Question

Photoelectric Effect: 1.5 mW of 400 nm light is directed at a photoelectric cell. If 0.10 percent of the incident photons produce photoelectrons, find the current in the cell.

Solution

Energy of each photon

$$\begin{aligned} h\nu = \frac{hc}{\lambda} &= \frac{(4.136\times^{-15})(3\times 10^8)}{400\times 10^{-9}} \\ &= 3.122\,eV \end{aligned}$$

Power of light source

$$\begin{aligned} 1.5\,mW &= (1.5\times 10^{-3})(6.242\times 10^{18}) \\ &= 9.363\times 10^{15}\,eV/s \end{aligned}$$

No of photons produced $/s \quad = 9.363\times 10^{15}/3.122 = 3.018\times 10^{15}$

No of photoelectrons produced $/s \quad = (3.018\times 10^{15})/10^3 = 3.018\times 10^{12}$

Current in cell $\quad = (3.018\times 10^{12})(1.602\times 10^{-19}) = 4.835\times 10^{-7}\,C/s$

The current in the cell is $\quad 4.8\times 10^{-7}\,A \quad$ or $\quad 0.48\,\mu A$.