Handwritten Notes
On
X-Rays

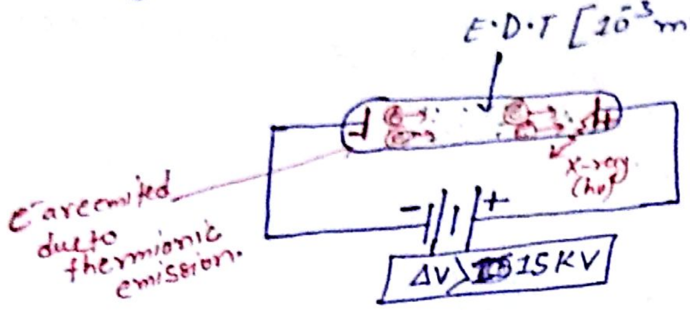
'X- RAYS'

Like photon ↑ ... undeflected from electric & magnetic field.

* Reverse of P.E.E.

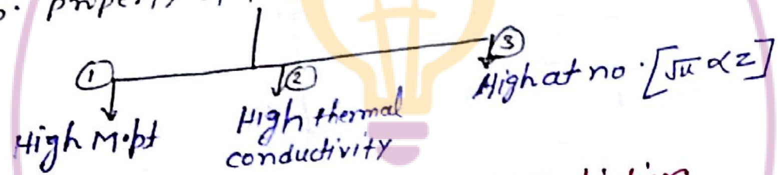
condn → * When highly energetic e⁻s are made to strike metal target, electromagnetic radiation of the order 0.01A° to 100A° was observed & known as X-ray.

|1| → Roengton Exp :→ In ⊕nce of high potential & low potential. Sum invisible radiation is emitted from anode which is called X-ray.

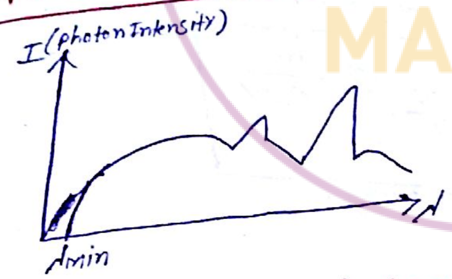


Basic requirment of X-ray production

|a| → e⁻ producing source
|b| → e⁻ Accelerating source (More than 15 KV pot.)
|c| → Sp. property of target.



Graph b/w Intensity & Wavelength of Radiation

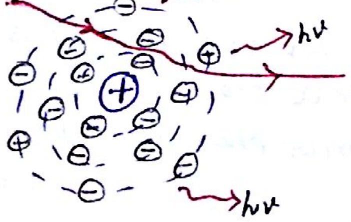


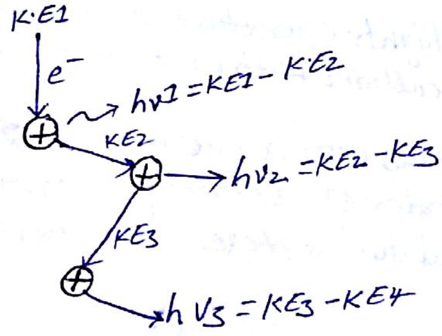
* There was a wavelength, below which no radiation was obtain, this λmin was named as cuttoff wavelength.

* If we observe the graph, then we see there are two type of variation, one is conti & the other is disconti or, in form of peak.

Production (Explanation) of continuous X-ray / White X-ray.

When highly energetic e⁻s passed through an atom with very high K.E, they are strongly deaccelerated in electric field of nucleus & a/c to maxwell electromagnetic theory every decelerating charge particle must radiate electromagnetic radiation & hence photon are emitted.





In successive collision e^- losses some part of its K.E energy & new photon with lost energy is generated.

** If accelerating voltage across coolidge tube is 'V_0'
K.E of e^- just before hitting the target

$$\frac{1}{2} m V_e^2 = eV_0$$ **

$$V_e = \sqrt{\frac{2eV_0}{m}}$$

** Photon with highest energy is librated when an e^- loose all its K.E in a single collision & crossponding to this loss only one photon come out.

$$h\nu_{max} = eV_0 = K.E$$

$$\frac{hc}{\lambda_{min}} = eV_0$$

$$\text{cutoff wave length} = \lambda_{min} = \frac{hc}{eV_0}$$

** other photons will have lesser energy so their wavelength will vary from λ_{min} to ∞.

** $$\Delta K_{Loss} = E_{x\text{-}ray} = \frac{1}{2} m (V_1^2 - V_2^2)$$

$$\lambda_{x\text{-}ray} = \frac{hc}{E_{x\text{-}ray}} = \frac{hc}{\frac{1}{2} m (V_1^2 - V_2^2)}$$

** Range of $V_2 = 0 - \infty$

* $V_2 - V_1 = E_{x\text{-}ray} = 0 \Rightarrow \lambda_{max} = \infty$
* $V_2 = 0 \Rightarrow (E_{x\text{-}ray})_{max} = \frac{1}{2} m V_1^2 = W = e\Delta V$

$$\lambda_{min} = \frac{hc}{(E_{x\text{-}ray})_{max}} = \frac{hc}{\frac{1}{2} m V_1^2} = \frac{hc}{e\Delta V}$$

$$\lambda_{min} = \frac{12400}{\Delta V\,(\text{volt})} \text{Å}$$

NOTE → ** Min wavelength of continuous x-ray only depend on anode potential. It is independent from at. no and nature of target.

