JEE MAIN

MODERN PHYSICS – PART 6

FORMULAE

X - RAYS

Now that's how you REVISE

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List of Content on Eduniti YouTube Channel:

1. PYQs Video Solution Topic Wise:
   (a) JEE Main 2018/2020/2021 Feb & March
2. Rank Booster Problems for JEE Main
3. Part Test Series for JEE Main
4. JEE Advanced Problem Solving Series
5. Short Concept Videos
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7. JEE Advanced PYQs
8. Formulae Revision Series

........and many more to come

MODERN PHYSICS

- ATOMIC PHYSICS — PART 1
- PHOTO ELECTRIC EFFECT — PART 2
- DUAL NATURE OF LIGHT — PART 3
- X-RAYS — PART 6
- RADIO ACTIVITY — PART 4
- NUCLEAR PHYSICS — PART 5

TOPICS COVERED

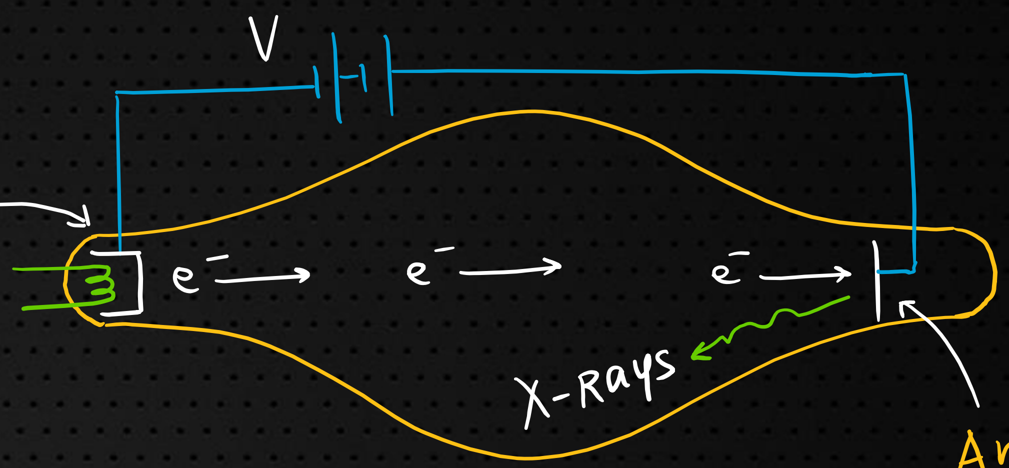
1. Soft and Hard X – Rays
2. Production of X – Rays : Coolidge Tube
3. Continuous X – Ray Production
4. Characteristic X – Ray Production
5. Complete Spectrum
6. Moseley's Law

1. X-RAYS (≈ 1 Å)

Soft X-RAYS
- High wavelength
- Low energy

Hard X Rays
- Low wavelengths
- High Energy

2. PRODUCTION OF X-RAYS
(X-ray tubes)



Cathode
(heated electrically)

Coolidge Tube

Anode
(Target)

