18. ELECTRONS AND PHOTONS

HOMEWORK SOLUTIONS

1. Given :

$\lambda = 4800 \mathring{A}$

$= 4.8 \times 10^{-7} m$

$h = 6.63 \times 10^{-34}$ J-s

$1eV = 1.6 \times 10^{-19}$ J

$c = 3 \times 10^{8}$ m/s

To Find :

Energy of Photon, E_p (in eV)

Formula :

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

Solution :

Energy of Photon,

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

$$\therefore E_p = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{4.8 \times 10^{-7}}$$

$$\therefore E_p = \frac{19.89}{4.8} \times 10^{-19} \text{ J}$$

$$\therefore E_p = \frac{19.89}{4.8 \times 1.6} \text{ eV}$$

$$\therefore E_p = Al\left[1.2987 - \left(\begin{array}{r} 0.6812 \\ +\ \underline{0.2041} \\ 0.8853 \end{array}\right)\right]$$

$$\therefore E_p = Al\left[\begin{array}{r} 1.2987 \\ -\ \underline{0.8853} \\ 0.4134 \end{array}\right]$$

$$\therefore E_p = 2.59 \text{ eV}$$

2. Given :

$W_0 = 5eV$

To Find :

$\lambda_0 = ?$

$\upsilon_0 = ?$

Formula :

$W_0 = h\upsilon_0$

and $\lambda_0 = \dfrac{c}{\upsilon_0}$

Solution :

$$W_0 = h\upsilon_0$$

$$\therefore \upsilon_0 = \frac{W_0}{h}$$

$$\therefore \upsilon_0 = \frac{5 \times 1.6 \times 10^{-19}}{6.63 \times 10^{-34}}$$

$$\therefore \upsilon_0 = \frac{8}{6.63} \times 10^{15}$$

$$\therefore \upsilon_0 = Al\left(\begin{array}{r} 0.9031 \\ -\ \underline{0.8215} \\ 0.0816 \end{array}\right) \times 10^{15}$$

$$\therefore \upsilon_0 = 1.207 \times 10^{15} \text{ Hz}$$

Also, $$\lambda_0 = \frac{c}{\upsilon_0} = \frac{3 \times 10^{8}}{1.207 \times 10^{15}}$$

$$\therefore \lambda_0 = Al\left(\begin{array}{r} 0.4771 \\ -\ \underline{0.0816} \\ 0.3955 \end{array}\right) \times 10^{-7}$$

$$\therefore \lambda_0 = 2.486 \times 10^{-7} m$$

$$\therefore \lambda_0 = 2486 \text{ A}^{o}$$

3. Given :

$W_0 = 3.3$ eV

To Find :

$\lambda_0 = ?$

$\upsilon_0 = ?$

Formula :

$W_0 = h\upsilon_0$

and $\lambda_0 = \dfrac{c}{\upsilon_0}$

Solution :

$$W_0 = h\upsilon_0$$

$$\upsilon_0 = \frac{W_0}{h}$$

$$\therefore \upsilon_0 = \frac{3.3 \times 1.6 \times 10^{-19}}{6.63 \times 10^{-34}}$$

$\therefore \quad \upsilon_0 = 7.964 \times 10^{14}$

$\therefore \quad \upsilon_0 = 7.964 \times 10^{14}$ Hz

$\lambda_0 = \frac{c}{\upsilon_0}$

$\therefore \quad \lambda_0 = \frac{3 \times 10^8}{8 \times 10^{14}}$

$\therefore \quad \lambda_0 = 0.375 \times 10^{-6}$

$\therefore \quad \lambda_0 = 3750\ A^o$

4. Given :

$\upsilon_0 = 5 \times 10^{14}$ Hz

To Find :

$\lambda_0 = ?$

Formula :

$\lambda_0 = \frac{c}{\upsilon_0}$

Solution :

$\lambda_0 = \frac{c}{\upsilon_0}$

$\therefore \quad \lambda_0 = \frac{3 \times 10^8}{5 \times 10^{14}}$

$\therefore \quad \lambda_0 = 0.6 \times 10^{-6}$ m

$\lambda_0 = 6000\ A^o$

5. Given :

$\lambda_0 = 2730 \mathring{A}$

To Find :

$W_0 = ?$

Formula :

$W_0 = \frac{hc}{\lambda_0}$

Solution :

