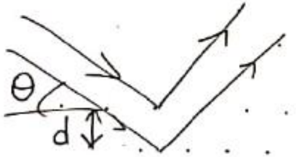
Session-17 – Modern Physics-I

$\omega = 2\pi f$

Recap – x-ray diffraction → There are certain specific glacing angles (θ) for which x-ray diffraction happens for a particular (λ) & (d) of crystallographic plane.



$$2d\sin\theta = n\lambda \;\rightarrow\; d = \frac{n\lambda}{2\sin\theta} \text{ or } \lambda = \frac{2d\sin\theta}{n}$$

- d → fixed
- θ → fixed
- λ → wavelength of light: 1 Å, 2 Å, 3 Å

→ X ray diffraction complements e^-/n diffraction by giving the info about structure of solid.

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Recap — e^- diffraction

X-ray wavelength → 1 Å

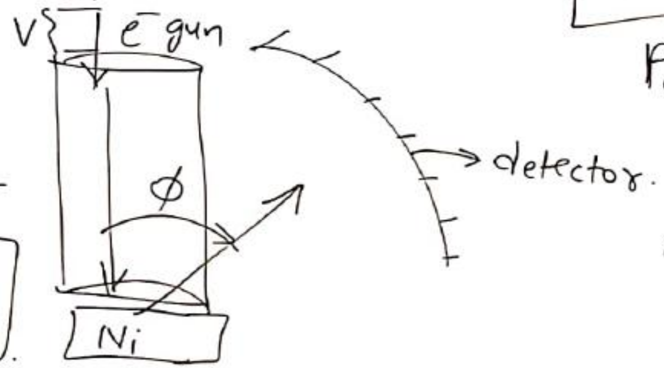
(1-1-1) plane

$e^- \to$ wave

→ λ

→ $\lambda = \frac{h}{p}$

$$\lambda_e = \frac{12.27}{\sqrt{V}} \text{Å}$$



$$\frac{1}{2} m_e v_e^2 = eV = k_e$$

$$\frac{1}{2} m_e^2 v_e^2 = m_e eV$$

$$m_e v_e = \sqrt{2 m_e eV}$$

$$p_e = \sqrt{2 m_e eV}$$

$$= \sqrt{2 m_e k_e}$$

$$\lambda_e = \frac{h}{\sqrt{2 m_e eV}} = \sqrt{\frac{150}{V}} \text{ Å}$$

V → (Volts)

$$\lambda_e = \frac{12.27}{\sqrt{V}} \text{Å}$$

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Recap – e^- diffraction

X-ray wavelength →

from x-ray diff →

(1-1-1) plane

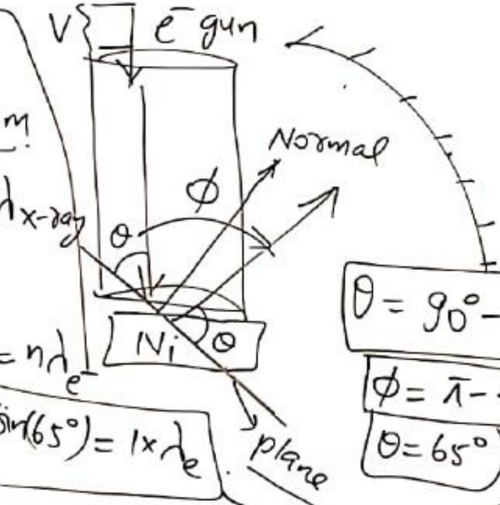
$d = 0.092\,nm$

$2d\sin\theta = n\lambda_{x\text{-}ray}$

$d =$

$2d\sin\theta = n\lambda_e$

$2 \times 0.092 \sin(65^\circ) = 1 \times \lambda_e$



$\theta = 90^\circ - \phi/2$

$\phi = \pi - 2\theta$

$\theta = 65^\circ$

e^- diffraction

$2d\sin\theta = n\lambda$.

As per experimental data, $\delta = \pi - 2\theta$

$V = 54\,V,\ \phi = 50^\circ \Longleftrightarrow \theta = 65^\circ$

$\lambda_{deBroglie} = \frac{12.27}{\sqrt{54}}\,\mathring{A} = 1.67\,\mathring{A}$.

$\lambda_e = 1.65\,\mathring{A}$

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Explanation of Bohr's Quantization Condition

$$\boxed{\Delta x = n\lambda}$$

$$mvr = \frac{nh}{2\pi}$$

$$2\pi r = n\left(\frac{h}{mv}\right)$$

$$\underset{\downarrow\,(\Delta x)}{2\pi r} = n\lambda_{DeBroglie(\bar{e})}$$