Solid State

2 Marks Questions

1. The window panes of the old buildings are thick at the bottom. Why?

Ans. Glass panes of old buildings are thicker at the bottom than at the top as from is an amorphous solid and flows down very slowly and makes the bottom portion thicker.

2. The stability of a crystal is reflected in the magnitude of its melting point. Explain

Ans. Melting point of a solid gives an idea about the intermolecular forces acting between particles. When these forces are strong, the melting point is higher and when these forces are weak, low melting point is observed. Higher is the melting point, more stable the solid is.

3. Graphite is soft and good conductor of electricity. Explain.

Ans. Graphite is soft and good conductor due to its typical structure here carbon atoms are arranged in different layers and each atom a covalently bonded to three of its neighbouring atoms in the same layer. The fourth electron of each atom is free to move about due to which it conducts electricity. Different layers can slide over the other which makes it a soft solid.

4. Ionic solids are good conductors in molten state and in aqueous solutions but not in solid state. Why?

Ans. In the solid state, the ions in the ionic solids are not free to move about due to their rigid structure & strong electrostatic forces. Therefore they cannot conduct electricity whereas in molten state and aqueous solution, the ions become free to move about and they conduct electricity.

5. Name three types of cubic unit cells?

Ans. (a) Simple cubic

(b) Face – centred cubic

(c) Body centred cubic

6. How many atoms are there in a unit cell of a metal crystallizing in a:

(a) FCC structure

(b) BCC structure

Ans. (a) FCC = 4   (b) BCC = 2

7. What is the contribution of an atom per unit cell if the atom is:

(a) At the corner of the cube.

(b) On the face of the cube.

(c) In the centre of the cube.

Ans. (a) When atom is at the corner of the cube, the contribution is $\frac{1}{8}$ atom.

(b) When the atom is on the face of the cube, its contribution is $\frac{1}{2}$ atom.

(c) If the atom is in the centre of the cube, its contribution is 1 atom.

8. A compound formed by A & B crystallizes in the cubic structure where 'A' are at the corners of the cube and B are at the face centre. What is the formula of the compound?

Ans. Contribution of atom A per unit cell = $\frac{1}{8}\times 8 = 1$ atom

Contribution of atom B per unit cell = $\frac{1}{2}\times 6 = 3$ atom

Ratio of A & B = 1:3   Formula = AB_3.

9. Calculate the no. of atoms in a cubic based unit – cell having one atom on each

corner and two atoms on each body diagonal.

Ans. No. of atoms contributed by 8 corners per unit cell = $\frac{1}{8} \times 8 = 1$ atom.

No. of atoms contributed by one diagonal = 2

No. of diagonal = 4

$\therefore$ Total contribution by diagonal = $4 \times 2 = 8$

$\therefore$ Total no. of atoms = 8 + 1 = 9 atoms

10. What is the no. of octahedral and tetrahedral voids present in a lattice?

Ans. No. of octahedral voids present in a lattice is equal to the no. of close packed particles and the number of tetrahedral voids is twice the no. of close packed particles.

11. Give the relationship between density and edge length of a cubic crystal.

Ans. Density, d of a cubic cell is given by –

$$d = \frac{ZM}{a^3 N_A}$$

Where Z = no. of atoms per unit cell

M = molar mass

N_A = Avogadro number

a = edge length

12. Copper which crystallizes as a face – centred cubic lattice has a density of $8.93\ g/cm^3$ at $20^\circ C$. calculate the length of the unit cell.

Ans. 63.1 u

13. An element crystallizes in BCC structure. The edge of its unit cell is 288 pm. If the density is $7.2\ g/cm^3$, calculate the atomic mass of the element.

Ans. 52 g/ mol

14. The compound CuCl has ZnS structure and the edge length of the unit cell in 500 pm. Calculate the density. (Atomic masses: Cu = 63, Cl = 35.5, Avogadro no = $6.02\times10^{23} mol^{-1}$**)**

Ans. $5.22\ g/cm^3$

15. In a compound, B ions form a close – packed structure & A ions occupy all the tetrahedral voids. What is the formula of the compound?

Ans. Let the no. of B ions = 100

No. of A ions = no. of tetrahedral voids

= 2 $\times$no. of B = 2 $\times$100 = 200

Ratio of A & B = 200 : 100 = 2 : 1

Formula = A_2B .

16. Define two main types of defects.

Ans. Defects are of two types –

Point defects: - Irregularities or deviations from ideal arrangement around a point or on atom in a crystal.

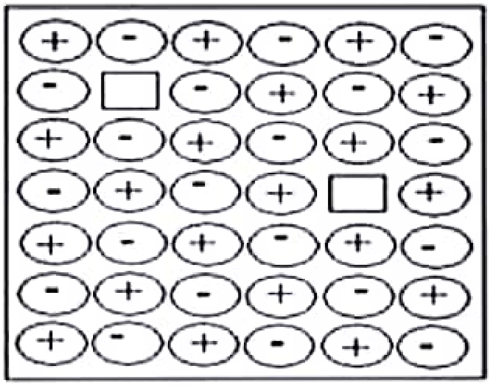
Line defect: - Irregularities or deviation from ideal arrangement in entire row of lattice points.

