$$E_n = -\frac{m Z^2 e^4}{8 \epsilon_0^2 h^2} \cdot \frac{1}{n^2} \quad \text{——— (9)}$$

$$\therefore \quad E_n = -\frac{Z^2 R h c}{n^2} \quad \text{——— (10)}$$

Where. $R = \frac{m e^4}{8 \epsilon_0^2 c h^3}$ = Rydberg Constant.

If n_i and n_f are the initial and final states of quantum numbers and E_i and E_f are their respective energies, we have

$$E_i = -\frac{Z^2 R h c}{n_i^2} \quad \text{——— (11)}$$

and $$E_f = -\frac{Z^2 R h c}{n_f^2} \quad \text{——— (12)}$$

If ν is the frequency of emitted radiation, we have from Bohr's fourth postulate

$$\nu = \frac{E_i - E_f}{h} = -\frac{Z^2 R c}{n_i^2} - \left(-\frac{Z^2 R c}{n_f^2}\right)$$

$$= Z^2 R c \left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) \quad \text{——— (13)}$$

The wave number i.e. reciprocal of wavelength of the emitted radiation is given by

$$\therefore \bar{\nu} = \frac{1}{\lambda} = \frac{\nu}{c} = Z^2 R \left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) \quad \text{——— (14)}$$

For hydrogen atom $Z = 1$;

$$\therefore \bar{\nu} = R \left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) \quad \text{——— (15)}$$

This relation explains successfully the origin

origin of various lines in the spectrum of hydrogen atom. The series of lines of obtained due to the transition of electrons from various outer orbits to a fixed inner orbits :-

1) Lyman series :- This series is produced when electron jumps from higher orbits to the first stationary orbit (i.e. $n_f = 1$). Thus for this series,

$$\bar{\nu} = R\left(\frac{1}{1^2} - \frac{1}{n_i^2}\right) \text{ Where } n_i = 2,3,4,5,\ldots$$

The lines of this series are fond in ultra-violet region.

2) Balmar series :- The series is produced when electron jumps from higher orbits to second stationary orbit ($n_f = 2$):

Thus for this series,

$$\bar{\nu} = R\left(\frac{1}{2^2} - \frac{1}{n_i^2}\right) \text{ When, } n_i = 3,4,5,6,\ldots$$

The lines of this series are fond in visible region and first, second, third .. lines are called H_α, H_β, H_γ ... Lines respectively.

3) Parchen series :- This series is produced when electron jumpe from higher orbits to third stationary orbit ($n_f = 3$).

Thus for this serie

$$\bar{\nu} = R\left(\frac{1}{3^2} - \frac{1}{n_i^2}\right) \text{ when, } n_i = 4,5,6,7\ldots$$

4) Brackett series :- This series is produced when electron jumps for higher orbits to fourth stationary orbit ($n_f = 4$).

Thus for this series,

$$\bar{\nu} = R\left(\frac{1}{4^2} - \frac{1}{n_i^2}\right) \text{ When, } n_i = 5,6,7,8\ldots$$