Previous Year JEE Problems with Explanations

Heat treatment of muscular pain involves radiation of wavelength of about 900 nm. Which spectral line of H atom is suitable for this purpose?

[$R_H = 1 \times 10^5\ cm^{-1}$, $h = 6.6 \times 10^{-34}$ Js, $c = 3 \times 10^8\ ms^{-1}$]

A Balmer, $\infty \rightarrow 2$

B Paschen, $5 \rightarrow 3$

C Paschen, $\infty \rightarrow 3$

D Lyman, $\infty \rightarrow 1$

Explanation

Given, $R_H = 1 \times 10^5\ cm^{-1}$

$\Rightarrow \frac{1}{R_H} = 10^{-5}$ cm

$\Rightarrow \frac{1}{R_H} = 10^{-7}$ cm $\times$ 100

$\Rightarrow \frac{1}{R_H} = 100$ nm

We know,

$$\frac{1}{\lambda} = \nu = R_H \times Z^2 \left(\frac{1}{n_L^2} - \frac{1}{n_H^2}\right)$$

$$\Rightarrow \lambda = \frac{1}{R_H \times (1)^2} \times \frac{1}{\left(\frac{1}{n_L^2} - \frac{1}{n_H^2}\right)}$$

[For H atom Z = 1]

$$\Rightarrow \lambda = \frac{1}{R_H} \times \frac{1}{\left(\frac{1}{n_L^2} - \frac{1}{n_H^2}\right)}$$

$$\Rightarrow \lambda = \frac{100}{\left(\frac{1}{n_L^2} - \frac{1}{n_H^2}\right)}$$

Given, $\lambda = 900$ nm

$$\therefore \frac{100}{\left(\frac{1}{n_L^2} - \frac{1}{n_H^2}\right)} = 900$$

$$\Rightarrow \left(\frac{1}{n_L^2} - \frac{1}{n_H^2}\right) = \frac{1}{9}$$

By checking each options you can see

when $n_L = 3$ and $n_H = \infty$ then

$$\left(\frac{1}{n_L^2} - \frac{1}{n_H^2}\right) = \frac{1}{9}$$

$\therefore$ Option C is correct.