$W_0 = \frac{hc}{\lambda_0}$

$\therefore \quad W_0 = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{273 \times 10^{-9}}$

$\therefore \quad W_0 = \frac{6.63 \times 3}{273} \times 10^{-17}$

$\therefore \quad W_0 = \frac{19.89}{273} \times 10^{-17}$

$\therefore \quad W_0 = Al\left[\begin{array}{r} 1.2987 \\ -\ 2.4362 \\ \hline \bar{2}.8625 \end{array}\right] \times 10^{-17}$

$W_0 = 7.286 \times 10^{-19}$ J

$W_0 = \frac{7.286 \times 10^{-19}}{1.6 \times 10^{-19}}$ eV

$W_0 = 4.55$ eV

6. Given :

$\lambda_0 = 4770\ A^o$

To Find :

$W_0 = ?$

Formula :

$W_0 = \frac{hc}{\lambda_0}$

Solution :

$W_0 = \frac{hc}{\lambda_0}$

$\therefore \quad W_0 = \frac{6.63 \times 3 \times 10^{-34} \times 10^8}{477 \times 10^{-9}}$

$\therefore \quad W_0 = \frac{19.89}{477} \times 10^{-17}$

$\therefore \quad W_0 = 41.69 \times 10^{-20}$ J

$\therefore \quad W_0 = \frac{41.69 \times 10^{-20}}{1.6 \times 10^{-19}}$ eV

$\therefore \quad W_0 = 26 \times 10^{-1}$ eV

$\therefore \quad W_0 = 2.606$ eV

7. Given :

Longest wavelength that can cause photoemission = threshold wavelength,

$\lambda_0 = 1980\ \mathring{A} = 1.98 \times 10^{-7}$ m

To Find :

W_0 (in eV) = ?

Formula :

$$W_0 = \frac{hc}{\lambda_0}$$

Solution :

$$W_0 = \frac{hc}{\lambda_0}$$

$$\therefore \quad W_0 = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{1.98 \times 10^{-7}}$$

$$\therefore \quad W_0 = \frac{19.89}{1.98} \times 10^{-19}$$

$$\therefore \quad W_0 = Al \begin{bmatrix} 1.2986 \\ -\underline{0.2967} \\ 1.0019 \end{bmatrix} \times 10^{-19}$$

$$\therefore \quad W_0 = 10.04 \times 10^{-19} \text{ J}$$

$$\therefore \quad W_0 = \frac{10.04}{1.6} \text{ eV}$$

$$\therefore \quad W_0 = Al \begin{bmatrix} 1.0017 \\ -\underline{0.2041} \\ 0.7976 \end{bmatrix}$$

$$\therefore \quad W_0 = 6.274 \text{ eV}$$

8. Given :

$\lambda = 2750$ Å

$\lambda_0 = 6800$ Å

To Find :

KE = ?

Formula :

$$KE = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$$

Solution :

$$KE = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$$

$$\therefore \quad KE = hc\left[\frac{1}{\lambda} - \frac{1}{\lambda_0}\right]$$

$$\therefore \quad KE = 6.63 \times 10^{-34} \times 3 \times 10^{8} \times \left[\frac{-1}{680 \times 10^{-9}} + \frac{1}{275 \times 10^{-9}}\right]$$

$$\therefore \quad KE = 19.89 \times 10^{-26} \times \left[\frac{680 - 275}{275 \times 680 \times 10^{-9}}\right]$$

$$\therefore \quad KE = \frac{19.89 \times 10^{-17} \times 405}{275 \times 680}$$

$$\therefore \quad KE = 0.0430 \times 10^{-17} \text{ J}$$

$$\therefore \quad KE = 0.043 \times 10^{-17}$$

$$KE = \frac{0.043 \times 10^{-17}}{1.6 \times 10^{-19}}$$

$$\therefore \quad KE = 2.692 \text{ eV}$$

9. Given :

$W_0 = 2.4$ eV

$\lambda = 6800$ Å

To Find :

i) υ and υ_0

ii) Photoemission would take place or not

Formula :

$$W_0 = h\upsilon_0$$

$$c = \upsilon\lambda$$

Solution :

$$W_0 = h\upsilon_0$$

$$\therefore \quad \upsilon_0 = \frac{W_0}{h}$$

$$\therefore \quad \upsilon_0 = \frac{2.4 \times 1.6 \times 10^{-19}}{6.63 \times 10^{-34}}$$

