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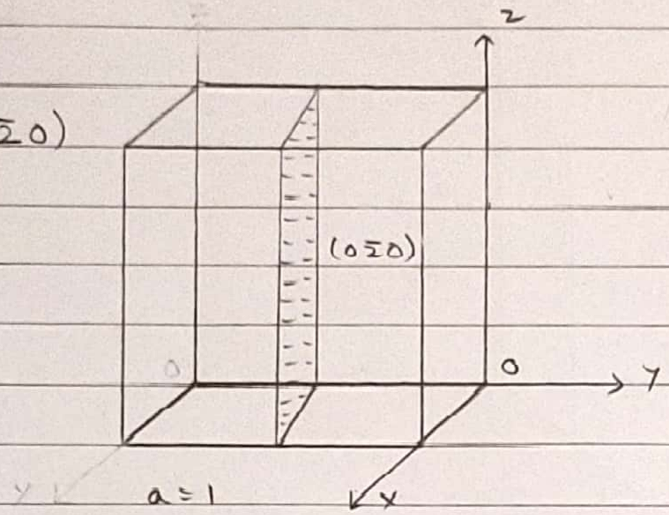
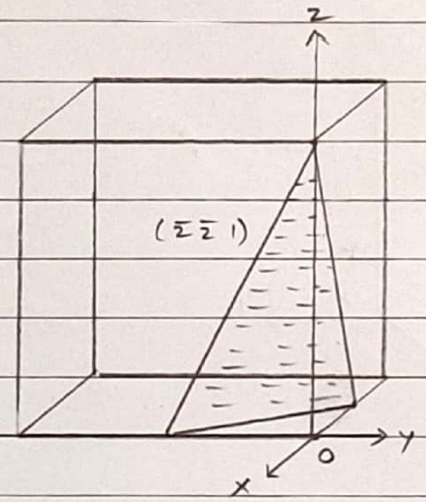
Engineering Physics

Tutorial - 1

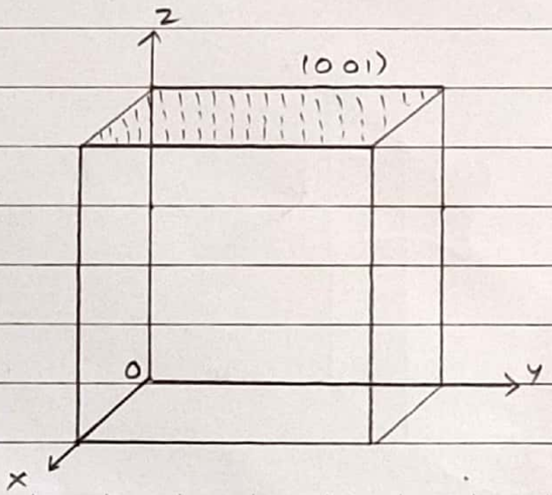
2.) $(0\bar{2}0)$



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



(001)



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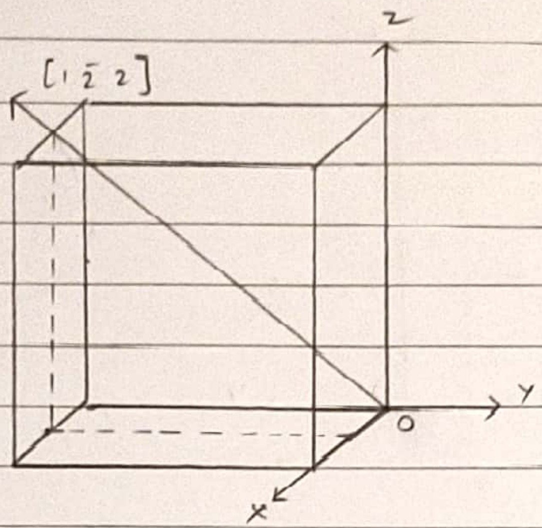
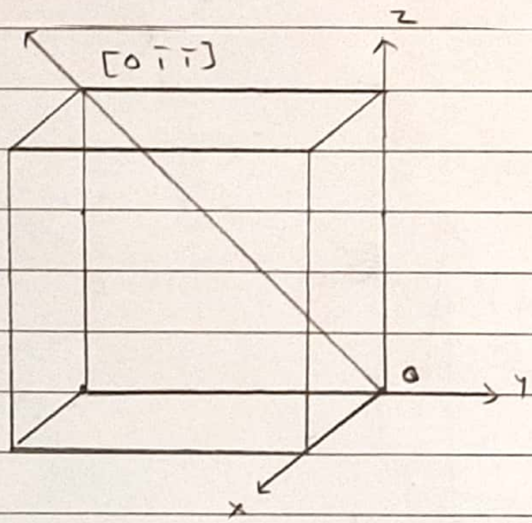
$[1\,\bar{2}\,2]$

