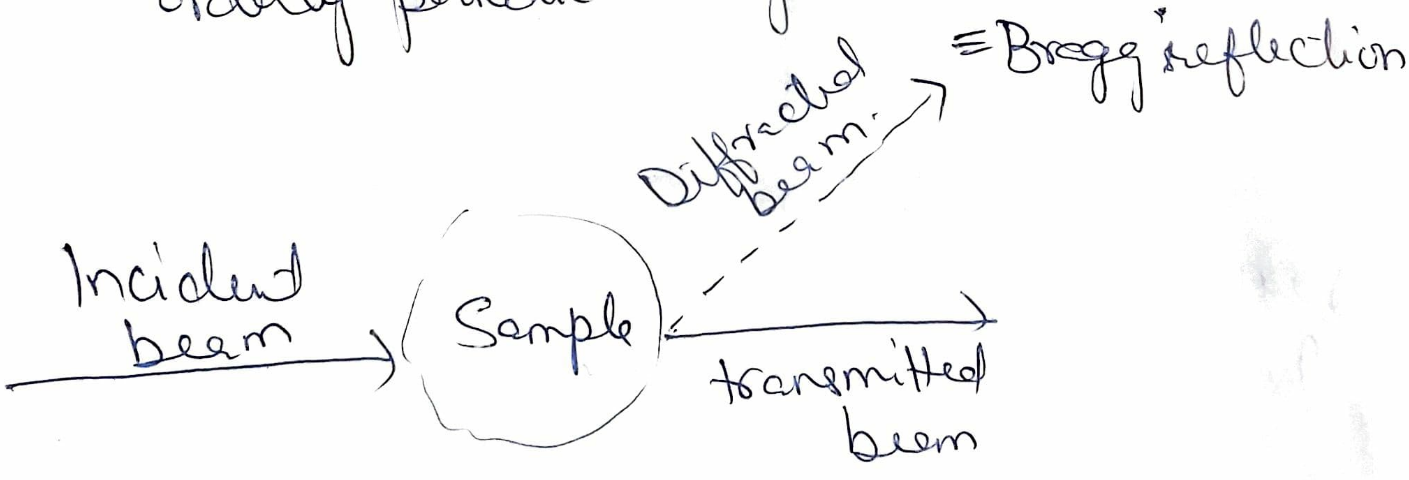
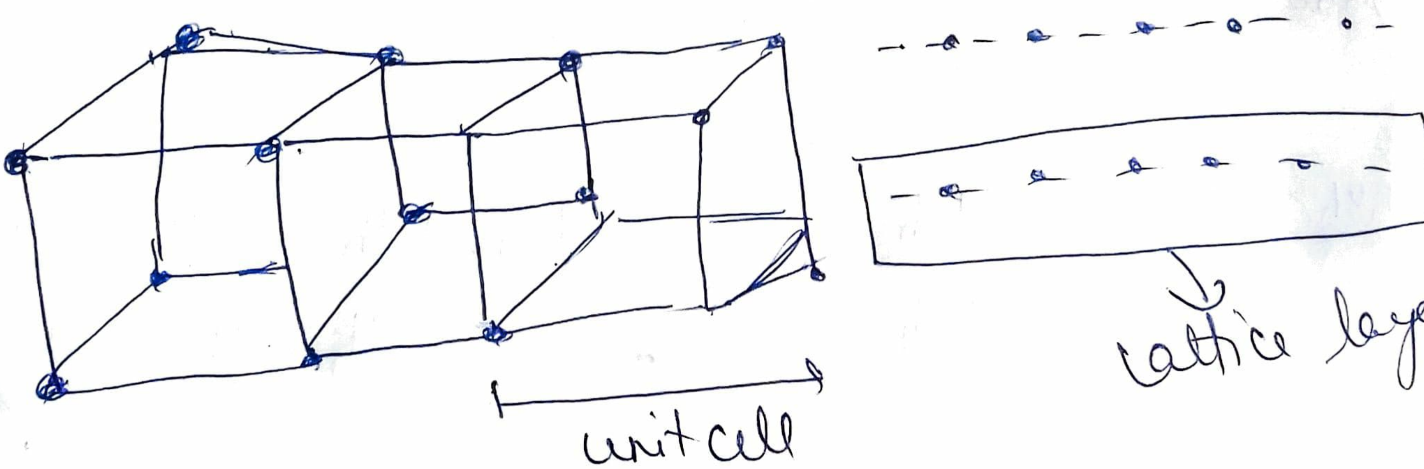
X-ray diffraction

