IIT-JEE-ADV-2013

(Q) The radius of the orbit of an electron in Hydrogen like atom is $4.5a_0$, where a_0 is the Bohr Radius. Its orbital angular momentum is $\frac{3h}{2\pi}$. It is given that h is planck constant and R is Rydberg constant. The possible wavelength(s) when the atom de-excite, is (are)

(a) $\frac{9}{32R}$ (b) $\frac{9}{16R}$ (c) $\frac{9}{5R}$ (d) $\frac{4}{3R}$

Sol^{n}:- angular momentum $\frac{nh}{2\pi} = \frac{3h}{2\pi} \Rightarrow \boxed{n=3}$

$$r_n = \frac{a_0 n^2}{Z} = 4.5a_0 \quad \{n=3\}$$

So

$$\boxed{Z=2}$$

$$\frac{1}{\lambda} = RZ^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \Rightarrow \frac{1}{\lambda} = 4R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

case: $n_1 = 1 \quad n_2 = 3$

$$\frac{1}{\lambda} = 4R\left[\frac{1}{1} - \frac{1}{9}\right] \Rightarrow \boxed{\lambda = \frac{9}{32R}}$$

For $n_2 = 3 \quad n_1 = 2 \Rightarrow \boxed{\lambda = \frac{9}{5R}}$

$n_2 = 2 \quad n_1 = 1 \Rightarrow \boxed{\lambda = \frac{1}{3R}}$

So option (a) & c matches.