$a = 2$



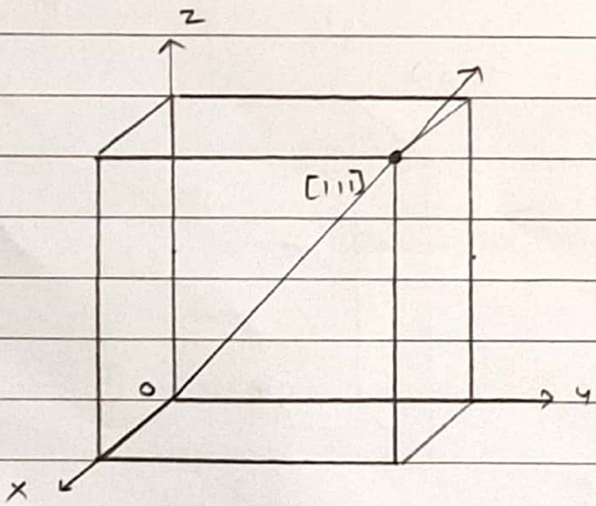
$[0\,\bar{1}\,1]$

$a = 1$



$[1\,1\,1]$

$a = 1$



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3) Given, a, b and c are primitive vectors.

Intercepts are 2a, 3b, 6c.

∴ Miller Indices : $\frac{a}{2a} : \frac{b}{3b} : \frac{c}{6c}$

$= \frac{1}{2} : \frac{1}{3} : \frac{1}{6}$

$= 3 : 2 : 1$

∴ Miller indices = (3 2 1)

4) ∴ Given : $d = 0.58 \mathring{A}$

Miller indices : (132)

$n = 2$

$a = 3.81 \mathring{A}$

To find : Glancing angle.

Sol :

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

$$d = \frac{3.81 \times 10^{-10}}{\sqrt{1+9+4}} = \frac{3.81 \times 10^{-10}}{\sqrt{14}} = 1.02 \times 10^{-10} \rightarrow 1.02 \mathring{A}$$

∴ By Bragg's law,

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

$$\cancel{2} \times 0.58 \times \cancel{10^{-10}} = \cancel{2} \times 1.02 \times \cancel{10^{-10}} \sin\theta$$

$$\frac{0.58}{1.02} = \sin\theta$$

$$\therefore \theta = \sin^{-1}\left(\frac{0.58}{1.02}\right) = \sin^{-1}(0.57) = 34.75^{\circ}$$

5) Taking $a=1$.

a) Intercepts are $1, -1, -1$

$\therefore$ Taking reciprocal: $\frac{1}{1} : \frac{-1}{1} : -1$

$\therefore$ Miller indices: ~~$(1, \bar{1}, \bar{1})$~~ $(1 \bar{1} \bar{1})$

b) Intercepts are $\left(\frac{1}{2}, -\frac{1}{2}, -1\right)$

$\therefore$ Taking reciprocal: $2, -2, -1$

$\therefore$ Miller indices: $(2 \bar{2} \bar{1})$

6) At $n=1$, $\theta_1 = 3.4^\circ$

At $n_2 = 2$, $\theta_2 = ?$

~~Sol: for n=1,~~

~~$n\lambda = 2d\sin\theta_1$~~

~~$1\lambda = 2d\sin(3.4)$~~

~~$\lambda = 2d$~~

Sol: By Bragg's law

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

$\therefore$ For $n=1$, $n_1\lambda = 2d\sin\theta_1$

$n=2$, $n_2\lambda = 2d\sin\theta_2$

$$\therefore \frac{n_1 \cancel{\lambda}}{n_2 \cancel{\lambda}} = \frac{\cancel{2d}\sin\theta_1}{\cancel{2d}\sin\theta_2}$$

