Calculation of energy of an electron:-

The total energy of an electron revolving in a particular Orbit is calculated by adding its Potential energy & Kinetic energy

$E_{Total} = P.E + K.E$

The kinetic energy of the electron $= \frac{1}{2}mu^2$

Potential energy $= -\frac{KZe^2}{r}$

Hence Total Energy $= P.E + K.E$

$$= -\frac{KZe^2}{r} + \frac{1}{2}mu^2 \quad \text{—— (11)}$$

We know, that:

the Centrifugal force is equal to Coulombic attraction force

so,

$$\frac{mu^2}{r} = \frac{K.Ze^2}{r^2}$$

$$\text{or } mu^2 = \frac{K.Ze^2}{r} \quad \text{—— (12)}$$

On substituting the value of $mu^2 = \frac{KZe^2}{r}$ in equation (11)

we have,

$$E_{Total} = -\frac{KZe^2}{r} + \frac{K.Ze^2}{2r}$$

$$\text{or } E_{Total} = \frac{KZe^2}{2r} - \frac{KZe^2}{r} = \frac{K.Ze^2}{r}\left(\frac{1}{2}-1\right)$$

$$= \frac{K.Ze^2}{r}\left(\frac{1-2}{2}\right)$$

$$= -\frac{K.Ze^2}{2r} \quad \text{—— (13)}$$

Again Substituting the value of

$$r = \frac{n^2h^2}{4\pi^2 m.Ze^2.K} \text{ in equation (13)}$$

$$E_{Total} = -\frac{K.Ze^2}{2} \times \frac{4\pi^2.m Ze^2.K}{n^2h^2}$$

$$= -\frac{2\pi^2 Z^2 e^4.m.K^2}{n^2h^2} \quad \text{—— (14)}$$

Thus the total Energy of electron in an Orbit of hydrogen atom is given by

$$E_n = -\frac{2\pi^2 Z^2 e^4 m K^2}{n^2h^2}$$

Where E_n is the total energy of electron moving in an orbit.

Calculation after putting the values.

$\pi = 3.1416$, $K = 9 \times 10^9 \, Nm^2/c^2$, $e = 1.6 \times 10^{-19} c$, $m = 9.1085 \times 10^{-31}$ kg

and $h = 6.6252 \times 10^{-34}$ joules - sec.

$$E = -\frac{21.79 \times 10^{-19}}{n^2} \text{ joules atom}^{-1}$$

$$= -\frac{21.79 \times 10^{-19}}{n^2} \times 6.2419 \times 10^{18} \text{ ev} \quad [\because 1 \text{ joule} = 6.2419 \times 10^{18} \text{ ev}]$$

$$= -\frac{13.6}{n^2} \text{ ev} = \frac{-13.6}{n^2} \times 23.053 \text{ kcals} \quad (\because 1 \text{ ev} = 23.053 \text{ K.Cal})$$

$$\text{or } E = -\frac{313.5208}{n^2} \text{ K.Cal mol}^{-1}$$

where $n = 1, 2, 3 \ldots$

Calculation of energy of an electron:-

The total energy of an electron revolving in a particular orbit is calculated by adding its potential energy & kinetic energy

$E_{Total} = P.E. + K.E$

The kinetic energy of the electron $= \frac{1}{2}mu^2$

Potential energy $= -\frac{kZe^2}{r}$

Hence Total Energy $= P.E + K.E$

$$= -\frac{kZe^2}{r} + \frac{1}{2}mu^2 \quad \text{——} (11)$$

We know that: the centrifugal force is equal to Coulombic attraction force

so,

$$\frac{mu^2}{r} = \frac{kZe^2}{r^2}$$

or $$mu^2 = \frac{k \cdot Ze^2}{r} \quad \text{——} (12)$$

On substituting the value of $mu^2 = \frac{kZe^2}{r}$ in equation (11)

we have,

$$E_{Total} = -\frac{kZe^2}{r} + \frac{k \cdot Ze^2}{2r}$$

or $$E_{Total} = \frac{kZe^2}{2r} - \frac{kZe^2}{r} = \frac{k \cdot Ze^2}{r}\left(\frac{1}{2} - 1\right)$$

$$= \frac{k \cdot Ze^2}{r}\left(\frac{1-2}{2}\right)$$

$$= -\frac{k \cdot Ze^2}{2r} \quad \text{——} (13)$$

Again substituting the value of

$$r = \frac{n^2h^2}{4\pi^2 m \cdot Ze^2 \cdot k}$$ in equation (13)

$$E_{Total} = -\frac{k \cdot Ze^2}{2} \times \frac{4\pi^2 \cdot m Ze^2 \cdot k}{n^2h^2}$$

$$= -\frac{2\pi^2 Z^2 e^4 \cdot m \cdot k^2}{n^2h^2} \quad \text{——} (14)$$

Thus the total Energy of electron in an orbit of hydrogen atom is given by

$$E_n = -\frac{2\pi^2 Z^2 e^4 m k^2}{n^2h^2}$$

Where E_n is the total energy of electron moving in an orbit.

Calculation after putting the values.

$\pi = 3.1416$, $K = 9 \times 10^9\ Nm^2/c^2$, $e = 1.6 \times 10^{-19}c$, $m = 9.1085 \times 10^{-31}$ kg and $h = 6.6252 \times 10^{-34}$ joules-sec.

$$E = -\frac{21.79 \times 10^{-19}}{n^2} \text{ joules atom}^{-1}$$

$$= -\frac{21.79 \times 10^{-19}}{n^2} \times 6.2419 \times 10^{18} \text{ eV} \quad [\because 1 \text{ joule} = 6.2419 \times 10^{18} \text{ eV}]$$

$$= -\frac{13.6}{n^2} \text{ eV} = -\frac{13.6}{n^2} \times 23.053 \text{ kcal} \quad (\because 1 \text{ eV} = 23.053 \text{ K.cal})$$

or $$E = -\frac{313.5208}{n^2} \text{ K.cal mol}^{-1}$$

where $n = 1, 2, 3 \ldots$