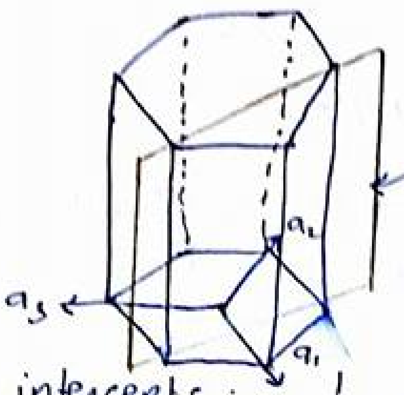
INDIAN INSTITUTE OF TECHNOLOGY

DATE | JOSHI NIKHIL VINAYAK
14ME30020 MT30001 | SHEET NO.

ASSIGNMENT 1

1) a) $(2\bar{1}\bar{1}0)$



finding the intercepts : $\frac{1}{2}$, -1, -1, ∞

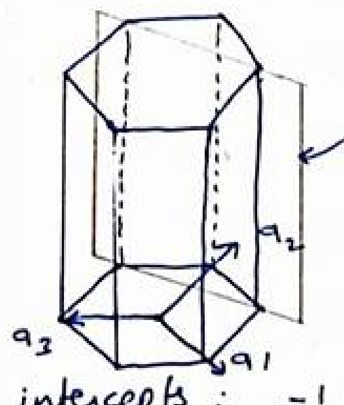
Normal to the plane : $\frac{1}{2}$, 0, 0

Miller index of Normal : [1 0 0]

for, MB Index : $\frac{2}{3}$, $\frac{1}{3}\times(0-1)$, $-\frac{1}{3}$, 0

$\therefore$ MB Index : $[2\bar{1}\bar{1}0]$ ...(for Normal direction)

b) $(\bar{1}2\bar{1}0)$



finding the intercepts : -1 $\frac{1}{2}$ -1 ∞

Normal to the plane : 0, $\frac{1}{2}$, 0

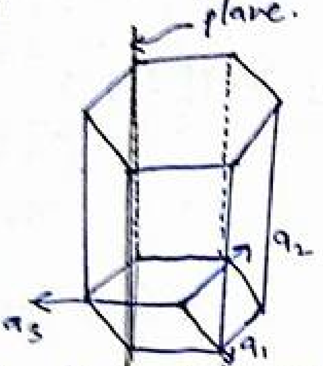
Miller index of Normal : [0 1 0]

for, MB Index : $-\frac{1}{3}$, $\frac{2}{3}$, $-\frac{1}{3}$, 0

$\therefore$ MB index : $[\bar{1}2\bar{1}0]$ ...(for Normal direction)

P.R.

c) $(\bar{1}\bar{1}20)$



finding the intercepts of plane: ~~$\frac{1}{2}, -\frac{1}{2}$~~ $-1, -1, \frac{1}{2}, \infty$

Normal to the plane : $-\frac{1}{2}, -\frac{1}{2}, 0$

Miller index of Normal: $[\bar{1}\bar{1}0]$

for, MB Index of Normal: $-\frac{1}{3}, -\frac{1}{3}, \frac{2}{3}, 0$

$\therefore$ MB Index : $[\bar{1}\bar{1}20]$

2) First 6 XRD peaks:

i) SC : 100 , 110 , 111 , 200, 210 , 211

ii) FCC: 111 , 200 , 220 , 311 , 222 , 400

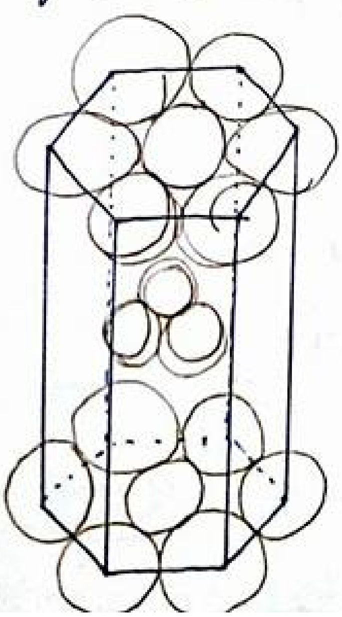
iii) BCC: 110 , 200 , 211 , 220 , 310, 222

