Q- An electron is trapped in an infinite well of width 11 nm. If the electron drops down 5 energy levels and, in the process, emits a photon with wavelength 642.94 nm, then what is the final energy of the electron?

When a particle of mass m is in a potential well of width 'a', its Eigen values (modes of energy) are given by

$$E_n = n^2 \frac{\pi^2 \hbar^2}{2ma^2} = n^2 \frac{h^2}{8ma^2} \qquad [n = 1, 2, 3, ...]$$

Let the electron is initially in nth level and drops down 5 levels and comes to (n – 5) th level then the loss of energy is given by

$$E_n - E_{n-5} = \frac{h^2}{8ma^2}[n^2 - (n-5)^2]$$

Or $$E_n - E_{n-5} = \frac{h^2}{8ma^2}[10n - 25]$$

This lost energy will convert to a photon of energy h c/λ hence we have

$$\frac{h^2}{8ma^2}[10n - 25] = \frac{hc}{\lambda}$$

Or $$[10n - 25] = \frac{8ma^2c}{\lambda h}$$

Or $$[10n - 25] = \frac{8*9.11*10^{-31}*(11*10^{-9})^2*3*10^8}{642.94*10^{-9}*6.63*10^{-34}} = 620.6$$

Gives n = 65

(Should be an integer but the values are not giving it so the nearest one, may take 64)

Hence the energy of the electron in the final level (n -5) will be

$$E_{n-5} = \frac{h^2}{8ma^2}(n-5)^2$$

Or $$E_{n-5} = \frac{(6.63*10^{-34})^2}{8*9.11*10^{-31}*(11*10^{-9})^2} * 60^2$$

Or $$E_{n-5} = 1.79*10^{-18}\ J = 11.2\ eV$$