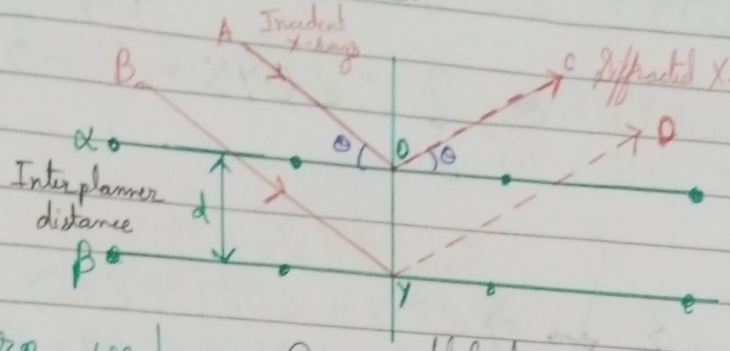
Bragg's Law :-

X-ray diffraction is a technique used for structural determination of any crystalline substance.



Here, we have 2 parallel planes of Crystal structure

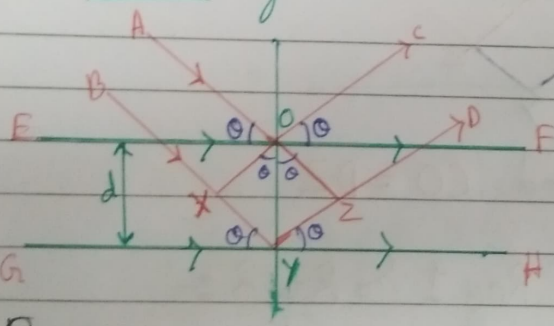
d → Inter planner distance

θ → glance angle of incidence (X-ray)

↳ Angle between Incident ray (X-ray) & surface (Plane of Crystal structure)

Beam of X-Rays falls on the Crystal at glance angle θ, then, some of these rays will be reflected from upper plate at same angle θ

(*)



We have two parallel planes EF & GH (EF ∥ GH)

To find ∠s :-

∠DYH & ∠BYG

The X-rays AO, BY (incident)

OC, YD (reflected)

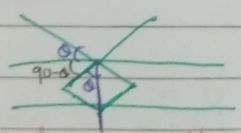
AO ∥ BY and OC ∥ YD

(*)

Extrapolate AO → OZ

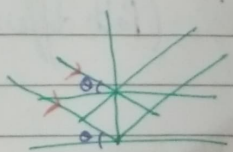
Extrapolate BO → OX

At :-



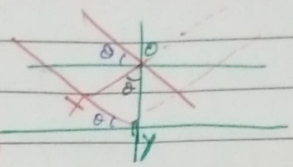
(Considering Reflection of X-rays)

At :-

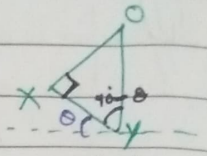


(∵ Same Parallel X-ray incident on 2nd plane)

① Angle Calculation :-

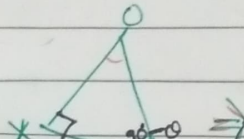


In $\triangle OXY$, $\angle OXY = 90^\circ$



Here, $\angle XYG_1 = \theta$
$\angle OYG_1 = 90^\circ$
$\Big\} \therefore \angle OYX = 90^\circ - \theta$

Again,



Sum of All $\angle$s = 180°

$\Rightarrow \angle OYX + \angle OXY + \angle XOY = 180^\circ$

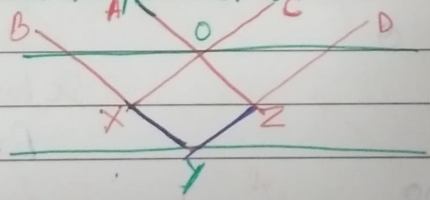
$\Rightarrow 90^\circ - \theta + 90^\circ + \angle XOY = 180^\circ$

$\Rightarrow \angle XOY = \theta$

② Path Calculation :-

Here, Path travelled by Ray $AO \rightarrow OC$ is less than Path travelled by Ray $BY \rightarrow YD$

$\because OC$ is extrapolated to OX
OA is extrapolated to OZ



$\therefore AB = BX$ and $CO = DZ$

Path difference bet^n Ray 1 & Ray 2 :-

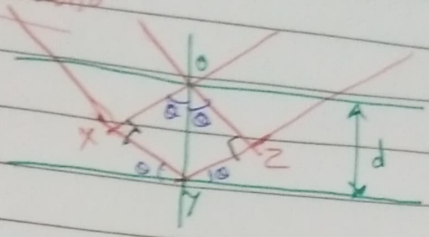
Path travelled (extra) = $XY + YZ$ (Path difference)

Now,

Path difference :- Integral Multiple of Wavelength

$\therefore$ Path difference $= n\lambda = XY + YZ$

③ Integral Calculation:-



$\triangle OXY \cong \triangle OZY$ [These two $\triangle$(s) are congruent]

$\therefore XY = YZ$

In $\triangle OXY$,

$$\sin\theta = \frac{p}{h} = \frac{XY}{OY}$$

$$\Rightarrow \sin\theta = \frac{XY}{d}$$

$$\Rightarrow XY = YZ = d\sin\theta$$

We know, Path difference → integral multiple of wavelength

$\therefore n\lambda = XY + YZ$

$\Rightarrow n\lambda = d\sin\theta + d\sin\theta$

$\Rightarrow \boxed{n\lambda = 2d\sin\theta}$ → Bragg's equation

where :- $n \rightarrow$ order of diffraction
$\lambda \rightarrow$ wavelength of X-ray
$\theta \rightarrow$ glance angle of X-Ray incidence
$d \rightarrow$ distance between parallel planes of crystal

∴ Bragg's equation gives us relationship between :-

1. Wavelength of X-ray (λ)
2. Interplane distance in crystal (d)
3. Glance angle (θ)