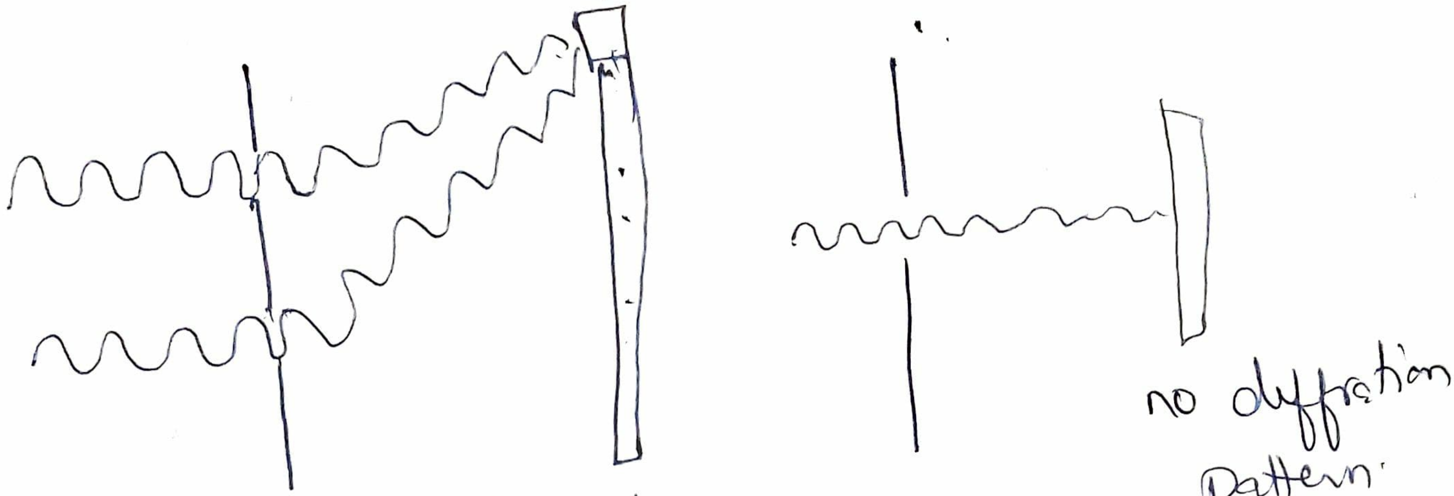
→ X-rays

→ Diffraction → rays are diffracted
↓
when there will be any obstacle.
→ atoms
↓
arranged in lattice plane.