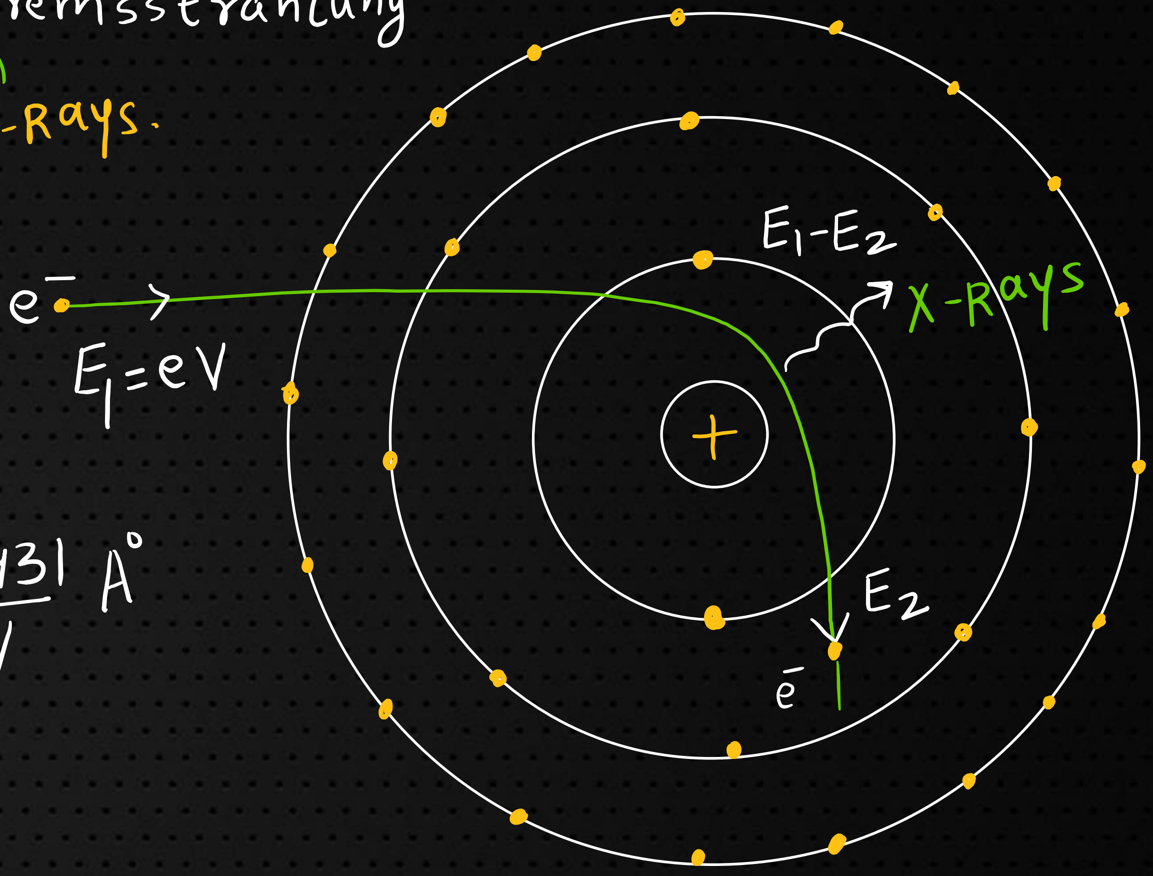
X-Rays are produced by incidence of accelerated e^- on target material.

- Continuous X-Rays (Bremsstrahlung)
- Characteristic X-Rays

3. CONTINUOUS X-RAY

This Phenomena is called Bremsstrahlung

↳ Deceleration of e^- when deflected by atomic nucleus causes production of X-Rays.

