Rightarrow 0.1 = \frac{\sqrt{2 \times 9.1 \times 10^{-31} \times 1.6 \times 10^{-19} \times 0.715}}{1.6 \times 10^{-19} \times B}$$

$$\Rightarrow B = 2.85 \times 10^{-5} \text{ T}$$

29. Given : fringe width,

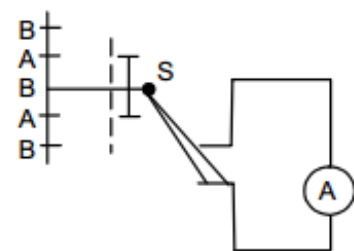
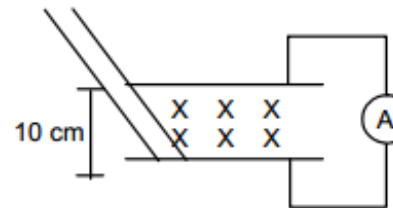
$$y = 1.0 \text{ mm} \times 2 = 2.0 \text{ mm}, D = 0.24 \text{ mm}, W_0 = 2.2 \text{ eV}, D = 1.2 \text{ m}$$

$$y = \frac{\lambda D}{d}$$

$$\text{or, } \lambda = \frac{yd}{D} = \frac{2 \times 10^{-3} \times 0.24 \times 10^{-3}}{1.2} = 4 \times 10^{-7} \text{ m}$$

$$E = \frac{hc}{\lambda} = \frac{4.14 \times 10^{-15} \times 3 \times 10^8}{4 \times 10^{-7}} = 3.105 \text{ eV}$$

$$\text{Stopping potential } eV_0 = 3.105 - 2.2 = 0.905 \text{ V}$$



30. $\phi = 4.5 \text{ eV}$, $\lambda = 200 \text{ nm}$

$$\text{Stopping potential or energy} = E - \phi = \frac{WC}{\lambda} - \phi$$

Minimum 1.7 V is necessary to stop the electron

The minimum K.E. = 2eV

[Since the electric potential of 2 V is reqd. to accelerate the electron to reach the plates]
the maximum K.E. = (2+1, 7)ev = 3.7 ev.

31. Given

$$\sigma = 1 \times 10^{-9} \text{ cm}^{-2}, W_0 (C_s) = 1.9 \text{ eV}, d = 20 \text{ cm} = 0.20 \text{ m}, \lambda = 400 \text{ nm}$$

we know \rightarrow Electric potential due to a charged plate = $V = E \times d$

Where $E \rightarrow$ electric field due to the charged plate = σ/E_0

$d \rightarrow$ Separation between the plates.

$$V = \frac{\sigma}{E_0} \times d = \frac{1 \times 10^{-9} \times 20}{8.85 \times 10^{-12} \times 100} = 22.598 \text{ V} = 22.6$$

$$V_0 e = h\nu - w_0 = \frac{hc}{\lambda} - w_0 = \frac{4.14 \times 10^{-15} \times 3 \times 10^8}{4 \times 10^{-7}} - 1.9$$

$$= 3.105 - 1.9 = 1.205 \text{ ev}$$

or, $V_0 = 1.205 \text{ V}$

As V_0 is much less than 'V'

Hence the minimum energy required to reach the charged plate must be = 22.6 eV

For maximum KE, the V must be an accelerating one.

Hence max KE = $V_0 + V = 1.205 + 22.6 = 23.8005 \text{ ev}$

32. Here electric field of metal plate = $E = P/E_0$

$$= \frac{1 \times 10^{-19}}{8.85 \times 10^{-12}} = 113 \text{ v/m}$$

$$\text{accl. } de = \phi = qE / m$$

$$= \frac{1.6 \times 10^{-19} \times 113}{9.1 \times 10^{-31}} = 19.87 \times 10^{12}$$

$$t = \frac{\sqrt{2y}}{a} = \frac{\sqrt{2 \times 20 \times 10^{-2}}}{19.87 \times 10^{12}} = 1.41 \times 10^{-7} \text{ sec}$$