→ Solid
↓
Crystal
↓
atoms are arranged in orderly periodic arrangement





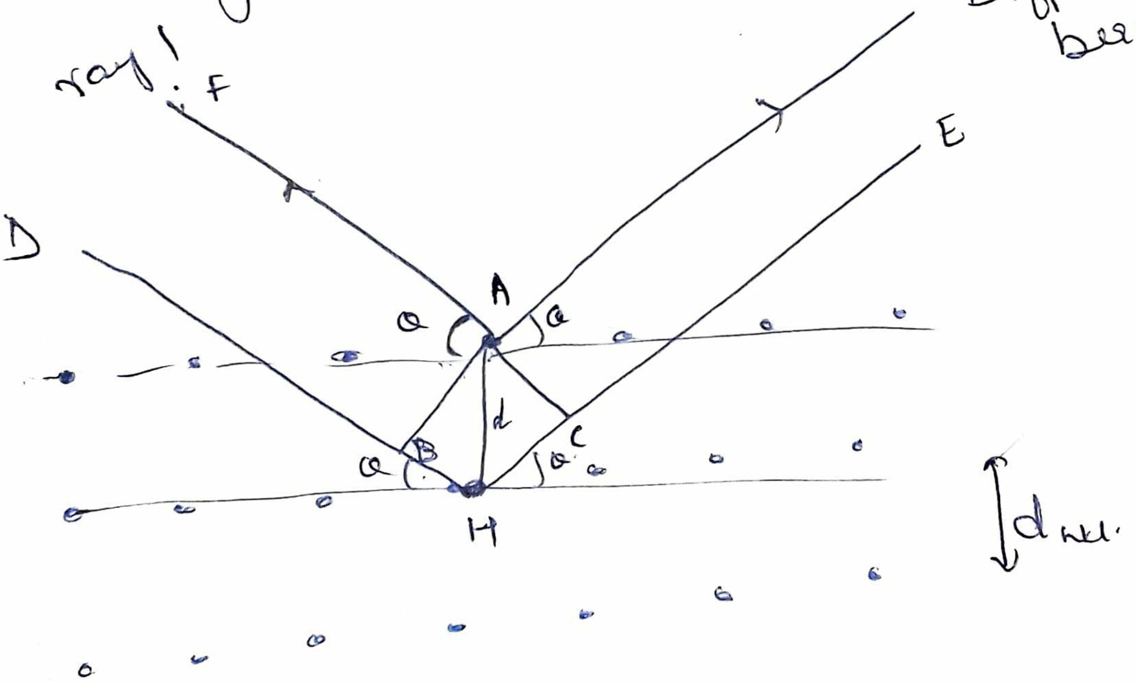


diffraction pattern observed

no diffraction pattern

Visible ligit → 10^{-6} m. λ

X-ray → 10^{-10} m λ → no pattern

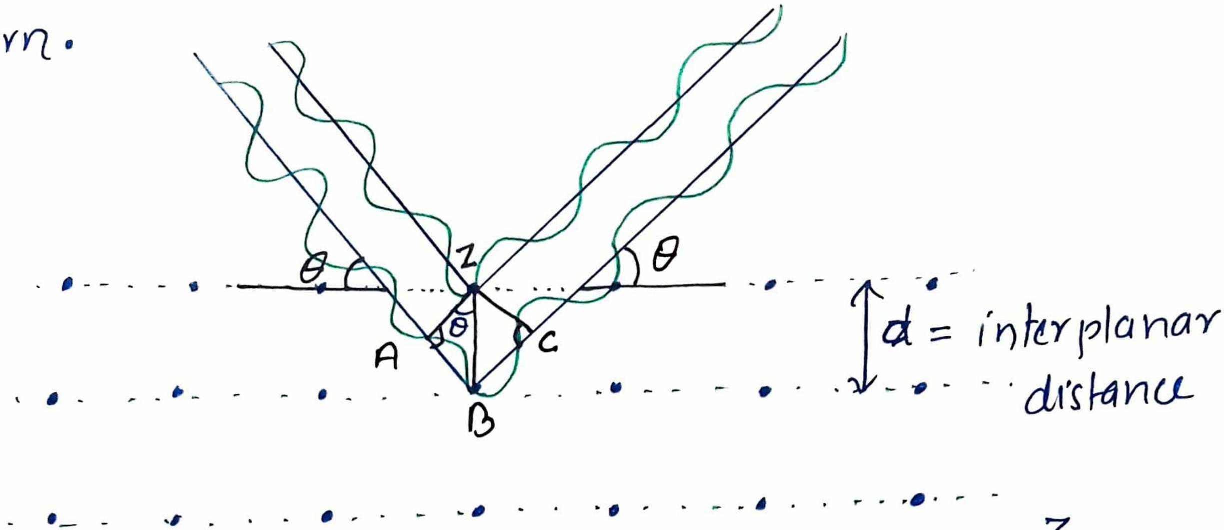


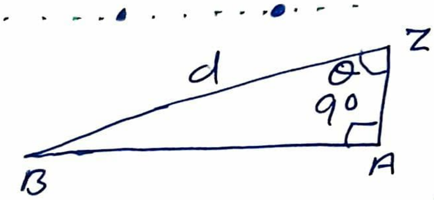
Bragg's eq → Path difference = $n\lambda$

↓

constructive interference. θ = Glancing angle

produces constructive interference ...
pattern.





θ = Angle of incidence
d = BZ interplanar distance
AZ & CZ are perpendicular on AB and AC respectively
λ = wavelength of X-ray.

- AB + BC distance wil be travelled by whole number multiple of wavelength λ.

$$n\lambda = AB + BC$$

$$n\lambda = 2AB \quad \text{—(I)} \quad (\text{Since } AB = BC)$$

From triangle ABZ; $\sin\theta = \frac{AB}{BZ} = \frac{AB}{d}$

$$AB = d\sin\theta \quad \text{—(II)}$$

From equation (I) & (II)

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

$n = 1, 2, 3, 4,$ etc.

- Constructive interference of wave 1 & 2 occurs only when, there path difference is n (whole no.) multiple of the wave length occurs.