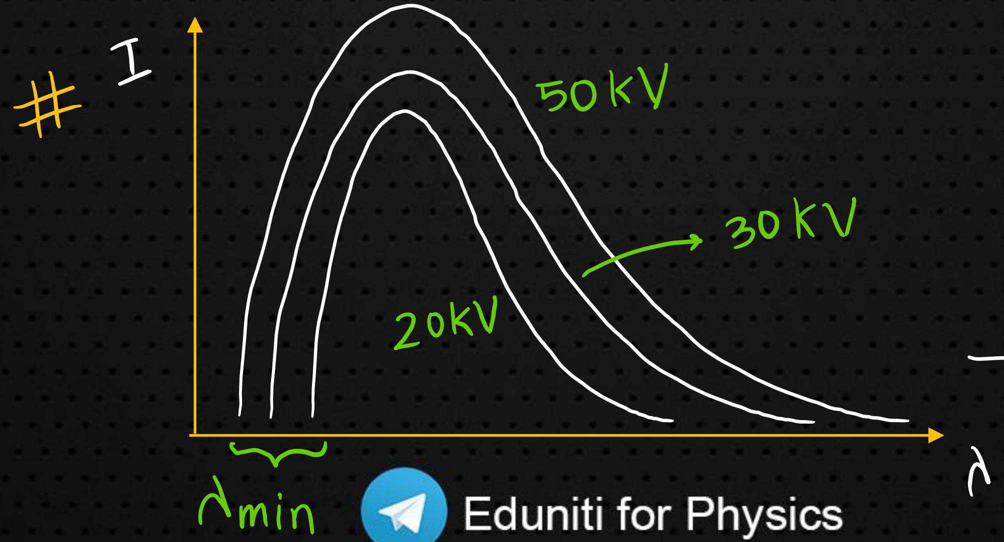


(a) Energy of X-rays, $E = E_1 - E_2$

$E_{max} = E_1 = eV \quad (E_2 = 0)$

∴ Cutoff Wavelength of X-Ray,

$\lambda_{min} = \dfrac{hc}{E_{max}} = \dfrac{hc}{eV} = \dfrac{12431}{V}\ \text{Å}$



