NATIONAL HIGHER SECONDARY SCHOOL, TINDIVANAM

6. SOLID STATE

1. Define unit cell.

A basic repeating structural unit of a crystalline solid in a three dimensional pattern is called a **unit cell**.

2. Give any three characteristics of ionic crystals.

- Ionic solids have high boiling & melting points.
- In solids state it do not conduct electricity & they conduct electricity when dissolved in water
- They are hard & brittle
- They dissolve in water

3. Differentiate crystalline solids and amorphous solids.

Crystalline solids	Amorphous solids
1. Long range orderly arrangement of constituents.	Short range, random arrangement of constituents
2. Definite shape	Irregular shape
3. They are anisotropic in nature	They are isotropic in nature
4. They are true solids	They are considered as pseudo solids
5. Definite Heat of fusion	Heat of fusion is not definite
6. They have sharp melting points.	They do not have sharp melting points.
7. Example: NaCl	Example: glass

4. Classify the following solids

a. P_4 b. Brass c. diamond d. NaCl e. Iodine

a. P_4 & S_8	**Molecular solid**
b. Brass	**Metallic solid (alloy)**
c. diamond	**Covalent solid**
d. NaCl	**Ionic solid**
e. Iodine	**Molecular solid**

5. What are point defects?

Point defects are the irregularities or deviations from ideal arrangement around a point or an atom in a crystalline substance**.**

6. Write short note on metal excess and metal deficiency defect with an example.

Metal excess defect:

- Metal excess defect arises due to the presence of more number of metal ions as compared to anions.
- It is due to anionic vacancies:

Example: *NaCl and KCl*

7. ***Metal deficiency defect:***

- Metal deficiency defect arises due to the **presence of less number of cations than the anions**.
- It is observed in a crystal in which, the cations have **variable oxidation states**.

Example: FeO crystal

8. Calculate the number of atoms in a SC, BCC, FCC unit cell?

$$\text{Number of atoms in a SC unit cell} = \left(\frac{Nc}{8}\right) = \left(\frac{8}{8}\right) = 1$$

$$\text{Number of atoms in a bcc unit cell} = \left(\frac{Nc}{8}\right)+\left(\frac{N_b}{1}\right) = \left(\frac{8}{8}+\frac{1}{1}\right) = (1+1) = 2$$

$$\therefore \text{Number of atoms in a fcc unitcell} = \left(\frac{Nc}{8}\right)+\left(\frac{N_f}{2}\right) = \left(\frac{8}{8}+\frac{6}{2}\right) = (1+3) = 4$$

9. **Calculate the packing efficiency in case of BCC (body centered cubic) crystal.**

$$r = \frac{\sqrt{3}}{4}a$$

∴ Volume of the sphere with radius 'r'

$$= \frac{4}{3}\pi r^3$$

$$= \frac{4}{3}\pi\left(\frac{\sqrt{3}}{4}a\right)^3$$

$$= \frac{\sqrt{3}}{16}\pi a^3$$

The total volume of all spheres

$$= 2 \times \left(\frac{\sqrt{3}\ \pi\ a^3}{16}\right) = \frac{\sqrt{3}\ \pi\ a^3}{8}$$

$$\left\{\begin{matrix}\text{Packing fraction}\\ \text{(or) efficiency}\end{matrix}\right\} = \frac{\left\{\begin{matrix}\text{Total volume occupied by}\\ \text{spheres in a unit cell}\end{matrix}\right\}}{\text{Volume of the unit cell}} \times 100$$

$$\text{Packing fraction} = \frac{\left(\frac{\sqrt{3}\ \pi\ a^3}{8}\right)}{(a^3)} \times 100$$

= 68%

Packing efficiency sc - 52.38 %, bcc - 68 %, fcc - 74 %

10. Barium has a BCC unit cell with a length of 508pm along an edge. What is the density of barium in g cm^{-3}?

$$\rho = \frac{n\,M}{a^3 N_A}$$

$$\rho = \frac{2 \text{ atoms} \times 137.3 \text{ g mol}^{-1}}{(5.08 \times 10^{-8} \text{ cm})^3 (6.023 \times 10^{23} \text{ atoms mol}^{-1})}$$

$$\rho = 3.5 \text{ g cm}^{-3}$$

11. Write Bragg's equation

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

Where, n = order of diffraction λ = wavelength of X-rays

θ = angle of diffraction d = inter planar distance

12. **Write note on covalent solids**

- **The constituents (atoms) are bound together in a 3D network by *covalent bonds*.**
- **They are very hard, and have high melting point.**

Example: Diamond

13. Difference between Isotropy & anisotropy

Isotropy	anisotropy
1. When the physical properties are identical in all directions. 2. Amorphous solids	1. When the physical properties are not identical in all directions. 2. Crystalline solids
Ex. Rubber	Ex. NaCl

14. Define Coordination number? What is the coordination number of atoms in a bcc structure?

***Coordination number*: The number of nearest neighbours that surrounding a particle in a crystal is called the coordination number of that particle.**

Coordination number of BCC: 8 Note: SC - 6, FCC - 12

15. Why ionic crystals are hard and brittle?

The cation and anion are bounded together by strong electrostatic attractive force. Hence it is hard and brittle.

