FREE NOTES · NCERT + JEE/NEET LEVEL

Atoms

Thomson aur Rutherford model, alpha scattering, closest approach, Bohr model, radius aur energy ke formulas, hydrogen spectrum ki series aur energy level diagram.

01 Thomson model (plum pudding)
02 Rutherford ka alpha scattering experiment
03 Closest approach & impact parameter
04 Rutherford model ki kami
05 Bohr model (hydrogen jaise atoms)
06 Radius, speed & energy
07 Energy level diagram (hydrogen)
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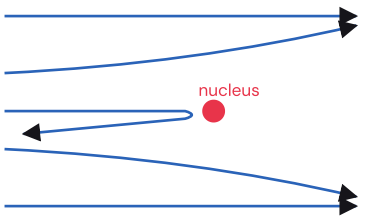
01 Thomson model (plum pudding)

Atom ek positive charge ka gola, jisme electrons jaise pudding me kishmish ki tarah fanse hue. Atom neutral. Ye model Rutherford ke experiment se galat sabit hua.

02 Rutherford ka alpha scattering experiment

Geiger aur Marsden ne patli gold foil pe alpha particles (He nuclei, +2e) daale.

Observation	Natija
Zyada tar seedhe nikal gaye	Atom zyada tar khaali
Kuch thoda mude	Andar positive charge
~1 in 8000 lagbhag 180° laute	Saara positive charge aur mass ek bahut chhoti jagah (nucleus) me



Seedha saamne wala alpha lagbhag wapas

Nucleus ka size ~10^{-15} m, atom ~10^{-10} m (1 lakh guna bada). Scattered particles ki sankhya $N \propto 1/\sin^4(\theta/2)$.

03 Closest approach & impact parameter

DISTANCE OF CLOSEST APPROACH (SEEDHI TAKKAR)

$$r_0 = (1/4\pi\varepsilon_0) \times 2Ze^2 / K$$

Saari KE PE me badal jaati. Isse nucleus ke size ki upper limit milti. K badhao ⇒ r_0 ghate.

IMPACT PARAMETER B

Alpha ki initial direction aur nucleus ke centre ki perpendicular doori. $b \propto \cot(\theta/2)$. b = 0 ⇒ θ = 180° (seedha wapas). b bada ⇒ kam mudta.

04 Rutherford model ki kami

Model: chhote positive nucleus ke chaaron taraf electrons ghoomte (planets jaise). **Problem:** ghoomta electron accelerated hai ⇒ electromagnetic theory ke hisaab se energy radiate karega ⇒ spiral bana ke nucleus me gir jaayega ⇒ atom stable nahi. Aur spectrum continuous hona chahiye, par asal me line spectrum hai.

05 Bohr model (hydrogen jaise atoms)

1. Electron sirf kuch **fixed orbits (stationary states)** me ghoom sakta, wahan energy radiate nahi karta.
2. Allowed orbits me angular momentum quantised: $mvr = nh/(2\pi)$, n = 1, 2, 3...
3. Electron ek orbit se doosre me jump kare toh energy ka fark photon ban ke: $h\nu = E_i - E_f$.

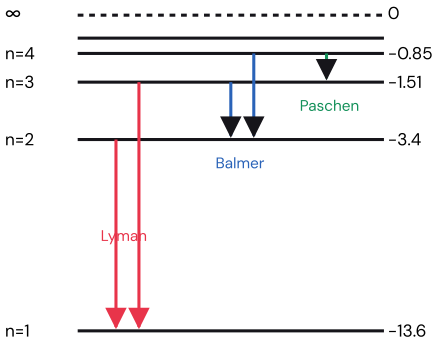
06 Radius, speed & energy

Quantity	Formula (H-like, atomic number Z)	Dependence
Radius	$r_n = 0.529\ n^2/Z$ Å	$\propto n^2/Z$
Speed	$v_n = 2.18 \times 10^6\ Z/n$ m/s $(= c/137$ for H, $n = 1)$	$\propto Z/n$
Total energy	$E_n = -13.6\ Z^2/n^2$ eV	$\propto Z^2/n^2$
KE, PE	$KE = -E,\ PE = 2E$	—
Time period	$\propto n^3/Z^2$	—

YAAD RAKHO

- Energy negative ⇒ electron bound hai.
- Ionisation energy (H, ground state) = 13.6 eV. Ground state = n = 1.
- Excitation energy n = 1 se 2: 10.2 eV; 1 se 3: 12.09 eV.
- Bohr radius a_o = 0.529 Å.

07 Energy level diagram (hydrogen)



Energy (eV) levels aur transitions

EMITTED WAVELENGTH

$$1/\lambda = R\,Z^2\,(1/n_1^2 - 1/n_2^2)$$

R = 1.097 × 10^7 m^{-1} (Rydberg constant). n_2 se n_1 pe gira ($n_2 > n_1$). Level n se gire toh total lines = n(n − 1)/2.

08 Hydrogen spectrum ki series

Series	Kahan gira (n_1)	Region
Lyman	1	Ultraviolet
Balmer	2	Visible (kuch near UV)
Paschen	3	Infrared
Brackett	4	Infrared
Pfund	5	Far infrared

SERIES LIMIT & FIRST LINE

Har series ki **sabse chhoti λ** (series limit): $n_2 = \infty$. **Sabse lambi λ** (pehli line): $n_2 = n_1 + 1$. Lyman ki sabse chhoti ≈ 91.2 nm, Balmer ki pehli line (H_α, laal) ≈ 656 nm.

