JEE MAIN

MODERN PHYSICS – PART 1

FORMULAE

ATOMIC PHYSICS

Now that's how you REVISE

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MODERN PHYSICS

- ATOMIC PHYSICS
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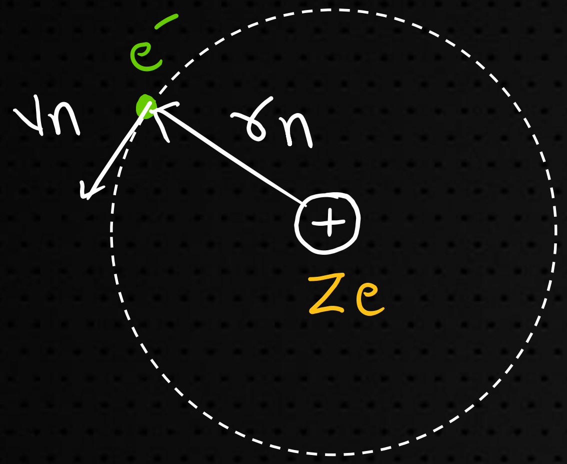
ATOMIC PHYSICS

- BOHR'S 3 POSTULATES
- r_n, V_n, ω_n, T_n, E_n
- ENERGY LEVEL of Hydrogen type atom ($1e^-$)
- EXCITATION OF ATOM
- λ of EMITTED RADIATION
- NUMBER OF SPECTRAL LINES
- HYDROGEN SPECTRAL SERIES

1. BOHR'S POSTULATES (for single e^- system)

1st



$$\frac{kZe^2}{r_n^2} = \frac{mv_n^2}{r_n}$$

2nd

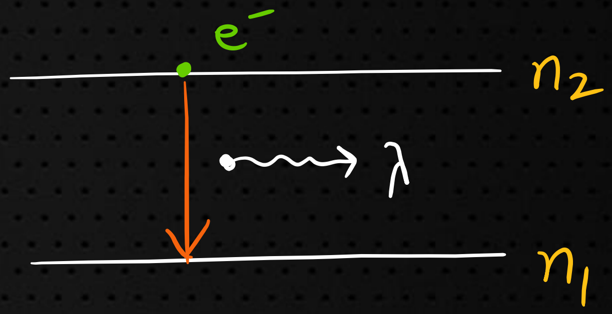
Bohr's Quantization

$$mv_n r_n = \frac{nh}{2\pi}$$

$(n \in I)$

3rd

Release of energy



$$\frac{hc}{\lambda} = E_{n_2} - E_{n_1}$$

2. BOHR's MODEL ($1e^-$ system)

$r_n \propto \frac{1}{m_e}$

- Radius of n^{th} orbit, $r_n = \frac{n^2h^2}{4\pi^2 k Z e^2 m} = 0.529 \times \frac{n^2}{Z}$ Å
- Velocity in n^{th} orbit, $V_n = \frac{2\pi k Z e^2}{nh} = 2.18 \times 10^6 \times \frac{Z}{n}$ m/s
- $\omega_n = \frac{V_n}{r_n}$ $\quad \omega_n \propto \frac{Z^2}{n^3}$ rad/s
- $T_n = \frac{2\pi}{\omega_n}$ $\quad T_n \propto \frac{n^3}{Z^2}$ s
- $E_n = K_n + U_n = -\frac{KZe^2}{2r_n} = -13.6 \times \frac{Z^2}{n^2}$ eV

Focus more on relations

3. ENERGY LEVEL OF HYDROGEN TYPE ATOM (1 e^- system)

$$E_n = -13.6 \times \frac{Z^2}{n^2} \text{ eV}$$

NOTE : Learn them for speed solving.

$E = 0$	$n \to \infty$
$-0.54Z^2$	$n=5$
$-0.85Z^2$	$n=4$
$-1.51Z^2$	$n=3$
$-3.4Z^2$	$n=2$
$-13.6Z^2$	$n=1$

↓ In eV

ENERGY LEVEL DIAGRAM

4. EXCITATION OF ATOM

↳ For e^- to absorb energy and excite from n_1 to n_2, the energy absorbed must be exactly equal to $E_{n_2} - E_{n_1}$

Ex:

$n=3$ ——— $-1.51\,eV$

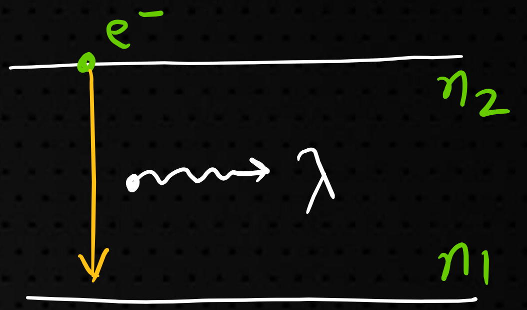
$n=1$ ——— $-13.6\,eV$

$\because E_3 - E_1 = 12.09\,eV$

* Thus $12.09\,eV$ of energy must be absorbed.

5. λ OF EMITTED RADIATION

$$\frac{hc}{\lambda} = E_{n_2} - E_{n_1}$$



$$\Rightarrow \frac{1}{\lambda} = R Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right), \quad R \sim 10^7\,m^{-1}$$

↳ Rydberg's constant

IMPORTANT:

(a) $\lambda = \dfrac{12430}{\Delta E\ (\text{in eV})}\ \mathring{A}$ or $= \dfrac{1243}{\Delta E\ (\text{in eV})}\ nm$

(b) $\Delta E = \dfrac{12430}{\lambda\ (\mathring{A})}\ eV$

6. NUMBER OF SPECTRAL LINES

↳ possible number of photon energies emitted due to de excitation of e^- from $n = n_2$ to $n = 1$ state

$$= {}^{n}C_2 = \frac{n(n-1)}{2}$$

7. HYDROGEN SPECTRAL SERIES