RYDBERG EQUATION

Absorption Spectrum : Emission Spectrum

RYDBERG EQUATION

$$\frac{1}{\lambda} = \bar{\nu} = R_H\left[\frac{1}{n_x^2} - \frac{1}{n_y^2}\right] \quad \ldots\ldots(i)$$

Rydberg Equation

$R_H = 109\ 678\ cm^{-1} = 1.1 \times 10^7 m^{-1}$

$n_x < n_y$

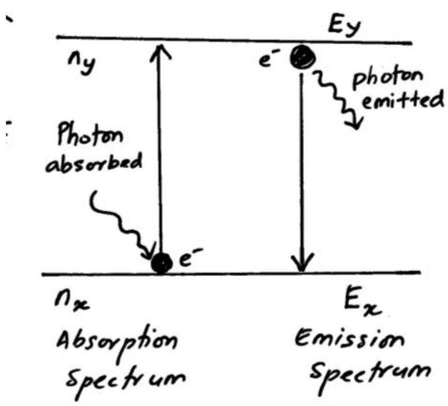
(quantum number)

$\bar{\nu}$ = wave number

λ = wavelength.

Remember also!

$$\Delta E = h\nu = \frac{hc}{\lambda} = hc\bar{\nu} \rightarrow \frac{1}{\lambda} = \frac{\Delta E}{hc}$$



$\Delta E = (E_y - E_x) \quad (\because E_Y > E_x)$

$$\frac{1}{\lambda} = (109\ 678\ cm^{-1})\left[\frac{1}{n_x^2} - \frac{1}{n_y^2}\right] = \frac{\Delta E}{hc}$$

or $\Delta E = (109678\ cm^{-1})\, hc\left[\frac{1}{n_x^2} - \frac{1}{n_y^2}\right]$

In SI unit:

$$\Delta E = (1.1 \times 10^7 m^{-1})\, hc\left[\frac{1}{n_x^2} - \frac{1}{n_y^2}\right]$$

Substituting for h and c:

$$\Delta E = (1.1 \times 10^7 m^{-1})(6.626 \times 10^{-34} Js)(2.998 \times 10^8 ms^{-1})\left[\frac{1}{n_x^2} - \frac{1}{n_y^2}\right]$$

$$\Delta E = 2.18 \times 10^{-18} J\left[\frac{1}{n_x^2} - \frac{1}{n_y^2}\right] \quad \ldots\ldots\ldots(ii)$$

If $E_x = E_1$ and $E_y = E_4$ $\Rightarrow \Delta E = 2.18 \times 10^{-18}\left(\frac{1}{1^2} - \frac{1}{4^2}\right)$
$n_x = 1$ $(n_y = 4)$ $= 2.04 \times 10^{-18} J$

- When an electron move from $n_x = 1$ to $n_y = 4$, $2.04 \times 10^{-18} J$ energy is absorbed, BUT
- When an electron move from $n_y = 4$ to $n_x = 1$, $2.04 \times 10^{-18} J$ energy is emitted.

3 TYPES OF RYDBERG FORMULA

<u>Rydberg Equation :</u>

$$\frac{1}{\lambda} = (10967800\ m^{-1})\left[\frac{1}{n_x^2} - \frac{1}{n_y^2}\right]$$

$$\frac{1}{\lambda} = \frac{\nu}{c} = (10967800\ m^{-1})\left[\frac{1}{n_x^2} - \frac{1}{n_y^2}\right]$$

$$\therefore \nu = (10967800\, m^{-1})(2.998\times10^{8}\, m s^{-1})\left[\frac{1}{n_x^2} - \frac{1}{n_y^2}\right]$$

$$\nu = 3.29\times10^{15}\, s^{-1}\left[\frac{1}{n_x^2} - \frac{1}{n_y^2}\right] \quad \ldots\ldots(iii)$$

So we have 3 forms of Rydberg Equation :

$$\left.\begin{array}{l} \dfrac{1}{\lambda} = \bar{\nu} = (109678\ cm^{-1})\left[\dfrac{1}{n_x^2} - \dfrac{1}{n_y^2}\right] \\ \text{OR}\quad \dfrac{1}{\lambda} = \bar{\nu} = (10967800\ m^{-1})\left[\dfrac{1}{n_x^2} - \dfrac{1}{n_y^2}\right] \end{array}\right\} \text{wavelength @ wave number}$$

$$\Delta E = (2.18\times10^{-18}\ J)\left[\frac{1}{n_x^2} - \frac{1}{n_y^2}\right] \quad \Big\}\ \text{Energy}$$

$$\nu = (3.29\times10^{15}\ s^{-1})\left[\frac{1}{n_x^2} - \frac{1}{n_y^2}\right] \quad \Big\}\ \text{frequency}$$

Prepared by
V.Manoharan
vmano@usm.my
manovv1955@yahoo.com
04-6533888 ext 3566