Miller Indices

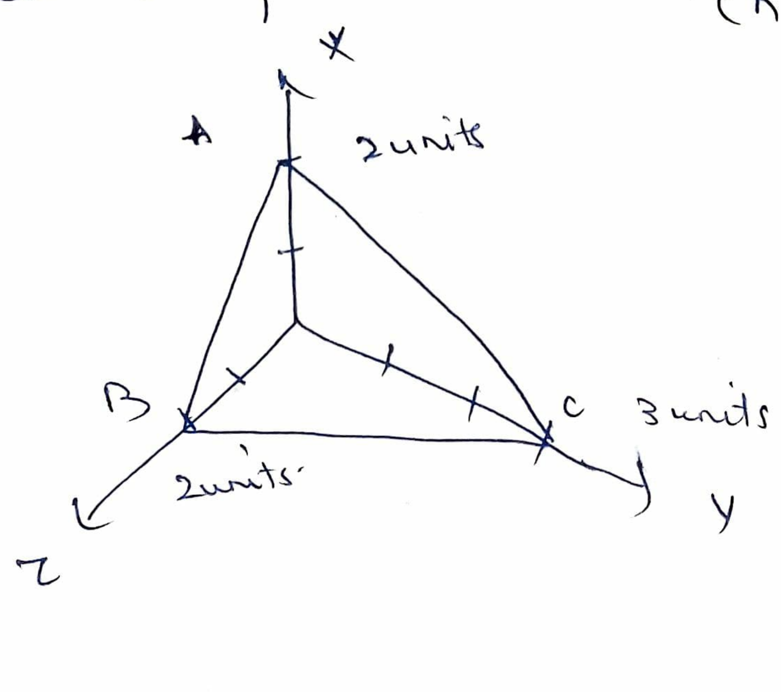
Indication of crystal planes
specify direction & planes

(h k l) → plane at x, y, z axis

reciprocals of the intercepts made by the plane.

Steps

1. Intercepts along x, y, z → a, b & c lattice constant
2. Reciprocal
3. LCM & multiply each
4. Result in parenthesis → miller indices (h k l)



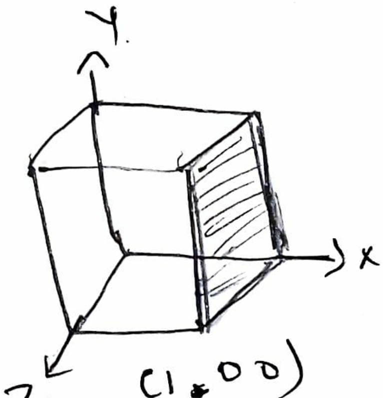
M. Indices

	Intercept	Reciprocal		M.I
x axis	2	1/2	$\frac{6}{2}$	3
y axis	3	1/3	$\frac{6}{3}$	2
z axis	2	1/2	6/2	3

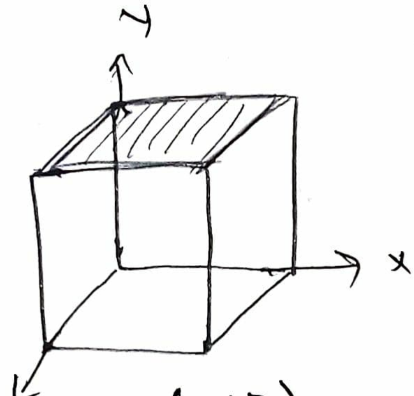
Miller Indices for plane ABC is (3 2 3)

Imp pt. ① → plane ∥ to any coordinate
↓
intercept ∞
↓
M.I = 0 for that axis

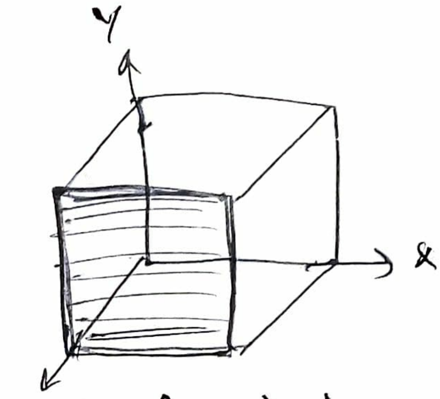
② plane cut on -ve side of the origin
↓
M. Index will be -ve
↓
$(\bar{1}00)$