→ X-Rays Continuum Radiation spectra

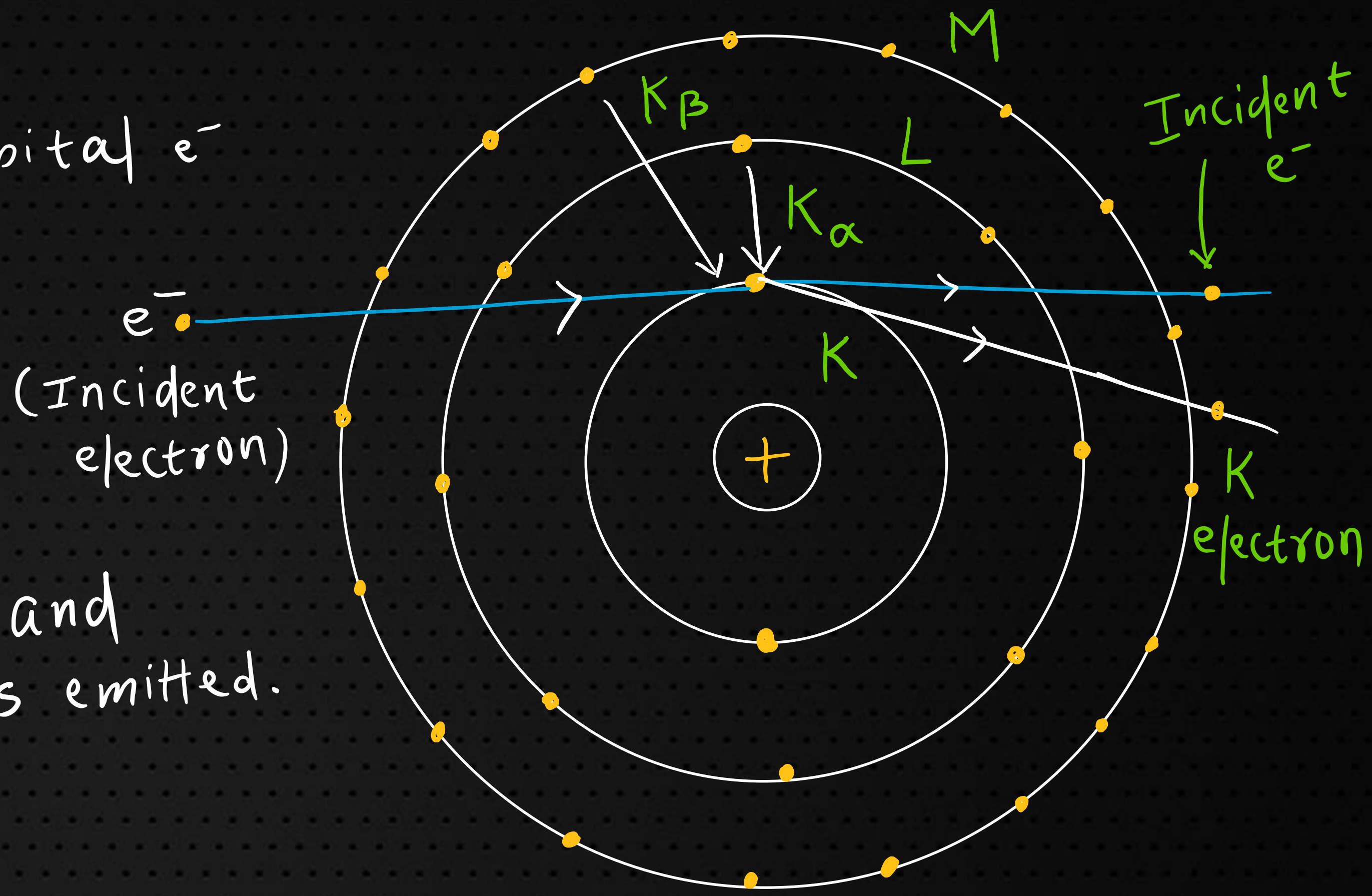
4. CHARACTERISTIC X-RAY

(i) some incident e^- knocks off orbital e^- of K, L, M .. shell.

(ii) If $eV >$ Binding Energy of "K shell e^-", only then it is removed.

(iii) e^- from L, M, N.. can jump to K and during this Photon (X-ray) is emitted.