$$\therefore \quad \upsilon_0 = \frac{3.84 \times 10^{15}}{6.63}$$

$$\therefore \quad \upsilon_0 = Al \begin{bmatrix} 0.5843 \\ -\underline{0.8215} \\ \bar{1}.7628 \end{bmatrix} \times 10^{15}$$

$$\therefore \quad \upsilon_0 = 5.792 \times 10^{14} \text{ Hz}$$

$$\text{Also, } \upsilon = \frac{c}{\lambda}$$

$$\therefore \quad \upsilon = \frac{3 \times 10^{8}}{6.8 \times 10^{-7}}$$

$\therefore \quad \upsilon = Al \begin{pmatrix} 0.4771 \\ -0.8325 \\ \bar{1}.6446 \end{pmatrix} \times 10^{15}$

$\therefore \quad \upsilon = 4.412 \times 10^{14}$ Hz

$\therefore \quad \upsilon < \upsilon_0$

$\therefore$ Photoemission won't take place.

10. Given :

$\lambda_0 = 3800$ Å

$\therefore \quad \lambda_0 = 3.8 \times 10^{-7}$ m

$\lambda = 3600$ Å

$\therefore \quad \lambda = 3.6 \times 10^{-7}$ m

To Find :

$(K.E.)_{max} = ?$

Formula :

$$(K.E.)_{max} = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$$

Solution :

According to Einstein's photoelectric equation

$$hf = W_0 + (K.E.)_{max}$$

$$\therefore \quad (K.E.)_{max} = hf - W_0$$

$$\therefore \quad (K.E.)_{max} = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$$

$$\therefore \quad (K.E.)_{max} = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$$

$$\therefore \quad (K.E.)_{max} = 6.63 \times 10^{-34} \times 3 \times 10^8 \times \left(\frac{1}{3.6 \times 10^{-7}} - \frac{1}{3.8 \times 10^{-7}}\right)$$

$$\therefore \quad (K.E.)_{max} = 19.89 \times 10^{-26} \times 10^7 \times \left(\frac{1}{3.6} - \frac{1}{3.8}\right)$$

$$\therefore \quad (K.E.)_{max} = 19.89 \times 10^{-19}\left(\frac{3.8 - 3.6}{3.8 \times 3.6}\right)$$

$$\therefore \quad (K.E.)_{max} = \frac{19.89 \times 10^{-19} \times 2 \times 10^{-1}}{3.8 \times 3.6}$$

$$\therefore \quad (K.E.)_{max} = \frac{19.89 \times 10^{-20}}{3.8 \times 1.8} \text{ J}$$

$$\therefore \quad (K.E.)_{max} = \frac{19.89 \times 10^{-20}}{3.8 \times 1.8} \text{ J}$$

$$\therefore \quad (K.E.)_{max} = \frac{19.89 \times 10^{-20}}{3.8 \times 1.8 \times 1.6 \times 10^{-19}} \text{ eV}$$

$$\therefore \quad (K.E.)_{max} = \frac{1.989}{3.8 \times 1.8 \times 1.6} \text{ eV}$$

$$\therefore \quad (K.E.)_{max} = \frac{1.989}{2.88 \times 3.8} \text{ eV}$$

$$\therefore \quad (K.E.)_{max} = Al\left[0.2986 - \begin{pmatrix} 0.4594 \\ +0.5798 \\ 1.0392 \end{pmatrix}\right]$$

$$\therefore \quad (K.E.)_{max} = Al\,[\bar{1}.2594]$$

$$\therefore \quad (K.E.)_{max} = 0.1817 \text{ eV}$$

11. Given :

$\lambda = 3 \times 10^{-7}$ m

$W_0 = 2$ eV

$\therefore \quad W_0 = 2 \times 1.6 \times 10^{-19}$ J

$W_0 = 3.2 \times 10^{-19}$ J

To Find :

$KE_{max} = ?$

Formula :

$$(K.E.)_{max} = \frac{hc}{\lambda} - W_0$$

Solution :

$$KE_{max} = \frac{hc}{\lambda} - W_0$$

$$KE_{max} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{3 \times 10^{-7}} - 3.2 \times 10^{-19}$$

$$KE_{max} = (6.63 - 3.2) \times 10^{-19}$$

$$KE_{max} = \frac{3.43 \times 10^{-19}}{1.6 \times 10^{-19}}$$

$$KE_{max} = 2.143 \text{ eV}$$

$$\therefore \quad KE_{max} = 2.144 \text{ eV}$$

12. Given :

$W_0 = 4.4$ eV

$W_0 = 7.04 \times 10^{-19}$ J

$\lambda = 500$ A^0

$\lambda = 5 \times 10^{-8}$ m

To Find :