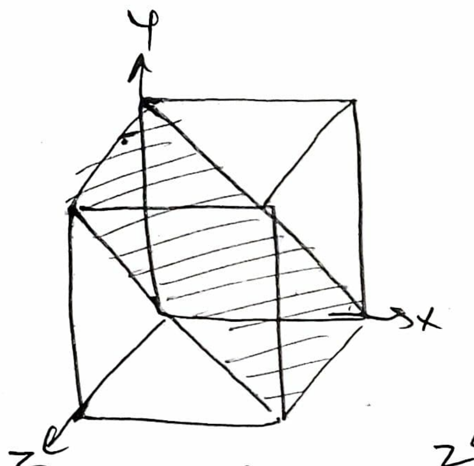
(1 0 0) plane



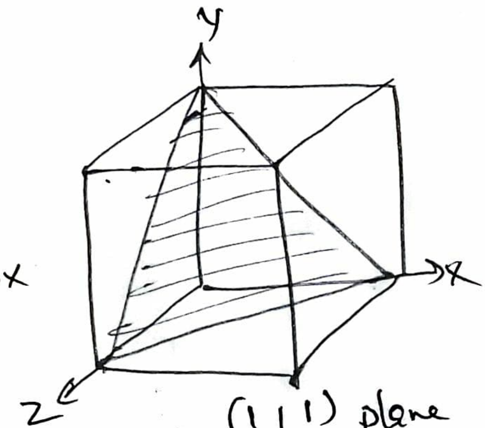
(0 1 0) plane



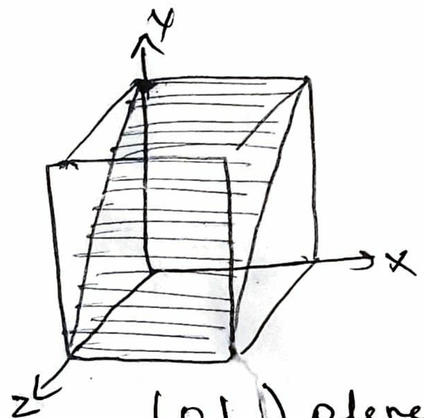
(0 0 1) plane



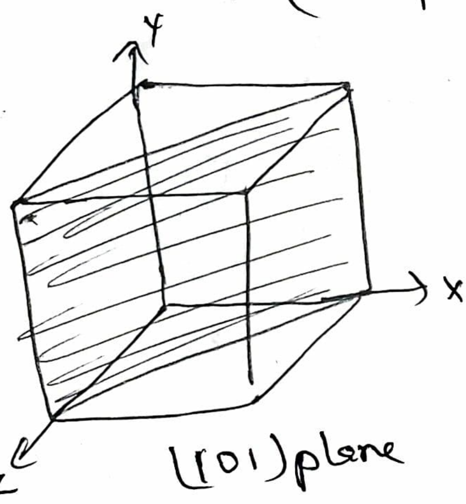
(1 1 0) plane



(1 1 1) plane



(0 1 1) plane



(1 0 1) plane

Example Calculate miller indices for the plane intersecting at $x = \frac{1}{4}$, $y = 1$, $z = 1/2$

∴

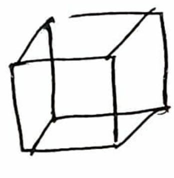
	Intercept	Reciprocal
x	$1/4$	4
y	-1	-1
z	$1/2$	2

∴ Miller Indicies $(4\bar{1}2)$

Interplanar Spacing (d_{hkl}): is the sep^n b/w sets of parallel planes formed by the individual cells in a lattice structure, depends on the radii of the atoms forming the structure as well as on the shape of the structure.

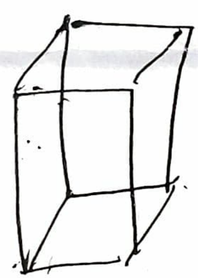
Interplanar spacing, d for a cubic structure of lattice parameter a, is given by:

$$d_{hkl} = \frac{a}{\sqrt{h^2+k^2+l^2}}$$



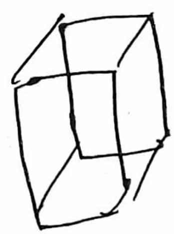
a = b = c
$\alpha = \beta = \gamma = 90°$
Cubic

$$d_{hkl} = \frac{a}{\sqrt{h^2+k^2}} + \frac{c}{\sqrt{l^2}}$$



a = b ≠ c
$\alpha = \beta = \gamma = 90$
tetragonal

$$d_{hkl} = \frac{a}{\sqrt{h^2}} + \frac{b}{\sqrt{k^2}} + \frac{c}{\sqrt{l^2}}$$



a ≠ b ≠ c
$\alpha = \beta = \gamma = 90°$
orthorhombic