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Numericals on Bragg's law:-

Q1. The utilized reflecting plane of Lithium Flouride (LiF) analyzing crystal has a interplanner distance of 2.5 Å. Calculate the wavelength of the 2nd order diffracted line which has a glancing angle of 60°

Sol:- By Bragg's eqn, $n\lambda = 2d\sin\theta$

where $n = 2$

$\lambda = ?$

$d = 2.5 Å = 2.5 \times 0.1\ nm$ [1 Å = 0.1 nm]

$\theta = 60°$

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

$\Rightarrow 2\lambda = 2 \times 2.5 \times \sin 60°$

$\Rightarrow \lambda = \frac{\cancel{2} \times 2.5}{\cancel{2}} \times \frac{\sqrt{3}}{2}$

$= 2.165\ Å$ $\therefore$ Wavelength = 2.165 Å

(*)

Q2. Calculate the angle at which
(a) First order reflection
(b) Second order reflection
will occur in an x-ray spectrometer when x-ray of wavelength 1.54 Å are diffracted by atoms of a crystal, given that the interplanner distance of 4.04 Å

Sol:- By Bragg's eqn, $n\lambda = 2d\sin\theta$

(a) where $n = 1$

$\lambda = 1.54\ Å$

$d = 4.04\ Å$

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

$\Rightarrow (1)(1.54) = 2(4.04)\sin\theta$

$\Rightarrow \sin\theta = \dfrac{1.54}{2\times 4.04}$

$= 0.191$

$\Rightarrow \theta = \sin^{-1}(0.191)$

$= 11^\circ$

(b) where $n = 2$

$\lambda = 1.54\,Å$

$d = 4.04\,Å$

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

$\Rightarrow (2)(1.54) = 2(4.04)\sin\theta$

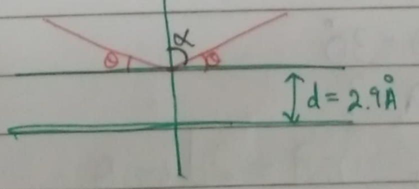
$\Rightarrow \sin\theta = \dfrac{\cancel{2}\times 1.54}{\cancel{2}\times 4.04}$

$= 0.381$

$\Rightarrow \theta = \sin^{-1}(0.381)$

$= 22.4^\circ$

Q3. X-ray of wavelength 1.54 Å are diffracted by a set of atomic plane in a crystal in the following manner.



Find angle (α) for 1st order diffraction

Sol:- Given,

$n = 1$

$\lambda = 1.54\,Å$

$d = 2.9\,Å$

$\theta = ?$

$\alpha = ?$

By Bragg's eqⁿ, $n\lambda = 2d\sin\theta$

$\Rightarrow (1)(1.54) = 2(2.9)\sin\theta$

$\Rightarrow \sin\theta = \frac{1.54}{2\times 2.9}$

$= 0.267$

$\Rightarrow \theta = \sin^{-1}(0.267)$

$= 15.49^\circ$

$\therefore \alpha = 90^\circ - \theta$

$= 90^\circ - 15.49$

$= 74.51$

(*) Q4. For 1st order diffraction by a crystal plane having $d = 2.3\,\mathring{A}$ in a solid observed at the angle of 30°

Using the same radiation, and first order diffraction, $\theta = 60^\circ$ for another solid. Calculate d value for 2nd solid

Sol:- $\because$ Same Radiation is used for 2nd solid,

$\therefore$ Wavelength of X-ray $\rightarrow$ constant

For 1st solid :- $d = 2.3\,\mathring{A}$

$n = 1$

$\theta = 30^\circ$

$\lambda = ?$

By Bragg's eqⁿ, $n\lambda = 2d\sin\theta$

$\Rightarrow (1)\lambda = 2(2.3)\sin 30^\circ$

$\Rightarrow \lambda = 4.6 \times \frac{1}{2}$

$\Rightarrow \lambda = 2.3\,\mathring{A}$

Now,

For 2^{nd} solid: $d = ?$

$n = 1$

$\theta = 60°$

$\lambda = 2.3 \mathring{A}$

By Bragg's eqⁿ; $n\lambda = 2d \sin\theta$

$\Rightarrow (1)(2.3) = 2d \cdot \sin 60°$

$\Rightarrow 2.3 = 2d \frac{\sqrt{3}}{2}$

$\Rightarrow d = \frac{2.3}{\cancel{2}} \times \frac{\cancel{2}}{1.731}$

$= 1.33 \mathring{A}$

$\therefore$ Interplanner distance for 2^{nd} solid $= 1.33 \mathring{A}$