$KE_{max} = ?$

Formula :

$$(K.E.)_{max} = \frac{hc}{\lambda} - W_0$$

Solution :

$$KE_{max} = \frac{hc}{\lambda} - W_0$$

$$\therefore KE_{max} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{5 \times 10^{-8}} - 7.04 \times 10^{-19} \text{ J}$$

$$\therefore KE_{max} = \frac{19.89 \times 10^{-18}}{5} - 7.04 \times 10^{-19}$$

$$KE_{max} = 39.82 \times 10^{-19} - 7.04 \times 10^{-19}$$

$$KE_{max} = 39.68 \times 10^{-19}$$

$$KE_{max} = \frac{39.68 \times 10^{-19}}{1.6 \times 10^{-19}}$$

$$\therefore KE_{max} = 20.46 \text{ eV}$$

13. Given :

$KE_{max} = 4$ eV

$W_0 = 2.4$ eV

To Find :

$\lambda = ?$

Formula :

$$\frac{hc}{\lambda} = W_0 + KE_{max}$$

Solution :

$$\therefore \frac{hc}{\lambda} = 2.4 + 4 = 6.4 \text{ eV}$$

$$\frac{hc}{\lambda} = 6.4 \times 1.6 \times 10^{-19}$$

$$\lambda = \frac{hc}{6.4 \times 1.6 \times 10^{-19}}$$

$$\therefore \lambda = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{6.4 \times 1.6 \times 10^{-19}}$$

$$\therefore \lambda = \frac{19.89}{10.24} \times 10^{-7}$$

$$\therefore \lambda = 1.942 \times 10^{-7} \text{ m}$$

$$\therefore \lambda = 1942 \text{ AU}$$

14. Given :

$\lambda_0 = 3800$ AU

$\lambda = 2600$ AU

To Find :

$KE_{max} = ?$

Formula :

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

Solution :

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

$$\therefore KE_{max} = hc \left[\frac{1}{\lambda} - \frac{1}{\lambda_0}\right]$$

$$= 6.63 \times 3 \times 10^{-26} \left[\frac{1}{26 \times 10^{-8}} - \frac{1}{38 \times 10^{-8}}\right]$$

$$= 19.89 \times 10^{-26} \left[\frac{38 - 26}{26 \times 38 \times 10^{-8}}\right]$$

$$= \frac{19.89 \times 10^{-26} \times 12}{26 \times 38 \times 10^{-8}}$$

$$= \frac{12 \times 19.89}{26 \times 38} \times 10^{-18}$$

$$= 0.241 \times 10^{-18}$$

$$\therefore KE_{max} = \frac{2.41 \times 10^{-19}}{1.6 \times 10^{-19}}$$

$$\therefore KE_{max} = 1.506 \text{ eV}$$

15. Given :

$V_s = 2.5$ V

$W_0 = 3.7$ eV

To Find :

$\lambda = ?$

Formula :

$$\frac{hc}{\lambda} = KE_{max} + W_0$$

Solution :

$$\frac{hc}{\lambda} = KE_{max} + W_0$$

$KE_{max} = eV_s$

$KE_{max} = e\,(2.5)$

$KE_{max} = 2.5eV$

$$\frac{hc}{\lambda} = 2.5 + 3.7$$

$$\frac{hc}{\lambda} = 6.2 \text{ eV}$$

$$\frac{hc}{\lambda} = 6.2 \times 1.6 \times 10^{-19} \text{ J}$$

$$\therefore \lambda = \frac{hc}{6.2 \times 1.6 \times 10^{-19}}$$

$$\therefore \lambda = \frac{19.89 \times 10^{-26}}{9.92 \times 10^{-19}}$$

$\therefore \lambda = 2.005 \times 10^{-7}$ m

$\therefore \lambda = 2005$ AU

16. Given :

$W_0 = 2.2$ eV

$\lambda = 3 \times 10^{-7}$ m

$m = 9.1 \times 10^{-31}$ kg

To Find :