$$\frac{n_1}{n_2} = \frac{\sin\theta_1}{\sin\theta_2}$$

$$\frac{1}{2} = \frac{\sin(3.4)}{\sin\theta_2}$$

$\therefore \sin\theta_2 = 2 \times \sin(3.4) = 2 \times 0.06 = 0.12$

$\therefore \theta_2 = \sin^{-1}(0.12)$

$\therefore \theta_2 = 6.8^\circ$

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7) $d = 2.7$ gm/cc

Packing fraction $= 0.74$

$\therefore$ It is FCC lattice.

$n = 4$

$a = 2.86\,\mathring{A} = 2.86 \times 10^{-8}$ cm

$\therefore$ To find: Atomic weight = ?

Sol:

$$a = \left(\frac{nM}{Na \times d}\right)^{1/3}$$

$$\therefore a^3 = \frac{nM}{Na \times d}$$

$$\therefore (2.86 \times 10^{-8})^3 = \frac{4 \times M}{6.023 \times 10^{23} \times 2.7}$$

$$\therefore M = \frac{(2.86)^3 \times 10^{-24} \times 6.023 \times 10^{23}}{4} \times 2.7$$

$$\therefore M = \frac{380.43 \times 10^{-1}}{4} = \frac{380.43}{40}$$

$$\therefore M = 9.51$$

8) Given a, b, c are primitive vectors.

$\therefore$ Intercepts are $3a : 4b : \infty$

$$\therefore \text{Reciprocals: } \frac{a}{3a} : \frac{b}{4b} : \frac{c}{\infty}$$

$$= \frac{1}{3} : \frac{1}{4} : \frac{1}{\infty} = 4 : 3 : 0$$

$\therefore$ Miller indices: $(4\,3\,0)$

9) $r = 1.746\ \mathring{A}$

For FCC,

$$a = 2\sqrt{2}\ r$$

$$\therefore a = 2\sqrt{2} \times 1.746$$

$$a = 4.938\ \mathring{A}$$

For (111) plane,

$$d_{(111)} = \frac{a}{\sqrt{1^2+1^2+1^2}} = \frac{4.938}{\sqrt{3}} = 2.851\ \mathring{A}$$

For (200) plane

$$d_{200} = \frac{a}{\sqrt{2^2+0+0}} = \frac{4.938}{2} = 2.47^{\circ}$$

10) $d = 9.6 \times 10^2\ kg/m^3$

$a = 4.3\ \mathring{A}$

$M = 23.$

Sol: $a = \left(\frac{NM}{N_0 \times d}\right)^{1/3}$

$$\therefore n = \frac{N_a \times d \times a^3}{M}$$

$$\therefore n = \frac{6.023 \times 10^{23} \times 9.6 \times 10^2 \times (4.3 \times 10^{-10})^3}{23}$$

$$n = 1.99 \approx 2$$

$\therefore$ Given crystal is of BCC structure.

11) Miller indices (3 2 6)

lattice constant, $a = 1.5\,\mathring{A}$, $b = 2\,\mathring{A}$, $c = 4\,\mathring{A}$

$\therefore$ Intercepts are : $\frac{a}{3}, \frac{b}{2}, \frac{c}{6}$

$\therefore \frac{1.5}{3}, \frac{2}{2}, \frac{4}{6}$

Taking common ratio,

x - intercept = $1.5\,\mathring{A}$

y - intercept = $\frac{2 \times 3}{2} = 3\,\mathring{A}$

z - intercept = $\frac{4 \times 3}{6} = 2\,\mathring{A}$

$\therefore$ y-intercept = $3\,\mathring{A}$, z-intercept = $2\,\mathring{A}$

12) $d = 6250\ kg/m^3$

$M = 60.2$

for FCC, $n = 4$

$$a = \left(\frac{n \times M}{N_a \times d}\right)^{1/3}$$

$$a = \left(\frac{4 \times (60.2) \times 10^{-3}}{6250 \times 6.023 \times 10^{23}}\right)^{1/3}$$

$$a = (6.39 \times 10^{-29})^{1/3}$$

$$a = 4 \times 10^{-10}\ m$$

$$a = 4\,\mathring{A}$$