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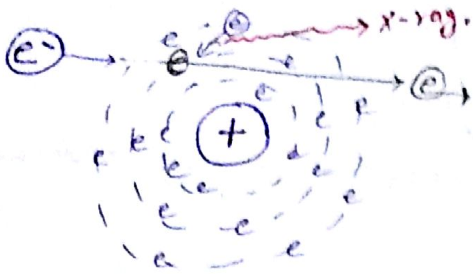
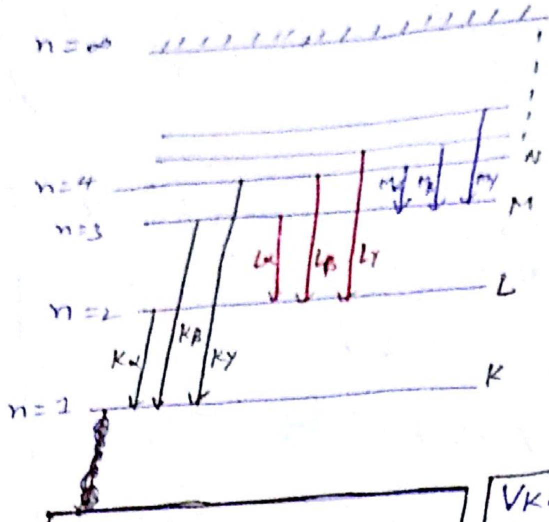
Explanation or, production of chararasteristic x-ray or, Explanation of peaks →

When highly energetic e^- enters into an atom, there is also some possibility that it collides with an e^- of the atom & ~~known~~ knowks out of the shell.

In this way a vacancy is ~~filled~~ created in shell, which is fielled by higher order e's by making transitions to a lower stage, radiation emitted during these transition is known as characteristic x-ray.





$V_{K\alpha} < V_{K\beta} < V_{K\gamma}$

$\lambda_{K\alpha} > \lambda_{\alpha\beta} > V\lambda_{\gamma}$

$V_{K\alpha} > V_{L\alpha} > V_{M\alpha}$

$\lambda_{K\alpha} < \lambda_{L\alpha} < \lambda_{M\alpha}$

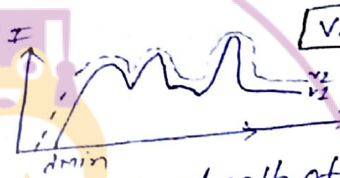
NOTE → Energy (E_K, E_L, E_M, E_N) are not found from Bohr model.

If e^- is knocked out from L-shell.

$L\alpha$, $L\beta$, $L\gamma$

$h\nu_{L\alpha} = E_L - E_M$

$h\nu_{L\beta} = E_L - E_N$



* In a same transition (α, β, γ) Wavelength of K-series is min.

* In a same series (K, L, M) Wavelength of α-transition is max.

* Wavelength of characterstic X-ray doesn't depend on Accelerating voltage, they depend only on target Material.

Moseley's Law →
Square root of frequency ∝ to effective atomic no. of multi e^- system.

$\sqrt{\nu} \propto Z_{eff}$

$\sqrt{\nu} = aZ_{eff}$

$Z_{eff} = Z - b$ (Z ← At. no.)

b or 6 ← Screening const.

**
- $K \Rightarrow b \Rightarrow 1$
- $L \Rightarrow b \Rightarrow 7.2$
- $M = b \Rightarrow 18.2$

Imp ***

Screening const (6) →
He explained screening const. as When an e^- makes a transition from a heigher shell to lower shell, for Eg → K-shell Whose a vacancy is created, then the effective nuclear charge ↓ by a factor '6' known as screening const.

In 'K' shell there is only one e^-, Wich belongs to 's'-orbitals i.e spherically symetry so for K-line, Effective nuclear charge become $Z - 1$

**

* For Kα-line

$$\sqrt{\nu_{K\alpha}} = \sqrt{\frac{3RC}{4}}(Z-1)$$

* For Kβ-line

$$\sqrt{\nu_{K\beta}} = \sqrt{\frac{8RC}{9}}(Z-1)$$

* For Kγ-line

$$\sqrt{\nu_{K\gamma}} = \sqrt{\frac{15RC}{16}}(Z-1)$$

!! ** → By this observation he concluded that property of Material / atom depend on atomic no. not on atomic Mass.

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

NOTE→ 'a' depend on transition & 'b' depend on series but both are independent from at. no. of Element.

$$\sqrt{V} = a(z-b)$$

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

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

$$E = hv = Rch = (z-b)^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

* R = Redeberg const $= 10^7 m^{-1}$
* $\frac{1}{R} = 912 A°$
* 1 Rydberg $= Rch = 13.6\ eV$ ↑ unit of energy

$$E = 13.6(z-b)^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)eV$$

$$V = 2\times10^{15}(z-b)^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

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A→ crystalline solid can cause x-ray to diffract.

R→ Interatomic distance in crystalline solid is of order of 0.1nm.

Ans → A