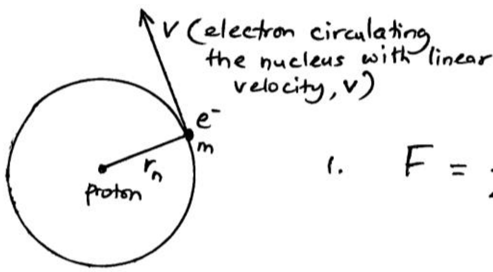
Derivation of Bohr Orbit Energy E_n



1. $F = \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1 q_2}{r^2}$ ← in SI unit.

where $\frac{1}{4\pi\epsilon_0} = 9.0 \times 10^9\ Nm^2C^{-2}$ @ $9.0 \times 10^9\ JmC^{-2}$

@ $F = \frac{(-e)(+e)}{4\pi\epsilon_0 r_n^2}$ ......(i)

$\therefore F = -\frac{e^2}{4\pi\epsilon_0 r_n^2}$

2. Using Newton's Law of motion, centrifugal force, F'

$F' = -\frac{mv^2}{r_n}$ ....(ii)

3. When sistem at equilibrium:

$F = F'$

$-\frac{e^2}{4\pi\epsilon_0 r_n^2} = -\frac{mv^2}{r_n}$

$\therefore mv^2 = \frac{e^2}{4\pi\epsilon_0 r_n}$ ....(iii)

4. Using Law of energy conservation:

Total energy, E_n for this system = Potential Energy + Kinetic energy

$= (F \times r_n) + \frac{1}{2}mv^2$

Substitute for F and mv^2 }

$E_n = -\frac{e^2}{4\pi\epsilon_0 r_n} + \frac{1}{2}\left(\frac{e^2}{4\pi\epsilon_0 r_n}\right)$

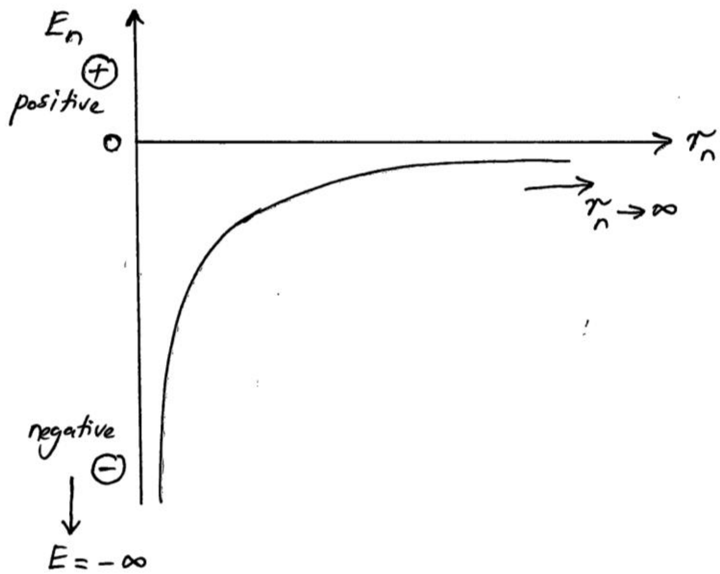
$E_n = -\frac{1}{2}\frac{e^2}{4\pi\epsilon_0 r_n}$ ......(iv)

$$E_n = -\frac{1}{2}\frac{e^2}{4\pi\epsilon_0 r_n}$$ ← Explanation of this formula

the negative sign has important meanings.

(i) When r_n decreases, E_n becomes more negative.
ie. when $r_n \to 0$, then $E_n \to -\infty$

(ii) When r_n increases (when the electron is away from the nucleus), E_n becomes less negative.
ie. when $r_n \to \infty$ the $E_n = 0$



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