Problem-Solving Example 8

How much energy does a hydrogen atom lose when its electron move from $n = 4$ to $n = 1$ and from $n = 3$ to $n = 2$. What is the wavenumber, $\bar{\nu}$ of the photon emitted? Name the spectrum series of the transition.

Solution

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$n_y = 4$ to $n_x = 1$ (Lyman series : 3rd line)

$$\Delta E_{(4\to1)} = 2.18\times10^{-18}\,J\left[\frac{1}{n_x^2} - \frac{1}{n_y^2}\right]$$

$$= 2.18\times10^{-18}\,J\left(\frac{1}{1^2} - \frac{1}{4^2}\right)$$

$$= 2.04\times10^{-18}\,J\,photon^{-1} \quad (Ans)$$

$$\Delta E = \frac{hc}{\lambda} = hc\bar{\nu}$$

$$\therefore \bar{\nu} = \frac{\Delta E}{hc} = \frac{2.04\times10^{-18}}{(6.626\times10^{-34}\,Js)(2.998\times10^{8}\,ms^{-1})}$$

$$= 1.03\times10^{7}\,m^{-1} \quad (Ans)$$

Alternative Method :

$$\bar{\nu} = \frac{1}{\lambda} = (109\,678\ cm^{-1})\left(\frac{1}{n_x^2} - \frac{1}{n_y^2}\right)$$

$$= (109\,678\ cm^{-1})\left(\frac{1}{1^2} - \frac{1}{4^2}\right)$$

$$= 102\,823\ cm^{-1}$$

$$= 102\,823\,00\ m^{-1} = 1.03\times10^{7}\,m^{-1} \quad (Ans)$$

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