TOPIC – IX PROBLEMS DISCUSSION

SNS COLLEGE OF ENGINEERING

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AN AUTONOMOUS INSTITUTION

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UNIT -IV CRYSTAL PHYSICS

PROBLEMS

1. **A crystal plane cut at 3a, 4b and 2c distances along the crystallographic axes. Find the Miller Indices of the plane.**

   Given data:

   Intercepts = 3a: 4b: 2c

   Solution

   Step (i) : Co-efficient of intercepts = 3:4:2

   Step (ii) : Reciprocal of intercepts $= \frac{1}{3}:\frac{1}{4}:\frac{1}{2}$

   Step (iii) : LCM $= 12$

   Step (iv) : Multiplying by LCM with the reciprocals

   $$= 12 \times \frac{1}{3}: 12 \times \frac{1}{4}: 12 \times \frac{1}{2}$$

   We have 4 3 6

   ∴ Miller Indices = (4 3 6)

2. **Calculate the value of d-spacing for (100) planes in a rock salt crystal of a = 2.814 Å.**

   Given data:

   a = 2.814 Å, h = 1, k = 0, l = 0

   Solution:

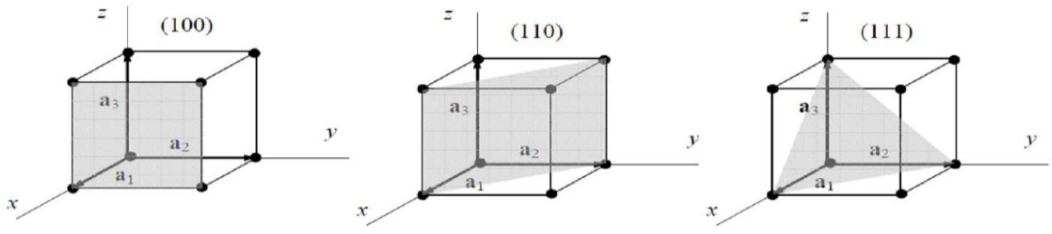
   $$d = \frac{a}{\sqrt{h^2+k^2+l^2}}$$

   $$d = \frac{2.814 \times 10^{-10}}{\sqrt{(1^2+0^2+0^2)}}$$

   d = 2.814 Å

3. **Draw the following planes in a cubic structure.**

   (100), (110) and (111)



4. **The interplanar spacing is 1.3 Å. The first order of Bragg's reflection is located at 23^0. Calculate the wavelength of X-ray.**

Given data:

$d = 1.3$ Å

$\theta = 23^0$

$n = 1$

$\lambda = ?$

Solution:

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

$$\lambda = \frac{2d\sin\theta}{n}$$

$$\lambda = \frac{2 \times 1.3 \times 10^{-10} \times \sin 23^0}{1}$$

$$\lambda = 1.015 \times 10^{-10} m$$

(or)

$\lambda = 1.015$ Å

5. **Sodium is a BCC crystal. Its density is 9.6×10^2 Kg/m^3 and atomic weight is 23. Calculate the lattice constant for sodium crystal.**

Given data:

Atomic weight (A) = 23

Density (ρ) = 9.6×10^2 Kg/m^3

For BCC, (n) = 2

Lattice constant (a) = ?

Avagadro Number (N) = 6.023×10^{26}

Solution:

$$a^3 = \frac{nA}{N\rho}$$

$$a^3 = \frac{2 \times 23}{6.023 \times 10^{26} \times 9.6 \times 10^2}$$

$$a^3 = (7.955 \times 10^{-30})$$

$$a = \sqrt[3]{(7.955 \times 10^{-30})}$$

a = 1.996 Å

6. **A crystal of BCC structure has atomic radius 1.2 Å. Find the volume of its unit cell.**

Given data:

Radius (r) = 1.2×10^{-10}m

Solution:

Lattice constant of BCC structure, $a = \frac{4r}{\sqrt{3}}$

$$a = \frac{4 \times 1.2 \times 10^{-10}}{\sqrt{3}}$$

$$a = 2.771 \times 10^{-10}\text{m}$$

Volume of the cell, $a^3 = (2.771 \times 10^{-10})^3\ \text{m}^3$

$$\mathbf{a^3 = 2.128 \times 10^{-29} m^3}$$

7. **Copper has FCC structure and its lattice parameter is 3.6 Å. Find the atomic radius.**

Given data:

Lattice parameter of copper (a) = 3.6 Å

Solution:

Atomic radius of copper, $r = \frac{a\sqrt{2}}{4}$

$$r = \frac{3.6 \times 10^{-10} \times \sqrt{2}}{4}\ \text{m}$$

$$r = 1.273 \times 10^{-10}\text{m}$$

$$\mathbf{r = 1.273\ Å}$$

8. **Magnesium has HCP structure. The radius of magnesium atom is 0.1605 nm.**

Calculate the volume of the unit cell of magnesium.

Given data:

Radius of magnesium, r = 0.1605 nm

Solution:

For HCP, the lattice constant, a = 2r

$$a = 2 \times 0.1605 \times 10^{-9}\ \text{m}$$

$$a = 0.321 \times 10^{-9}\ \text{m}$$

Also, $c/a = \sqrt{(8/3)}$

$$c = 0.321 \times 10^{-9}\ \sqrt{(8/3)}$$

$$c = 0.5242 \times 10^{-9}\ \text{m}$$

Volume of unit cell, $V = \frac{3\sqrt{3}\, a^2 c}{2}$

$$V = \frac{3\sqrt{3}\,(0.321 \times 10^{-9})^2 (0.5242 \times 10^{-9})}{2}$$

$$\mathbf{V = 1.409 \times 10^{-28}\ m^3}$$