IIT-JEE-1998

(9) The electron in a hydrogen atom makes a transition $n_1 \to n_2$ where n_1 and n_2 are principal quantum numbers of the two states. Assume the Bohr model to be valid. The time period of the electron in the initial state is 8 times that in the final state. The possible values of n_1 and n_2 are-

(a) $n_1 = 4$, $n_2 = 2$ (b) $n_1 = 8$, $n_2 = 2$

(c) $n_1 = 8$, $n_2 = 1$ (d) $n_1 = 6$, $n_2 = 3$

Soln:- Time period of [illegible] of electron in a Bohr orbit

$$T = \frac{2\pi r}{v}$$

$$mvr = \frac{nh}{2\pi}$$

$$T = \frac{2\pi r}{nh/2\pi mr} = \frac{4\pi^2 m}{nh} r^2$$

and $$r = n^2 \left[\frac{h^2 \varepsilon_0}{\pi m e^2}\right]$$

so $$T = n^3 \left[\frac{4h^3 \varepsilon_0^2}{me^4}\right]$$

$$T \propto n \Rightarrow \frac{T_1}{T_2} = \left[\frac{n_1}{n_2}\right]^3 = 8^{1/3} = n_1/n_2 = 2$$

$\boxed{n_1/n_2 = 2}$ option (a, d) matches