09 de Broglie se Bohr ka 2nd postulate

Electron ek standing wave ki tarah orbit me fit hona chahiye: orbit ki lambai = poore wavelengths.

$2\pi r_n = n\lambda = nh/(mv) \Rightarrow mvr = nh/2\pi$ ✓

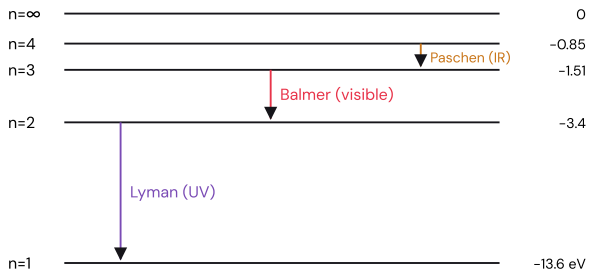
BOHR MODEL KI LIMITATIONS

- Sirf ek electron wale atoms (H, He^{+}, Li^{2+}) pe chalta.
- Lines ki intensity aur fine structure nahi batata.
- Classical aur quantum ka mix, poori theory nahi.

10 JEE Extra + Tricks

JEE LEVEL

- Bohr model: $r_n = 0.529\ n^2/Z$ Å; $v_n = 2.18 \times 10^6\ Z/n$ m/s; $E_n = -13.6\ Z^2/n^2$ eV.
- KE = −E, PE = 2E (PE = −2KE). H ki ionisation energy = 13.6 eV; pehli excitation = 10.2 eV.
- Level n se ground tak spectral lines = n(n − 1)/2.
- Rydberg: $1/\lambda = RZ^2(1/n_1^2 - 1/n_2^2)$, $R \approx 1.097 \times 10^7\ m^{-1}$.
- Series: Lyman ($n_1 = 1$, UV), Balmer (2, visible), Paschen (3), Brackett (4), Pfund (5) (infrared).



Hydrogen ke energy levels

11 Solved numericals

Q1. H atom ke n = 3 orbit ka radius aur energy?
r = 0.529 × 9 = 4.76 Å. E = −13.6/9 = −1.51 eV. **Ans: 4.76 Å, −1.51 eV**

Q2. He^+ (Z = 2) ki ground state energy?
E = −13.6 × 4 = −54.4 eV. **Ans: −54.4 eV**

Q3. H me n = 3 se n = 2 jump ka photon (eV aur nm)?
ΔE = 3.4 − 1.51 = 1.89 eV. λ = 1240/1.89 ≈ 656 nm (laal, Balmer H_α). **Ans: 1.89 eV, 656 nm**

Q4. Lyman series ki sabse chhoti wavelength?
$1/\lambda = R(1 - 0) \Rightarrow \lambda = 1/R \approx 91.2$ nm. **Ans: ≈ 91.2 nm**

Q5. 5 MeV alpha, gold (Z = 79). Closest approach? ($k = 9 \times 10^9$)
$r_0 = 9 \times 10^9 \times 2 \times 79 \times (1.6 \times 10^{-19})^2/(5 \times 1.6 \times 10^{-13}) = 9 \times 10^9 \times 158 \times 2.56 \times 10^{-38}/8 \times 10^{-13} \approx 4.5 \times 10^{-14}$ m.
Ans: ≈ 45 fm

Q6. Electron n = 5 se ground state tak. Kitni spectral lines?
5 × 4/2 = 10. **Ans: 10**

12 Common mistakes

- Energy ka sign bhoolna (bound electron ki energy negative).
- Radius ko n pe linear maan lena (n^2 pe).
- Series limit me $n_2 = n_1 + 1$ lena (∞ lena hai).
- Lyman ko visible maan lena (UV hai; Balmer visible).
- Bohr model ko multi-electron atom pe lagana.

13 Formula sheet

Closest approach	$r_0 = 2kZe^2/K$
Angular momentum	$mvr = nh/2\pi$
Radius	$r_n = 0.529\ n^2/Z$ Å
Speed	$v_n = 2.18 \times 10^6\ Z/n$ m/s
Energy	$E_n = -13.6\ Z^2/n^2$ eV
KE, PE	$KE = -E,\ PE = 2E$
Photon	$h\nu = E_i - E_f$
Rydberg	$1/\lambda = RZ^2(1/n_1^2 - 1/n_2^2)$
Number of lines	$n(n-1)/2$

14 Practice questions

1. H atom ka ground state ionisation energy?
2. H me n = 2 ki radius, n = 1 ke kitni guna?
3. Balmer series kis region me?
4. Kisi state me KE = 3.4 eV. Total energy aur PE?

ANSWERS

1) 13.6 eV · 2) 4 guna · 3) Visible · 4) E = -3.4 eV, PE = -6.8 eV

15 Quick revision: exam se pehle 5 minute

RUTHERFORD

- Zyada tar seedhe ⇒ khaali atom.
- 180° wapas ⇒ chhota heavy nucleus.
- $r_o = 2kZe^2/K$.

BOHR

- $mvr = nh/2\pi$.
- $r \propto n^2/Z$, $v \propto Z/n$, $E \propto -Z^2/n^2$.
- $E_1 = -13.6$ eV; KE = −E, PE = 2E.

SPECTRUM

- Lyman UV, Balmer visible, Paschen IR.
- Limit: $n_2 = \infty$; first: $n_2 = n_1 + 1$.
- Lines $n(n-1)/2$.

NUMBERS

- $a_o = 0.529$ Å.
- H_α 656 nm; Lyman limit 91.2 nm.

Doubt hai? padhaiadda.netlify.app pe AI Doubt Solver se poocho, ya is chapter ka mock test do.