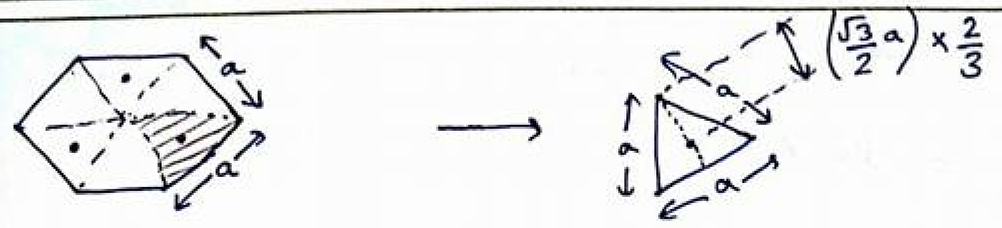
3) Interplanar spacing between planes (111) $= \frac{a}{\sqrt{1^2+1^2+1^2}} = \frac{a}{\sqrt{3}}$

Interplanar spacing between plane $(221) = \frac{a}{\sqrt{4+4+1}} = \frac{a}{3}$

Ratio of interplanar spacings $= \frac{(a/\sqrt{3})}{(a/3)} = \underline{\underline{\sqrt{3}}}$.

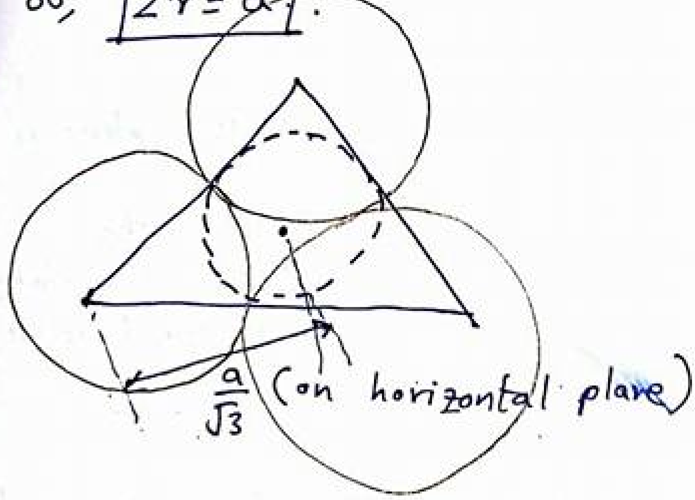
4)





All atom on the base plane touch each other.

So, $\boxed{2r = a}$.



○ : On the plane of triangle/paper.

◌ : Above 3 atoms, ~~[illegible]~~ forming tetrahydral void.

So, by pythagoras theorem,

$$a^2 = \left(\frac{a}{\sqrt{3}}\right)^2 + \left(\frac{c}{2}\right)^2$$

$$c = \frac{2\sqrt{6}}{3}a = \sqrt{\frac{2}{3}} \times (2a) = 1.633a.$$

5) Angle between planes is equal to angle between Normal to the planes.

So,
$$\cos\theta = \frac{2}{2 \times \sqrt{1^2+1^2+1^2}} = \frac{1}{\sqrt{3}}$$

Angle between planes $\theta = \cos^{-1}\left(\frac{1}{\sqrt{3}}\right)$.