$KE_{max} = ?$

Formula :

$$KE_{max} = \frac{hc}{\lambda} - W_0$$

Solution :

$$KE_{max} = \frac{hc}{\lambda} - W_0$$

$$KE_{max} = \frac{6.63 \times 3 \times 10^{-26}}{3 \times 10^{-7}} - 2.2 \times 1.6 \times 10^{-19}$$

$KE_{max} = (6.63 - 3.52) \times 10^{-19}$

$KE_{max} = 3.11 \times 10^{-19}$ J

$$\therefore v^2 = \frac{2 \times 3.11 \times 10^{-19}}{9.1 \times 10^{-31}}$$

$\therefore v^2 = 6.835 \times 10^{11}$

$\therefore v^2 = 68.35 \times 10^{10}$

$\therefore v = 8.26 \times 10^5$ m/s

17. Given :

$\lambda = 5000$ AU

$V_s = 0.45$ V

To Find :

$KE_{max} = ?$

$W_0 = ?$

$\lambda_0 = ?$

Formula :

$KE_{max} = eV_s$

$$\frac{hc}{\lambda} = KE_{max} + W_0$$

$$W_0 = \frac{hc}{\lambda_0}$$

Solution :

$KE_{max} = eV_s$

$= e \times 0.45$

$KE_{max} = 0.45$ eV

$$W_0 = \frac{hc}{\lambda} - KE_{max}$$

$$\therefore W_0 = \frac{19.89 \times 10^{-26}}{5 \times 10^{-7}} - 0.72 \times 10^{-19}$$

$\therefore W_0 = (3.978 - 0.72) \times 10^{-19}$

$W_0 = 3.258 \times 10^{-19}$

$W_0 = \frac{3.258 \times 10^{-19}}{1.6 \times 10^{-19}}$

$W_0 = 2.036$ eV

$W_0 = \frac{hc}{\lambda_0}$

$\therefore \lambda_0 = \frac{hc}{W_0}$

$\therefore \lambda_0 = \frac{19.89 \times 10^{-26}}{3.258 \times 10^{-19}}$

$\therefore \lambda_0 = 6.104 \times 10^{-7}$ m

$\therefore \lambda_0 = 6104$ AU

18. Given :

$W_0 = 4.2$ eV

$\lambda = 2 \times 10^{-7}$ m

To Find :

$KE_{max} = ?$

$W_0 = ?$

$\lambda_0 = ?$

Formula :

$KE_{max} = \frac{hc}{\lambda} - W_0$

$KE_{max} = eVs$

$W_0 = \frac{hc}{\lambda_0}$

Solution :

$KE_{max} = \frac{hc}{\lambda_0} - W_0$

$\therefore KE_{max} = \frac{19.89 \times 10^{-26}}{2 \times 10^{-7}} - 4.2 \times 1.6 \times 10^{-19}$

$\therefore KE_{max} = [9.945 - 6.72] \times 10^{-19}$

$\therefore KE_{max} = \frac{3.225 \times 10^{-19}}{1.6 \times 10^{-19}}$

$\therefore KE_{max} = 2.015$ eV

$\therefore KE_{max} = eV_s$

$\therefore V_s = \frac{KE_{max}}{e} = \frac{3.225 \times 10^{-19}}{1.6 \times 10^{-19}}$

$\therefore V_s = 2.015$ V

$W_0 = \frac{hc}{\lambda_0}$

$\therefore \lambda_0 = \frac{hc}{W_0}$

$\therefore \lambda_0 = \frac{19.89 \times 19^{-26}}{4.2 \times 1.6 \times 10^{-19}}$

$\therefore \lambda_0 = 2959$ AU

19. Given :

$W_0 = 3$ eV

$\lambda = 4000$ AU

To Find :

$KE_{max} = ?$

$v_{max} = ?$

Formula :

$KE_{max} = \frac{hc}{\lambda} - W_0$

Solution :

$KE_{max} = \frac{hc}{\lambda} - W_0$

$\therefore KE_{max} = \frac{19.89 \times 10^{-26}}{4 \times 10^{-7}} - 3 \times 1.6 \times 10^{-19}$

$\therefore KE_{max} = (4.972 - 4.8) \times 10^{-19}$

$\therefore KE_{max} = 0.172 \times 10^{-19}$

$\therefore KE_{max} = 1.72 \times 10^{-20}$ J

$\frac{1}{2} mv^2 = 1.72 \times 10^{-20}$

$\therefore v^2 = \frac{2 \times 1.72 \times 10^{-20}}{9.1 \times 10^{-31}}$

$\therefore v^2 = 0.3780 \times 10^{11}$

$\therefore v^2 = 3.780 \times 10^{10}$

$\therefore v = 1.944 \times 10^5$ m/s

20. Given :

$W_0 = 1.8$ eV

$\lambda = 400$ AU

$= 400 \times 10^{-10}$ m

$\therefore \lambda = 4 \times 10^{-8}$ m

To Find :

