

Engineering physics – I

2Mark questions with Answers

UNIT – V

CRYSTAL PHYSICS

1. What is a unit cell?

It is the smallest volume of a solid from which the entire crystal structure can be constructed by repetition in three-dimension.

2. What is primitive cell?

A primitive cell is the simplest type of unit cell which contains only one lattice point per unit cell.

3. Define coordination number?

It is the number of nearest neighbouring atoms that an atom has in the given crystal structure.

4. Name the seven-crystal system?

- i. Cubic
- ii. hexagonal
- iii. Tetragonal
- iv. Triclinic
- v. Monoclinic
- vi. Orthorhombic
- vii. Rhombohedral

5. What are Bravais lattices?

There are only 14 ways of arranging points in 3-dimensional space such that the environment looks same from each point i.e., there are 14 possible types of space lattices out of the seven crystal systems. These 14 space lattices are called Bravais lattices.

6. Give the coordination numbers for SC, BCC, FCC, HCP and Diamond

Type of Structure	Coordination number
Simple Cubic (SC)	6
Body Centred Cubic (BCC)	8
Face Centred Cubic (FCC)	12
Hexagonal Close Packed (HCP)	12
Diamond	4

7. Define atomic radius.

The half of the distance between nearest neighbouring atoms in a crystal is known as atomic radius. The atomic radius is denoted by 'r' and it is usually expressed in terms of the cube edge 'a' (lattice parameter)

8. Define packing factor. What is its unit?

It is the ratio of volume of atoms in unit cell to the volume of the unit cell. It has no unit, since it is a ratio of same physical quantity.

9. Calculate packing factor in the case of simple cubic structure.

$$\text{Packing factor} = \frac{\text{Volume occupied by the atoms in a unit cell (v)}}{\text{Volume of unit cell (V)}}$$

$$= \frac{1 \times \left(\frac{4}{3}\right) \pi r^3}{a^3}$$

$$\text{For SC, } r = \frac{a}{2}$$

$$\text{Packing factor} = \frac{1 \times \left(\frac{4}{3}\right) \pi r^3}{a^3}$$

$$\text{PF} = \frac{\frac{4}{3} \pi \left(\frac{a}{2}\right)^3}{a^3}$$

$$\text{PF} = \frac{\frac{4}{3} \pi \frac{a^3}{2^3}}{a^3} = \frac{\pi}{6} = \frac{3.14}{6} = 0.52$$

$$\text{PF} = 52\%$$

10. What are Miller indices?

A set of three numbers to designate a plane in a crystal is known as Miller indices of the concerned plane, symbolized by (h k l)

The reciprocal of the intercepts made by the plane on the crystallographic axes which are reduced to smallest integers.

11. What is a space lattice?

It is an array of point in three dimensions in which every point has an identical surroundings.

12. State $\frac{c}{a}$ ratio and packing factor for HCP.

$$\frac{c}{a} = \sqrt{\frac{8}{3}}$$

$$\frac{c}{a} = 1.6333$$

$$\text{Packing factor} = \frac{\pi}{3\sqrt{2}} = 0.74$$

$$\text{PF} = 74\%$$

13. What are lattice points?

The points in the space to represent position of atom or group of atoms of the crystal are called lattice points.

14. What are the differences between crystalline and non-crystalline material?

Sl. No	Crystalline material	Non-crystalline material
1	They have a definite and regular geometrical shape which extend throughout the crystal.	They don't have definite geometrical shape.
2	They are anisotropic	They are isotropic
3	They are most stable	They are less stable
4	Example: NaCl, KCl, Cu, Au, etc.	Example: Plastic, glass, rubber, etc

15. What is crystal defect?

The deviation from the regularity of arrangement of atoms is called crystal imperfection or crystal defect.

16. What is Frenkel defect?

A vacancy associated with interstitial impurity is called Frenkel defect.

17. Mention the various crystal growing techniques.

- Melt growth
- Low temperature solution growth.
- High temperature solution growth
- Growth from vapour.

18. What are the limitations of Czochralski method?

- High vapour pressure affects the quality of crystal materials
- Liquid phase encapsulation
- Possible contamination of the melt by the crucible
- No reproductivity of the crystal shape.

19. What is basic principle of Bridgeman technique?

A common technique for growing single crystals involves selective cooling of the molten materials, so that solidification occurs along a particular crystal direction.

In this technique, the melt in a sealed crucible is progressively frozen from one end.

20. What are the disadvantages of slow evaporation method?

- The growth substance should not react with the solvent.
- This method is applicable only for substances which are fairly soluble in a solvent.

21. What are vacancies?

Vacancies are empty atomic sites. Vacancies may occur as a result of imperfect packing during the original crystallization or they arise from the thermal vibrations of atoms at higher temperatures.

There are different kinds of vacancies like Frenkel defect, Schottky defect, Colour centers etc.