6) $N_v = N e^{-\left(\frac{\theta_v}{kT}\right)}$

$$N_{v1} = N e^{-\left(\frac{\theta_v}{k800}\right)}$$

$$N_{v2} = N e^{\left(-\frac{\theta_v}{k1000}\right)}$$

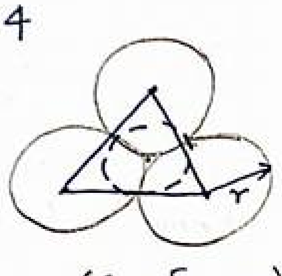
$$N e^{-\frac{\theta_v}{k1000}} = 6 N e^{-\frac{\theta_v}{k800}} \qquad \ldots (N_{v2} = 6 N_{v1})$$

$$\therefore e^{-\frac{\theta_v}{k}\left(\frac{1}{1000} - \frac{1}{800}\right)} = 6$$

$$\therefore \frac{\theta_v}{4000k} = \ln 6$$

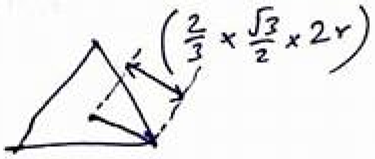
$$\therefore \theta_v = 9.89 \times 10^{-20}\ J = \underline{\underline{0.6176\ eV}}$$

) CN: 4



○ : In the plane of paper.

◌ : Above the 3 atoms forming a ~~octahydre~~ tetrahyderal void.

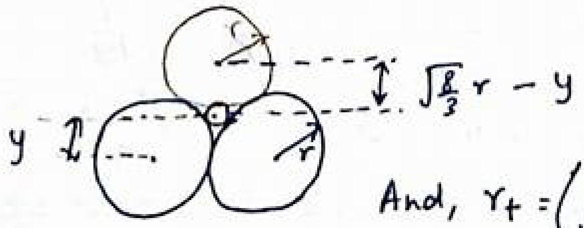


Now, distance between the base plane containing the centers of 3 atoms and the center of above atom

$$= \sqrt{4 - \frac{4}{3}}\ r = \sqrt{\frac{8}{3}}\ r. \quad \ldots \text{(calculation similar to the one done in Q-4)}$$

Now, let the cation atom in the tetrahyderal void be at a distance y from the base plane.

∴ Using pythagoras theorem,



And, $r_+ = \left(\sqrt{\frac{8}{3}}r - y\right) - r$

INDIAN INSTITUTE OF TECHNOLOGY

DATE SHEET NO.

$$y^2 + \frac{4r^2}{3} = \left(\sqrt{\frac{8}{3}}\, r - y\right)^2$$

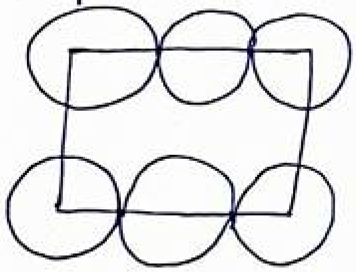
$$\therefore \cancel{y^2} + \frac{4r^2}{3} = \frac{8}{3}r^2 + \cancel{y^2} - \frac{2\sqrt{8}}{\sqrt{3}}\, ry$$

$$\boxed{y = \frac{r}{\sqrt{6}}}$$

$$\therefore\ r_+ = \left(\sqrt{\frac{8}{3}}\, r - \frac{r}{\sqrt{6}} - r\right) = \underline{\underline{0.225}}\ r$$

$\therefore$ Radius Ratio = ~~0.225~~ 0.225.

8) (110) plane in FCC.



Number of atoms in plane

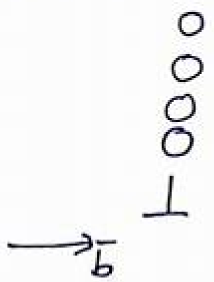
$$= \frac{1}{2} \times 2 + \frac{1}{4} \times 4 = \underline{\underline{2}}$$

Area of plane = $\underline{\underline{\sqrt{2}\, a^2}}$

$$\text{planar density} = \frac{2}{\sqrt{2}\, a^2} = \underline{\underline{\frac{\sqrt{2}}{a^2}}}$$

9)

10) Edge dislocation:



~~Berge~~ Burger's vector is perpendicular to dislocation line in edge dislocation. (90° angle)

Screw dislocation:

Berger's vector along the dislocation line in screw dislocation. (0° angle).