16. Write note on Primitive unit cell & Non primitive unit cell

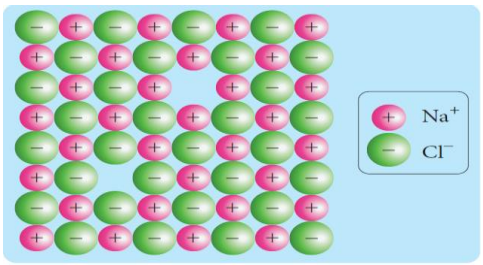
- **A unit cell that contain *only one lattice point* is called a primitive unit cell. It is made up from the lattice points at each of the corner.**
- **In case of non-primitive unit cells, there are *additional lattice points*,either on face of the unit cell or within the unit cell.**

17. Write seven primitive crystal systems (OR) What are the seven types of Primitive Unit cells?

Cubic, tetragonal, orthorhombic, hexagonal, monoclinic, triclinic & rhombohedral

18. Explain Schottky defect

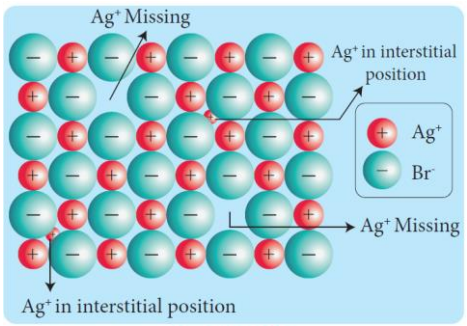
- **It arises due to the *missing of equal number of cations and anions* from the crystal lattice.**
- **This effect does not change the stoichiometry of the crystal.**
- **The cation and anion are of almost of similar size**
- **Presence of large number of schottky defects in a crystal, lowers its density.**
- ✓ **Example: NaCl**



Schottky Defect

19. **Explain Frenkel defect**

- **This defect arises due to *the dislocation of ions* from its crystal lattice.**
- **The ion which is missing from the lattice point occupies an interstitial position.**
- **They differ in size: (anion is larger than cation)**
- **This defect does not affect the density of the crystal.**
- **Example: AgBr**



Frenkel Defect

20. Distinguish between tetrahedral and octahedral voids.

Tetrahedral voids	Octahedral voids
1. The number of Tetrahedral voids is given by '2n'.	1. The number of Tetrahedral voids is given by 'n'.
2. When the spheres of the second layer is above the voids of the first layer	2. When the spheres of the second layer partially covers the voids of the first layer
3. When the four spheres are joined, the center gives a Tetrahedron	3. When the six spheres are joined, the center gives a Octahedron

21. Atoms X and Y form bcc crystalline structure. Atom X is present at the corners of the cube and Y is at the centre of the cube. What is the formula of the compound?

Formula of the compound = XY

22. Define crystal lattice.

The regular arrangement of the ions in a crystal is called as crystal lattice.

23. Write note on Molecular solids

- **It consists of *neutral molecules*.**
- **They are held together by weak *van der Waals* forces.**

Molecular solids - types

1. *Non-polar molecular solids* - weak London forces - Ex: naphthalene, anthracene

2. *Polar molecular solids* - strong dipole-dipole interactions.- Ex: solid CO_2 & solid NH_3

3. *Hydrogen bonded molecular solids* - hydrogen bonds- Ex: solid ice (H_2O), glucose, urea

24. Distinguish between hexagonal close packing (hcp) and cubic close packing (ccp).

Hexagonal close packing (hcp)	Cubic close packing (ccp)
1. ABA - arrangement	1. ABC - arrangement
2. Tetrahedral voids of the second layer are covered by the spheres of the third layer.	2. Octahedral voids of the third layer may be placed over the second layer
3. The unit cell has six spheres	3. The unit cell has four spheres
4. The third layer is directly over a first layer	4. The third layer placed over the II-nd layer

25. What is f center?

Anionic vacancies in metal excess defect which are occupied by unpaired electrons are called 'F' centers.

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