$V_s = ?$

$V_{max} = ?$

Formula :

$$KE_{max} = \frac{hc}{\lambda} - W_0$$

$$KE_{max} = \frac{1}{2} m v^2_{max}$$

Solution :

$$KE_{max} = \frac{hc}{\lambda} - W_0$$

$$= \frac{19.89 \times 10^{-26}}{4 \times 10^{-8}} - 1.8 \times 1.6 \times 10^{-19}$$

$$= 4.9725 \times 10^{-18} - 2.88 \times 10^{-19}$$

$$= 49.725 \times 10^{-19} - 2.88 \times 10^{-19}$$

$$= 46.845 \times 10^{-19}$$

$$KE_{max} = 29.28 \text{ eV}$$

$$\therefore KE_{max} = eV_s$$

$$\therefore eV_s = KE_{max}$$

$$= \frac{KE_{max}}{e}$$

$$\therefore V_s = 29.28 \text{ V}$$

$$\therefore KE_{max} = \frac{1}{2} m v^2_{max}$$

$$v^2_{max} = \frac{2\, KE_{max}}{m}$$

$$= \frac{2 \times 46.845 \times 10^{-19}}{9.1 \times 10^{-31}}$$

$$v^2_{max} = 10.2956 \times 10^{12}$$

$$v_{max} = 3.209 \times 10^{6} \text{ m/s}$$

$$= 3209 \times 10^{3} \text{ m/s}$$

$$\therefore v_{max} = 3209 \text{ km/s}$$

21. Given :

$W_0 = 2.14$ eV

$V_s = 0.60$ V

To Find :

i) $\upsilon_0 = ?$

ii) $\lambda = ?$

Formula :

$$\omega_0 = h\upsilon_0$$

$$KE = eV_s$$

Solution :

$$\omega_0 = hf_0$$

$$\upsilon_0 = \frac{\omega_0}{h}$$

$$= \frac{2.14 \times 1.6 \times 10^{-19}}{6.63 \times 10^{-34}}$$

$$= 0.3228 \times 10^{15}$$

$$\therefore \upsilon_0 = 3.228 \times 10^{14} \text{ Hz}$$

$$\therefore KE = eVs$$

$$\therefore KE = 0.60 \text{ eV}$$

$$KE_{max} = \frac{hc}{\lambda} - \omega_0$$

$$\frac{hc}{\lambda} = \omega_0 + KE$$

$$\lambda = \frac{hc}{2.74 \text{ eV}}$$

$$= \frac{19.89 \times 10^{-26}}{2.74 \times 1.6 \times 10^{-19}}$$

$$= 4.537 \times 10^{-7}$$

$$= 4537 \times 10^{-10}$$

$$\therefore \lambda = 4537 \text{ A}^{o}$$

22. Solution :

$$\frac{hc}{\lambda} = W_0 + eV_s$$

Case I :

$$\frac{hc}{\lambda} = W_0 + e(3V_0)$$

$$\frac{hc}{\lambda} = W_0 + 3\,eV_0 \qquad ...(i)$$

Case II :

$$\frac{hc}{2\lambda} = W_0 + eV_0$$

$$\therefore \quad eV_0 = \frac{hc}{2\lambda} - W_0 \qquad ...(ii)$$

Substituting equation (ii) in equation (i)

$$\frac{hc}{\lambda} = W_0 + 3\left[\frac{hc}{2\lambda} - W_0\right]$$

$$\therefore \quad \frac{hc}{\lambda} = W_0 + \frac{3hc}{2\lambda} - 3W_0$$

$$\therefore \quad \frac{hc}{\lambda} - \frac{3hc}{2\lambda} = W_0 - 3W_0$$

$$-\frac{1}{2}\frac{hc}{\lambda} = -2W_0$$

$$\therefore \quad W_0 = \frac{hc}{4\lambda}$$

Comparing with the equation,

$$W_0 = \frac{hc}{\lambda_0}$$

we get,

$$\lambda_0 = 4\lambda$$