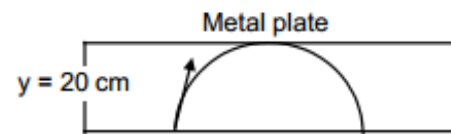
$$\text{K.E.} = \frac{hc}{\lambda} - w = 1.2 \text{ eV}$$

$$= 1.2 \times 1.6 \times 10^{-19} \text{ J [because in previous problem i.e. in problem 31 : KE = 1.2 eV]}$$

$$\therefore V = \frac{\sqrt{2KE}}{m} = \frac{\sqrt{2 \times 1.2 \times 1.6 \times 10^{-19}}}{9.1 \times 10^{-31}} = 0.665 \times 10^{-6}$$

$$\therefore \text{Horizontal displacement} = V_t \times t$$

$$= 0.665 \times 10^{-6} \times 1.4 \times 10^{-7} = 0.092 \text{ m} = 9.2 \text{ cm.}$$



33. When $\lambda = 250 \text{ nm}$

$$\text{Energy of photon} = \frac{hc}{\lambda} = \frac{1240}{250} = 4.96 \text{ eV}$$

$$\therefore \text{K.E.} = \frac{hc}{\lambda} - w = 4.96 - 1.9 \text{ eV} = 3.06 \text{ eV.}$$

Velocity to be non positive for each photo electron

The minimum value of velocity of plate should be = velocity of photo electron

$$\therefore \text{Velocity of photo electron} = \sqrt{2KE/m}$$

$$= \sqrt{\frac{3.06}{9.1 \times 10^{-31}}} = \sqrt{\frac{3.06 \times 1.6 \times 10^{-19}}{9.1 \times 10^{-31}}} = 1.04 \times 10^6 \text{ m/sec.}$$

34. Work function = ϕ , distance = d

The particle will move in a circle

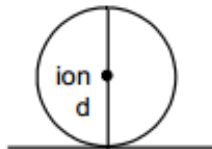
When the stopping potential is equal to the potential due to the singly charged ion at that point.

$$eV_0 = \frac{hc}{\lambda} - \phi$$

$$\Rightarrow V_0 = \left(\frac{hc}{\lambda} - \phi \right) \frac{1}{e} \Rightarrow \frac{ke}{2d} = \left(\frac{hc}{\lambda} - \phi \right) \frac{1}{e}$$

$$\Rightarrow \frac{Ke^2}{2d} = \frac{hc}{\lambda} - \phi \Rightarrow \frac{hc}{\lambda} = \frac{Ke^2}{2d} + \phi = \frac{Ke^2 + 2d\phi}{2d}$$

$$\Rightarrow \lambda = \frac{hc \cdot 2d}{Ke^2 + 2d\phi} = \frac{2hcd}{\frac{1}{4\pi\epsilon_0 e^2} + 2d\phi} = \frac{8\pi\epsilon_0 hcd}{e^2 + 8\pi\epsilon_0 d\phi}$$



35. a) When $\lambda = 400 \text{ nm}$

$$\text{Energy of photon} = \frac{hc}{\lambda} = \frac{1240}{400} = 3.1 \text{ eV}$$

This energy given to electron

But for the first collision energy lost = $3.1 \text{ eV} \times 10\% = 0.31 \text{ eV}$

for second collision energy lost = $3.1 \text{ eV} \times 10\% = 0.31 \text{ eV}$

Total energy lost the two collision = $0.31 + 0.31 = 0.62 \text{ eV}$

K.E. of photon electron when it comes out of metal

= $hc/\lambda - \text{work function} - \text{Energy lost due to collision}$

= $3.1 \text{ eV} - 2.2 - 0.62 = 0.31 \text{ eV}$

b) For the 3rd collision the energy lost = 0.31 eV

Which just equative the KE lost in the 3rd collision electron. It just comes out of the metal