$$\lambda = \frac{hc}{\Delta E}$$



(a) K_α X-Ray → If e^- jumps from L → K

(b) K_β → e^- jumps from M → K

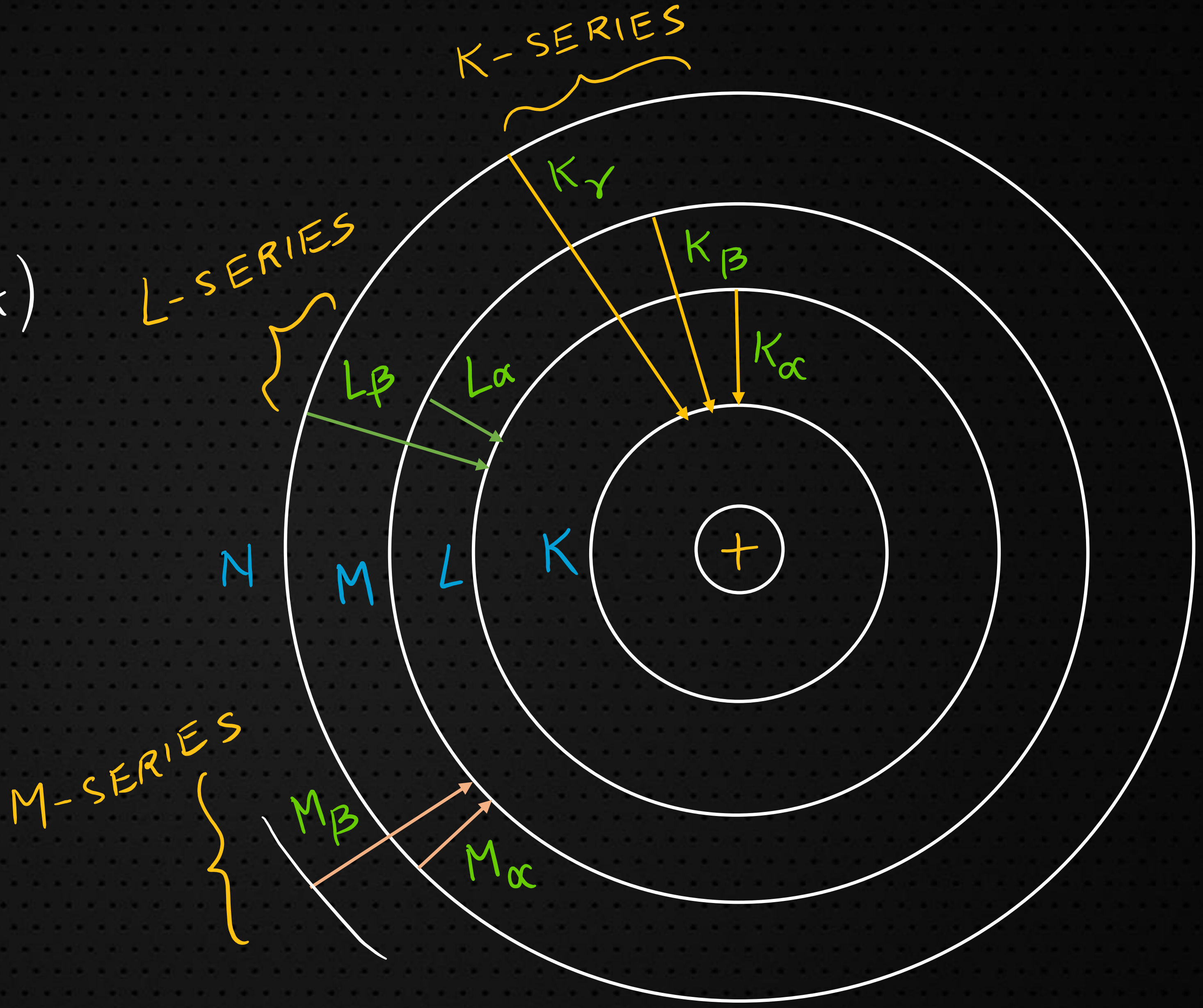
(c) K_γ → e^- jumps from N → K

} K- series

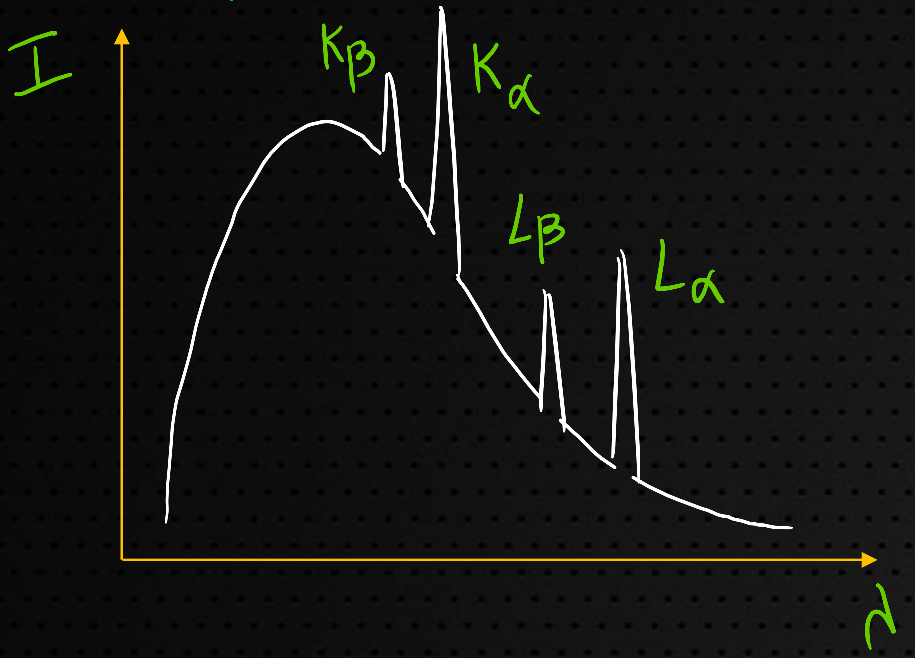
NOTE:

(i) If you compare K_β and K_α

$\lambda_{K_\beta} < \lambda_{K_\alpha}$ $(\because \Delta E_{MK} > \Delta E_{LK})$



5. COMPLETE SPECTRUM



$K_\beta : M \to K$

$K_\alpha : N \to K$

$L_\beta : N \to L$

$L_\alpha : M \to L$

6. MOSELEY'S LAW $\left(\sqrt{\nu} = a(z-\sigma)\right)$

λ of characteristic X-Rays :

$$\frac{1}{\lambda} = R(z-\sigma)^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$\underbrace{z-\sigma}$ effective atomic no

$$\therefore \nu = \frac{c}{\lambda}$$

$$\Rightarrow \nu = Rc(z-\sigma)^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

For K-Series $\sigma = 1$

$R : 10^7 \, m^{-1}$

↳ Rydbergs const.

$$\therefore \sqrt{\nu} = a(z-\sigma)$$

$$a = \sqrt{Rc\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)}$$

↳ square root of frequency is linearly proportional to Atomic number.