17. (a) Identify the defect in figure below :

(b) How does it affect the density of crystal?

(c) Give an example of crystal where this defect can be found.

(d) What is its effect on electrical neutrality of crystal?



Ans. (a) Schottky defect.

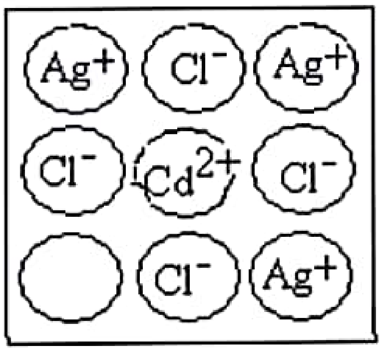
(b) It decreases the density of crystal.

(c) NaCl, KCl

(d) The crystal remains electrically neutral.

18. Which defect is observed in a solid solution of $CdCl_2$ and AgCl? Explain.

Ans. In a solid solution of $CdCl_2$ and AgCl, impurity defect is observed. In the crystal of AgCl, some of the sites of Ag^+ are occupied by Cd^{2+}, each Cd^{2+} replacing two Ag^+. It replaces the site of one ion and other site remains vacant.



19. Excess of lithium makes LiCl crystal pink. Explain.

Ans. When crystals of LiCl are heated in an atmosphere of Li vapour the Lithium atoms are deposited on the surface of crystal. The Cl^- ions diffuse to the surface of crystal & combine with Li atoms to from LiCl which happens by loss of electrons by Li atoms to form Li^+ ions. These released elements diffuse into the crystal & electrons get excited after absorbing light from visible region & emit pink colour.

20. In the fig –

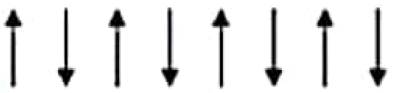
(i) 

Fig. (i)

(a) Identify the magnetic behaviour of substance.

(b) How are these substances different from diamagnetic substances?

Ans. (a) Antiferromagnetic field.

(b)In Antiferromagnetic substance the domain structure is similar to ferromagnetic substance but the domains are oppositely oriented and cancel out each others magnetic moment whereas in diamagnetic substance all individual electron are paired which cancels the individual magnetic moments.

21. Define the terms – Intrinsic semiconductor and extrinsic semiconductor.

Ans. Intrinsic semiconductor – An insulator which conducts electricity when heated.

Extrinsic semiconductor – An insulator which conducts electricity on addition of an impurity.

22. Classify solids on the basis of their conductivities.

Ans. Solids can be classified into three types on the basis of their conductivities –

Solids	Conductivities
1. Conductor	$10^{4} \, to \, 10^{7} \, \Omega^{-1} m^{-1}$
2. Insulators	$10^{-20} \, to \, 10^{-10} \, \Omega^{-1} m^{-1}$
3. Semi – conductor	$10^{-6} \, to \, 10^{4} \, \Omega^{-1} m^{-1}$

23. Give two examples of each.

(a) Ferromagnetic substances

(b) Ferrimagnetic substances

Ans. (i) Ferromagnetic substances –Fe, Co, Ni, CrO_2, Gadolinium.

(ii) Ferrimagnetic substance – Fe_3O_4 , Magnetite and Ferrites.

24. Give two application of p – type and n – type semiconductors.

Ans. Application –

(i) A combination of both p – type and n – type semiconductors is used in diode which is used as rectifiers.

(ii) npn & pnp types of transistors are used as amplifiers.

25. Non-stoichiometric cuprous oxide, Cu_2O can be prepared in laboratory. In this oxide, copper to oxygen ratio is slightly less than 2:1. Can you account for the fact that this substance is a *p*-type semiconductor?

Ans. In the cuprous oxide (Cu_2O) prepared in the laboratory, copper to oxygen ratio is slightly less than 2:1. This means that the number of Cu^{+}ions is slightly less than twice the number of O_2 –ions. This is because some Cu^{+}ions have been replaced by Cu^{2+}ions. Every Cu^{2+}ion replaces two Cu^{+}ions, thereby creating holes. As a result, the substance conducts electricity with the help of these positive holes. Hence, the substance is a *p*-type semiconductor.

26. Ferric oxide crystallises in a hexagonal close-packed array of oxide ions with two out of every three octahedral holes occupied by ferric ions. Derive the formula of the ferric oxide.

Ans. Let the number of oxide (O_{2-}) ions be *x*.

So, number of octahedral voids = *x*

It is given that two out of every three octahedral holes are occupied by ferric ions.

So, number of ferric (Fe^{3+}) ions=23x

Therefore, ratio of the number of Fe3+ions to the number of O2− ions, Fe^{3+} Fe3+: O2−=23 x:x

=23:1

= 2 : 3

Hence, the formula of the ferric oxide isFe2O3.

27. Classify each of the following as being either a *p*-type or an *n*-type semiconductor:

(i) Ge doped with In (ii) B doped with Si.

Ans. (i) Ge (a group 14 element) is doped with In (a group 13 element). Therefore, a hole will be created and the semiconductor generated will be a *p*-type semiconductor.

(ii) B (a group 13 element) is doped with Si (a group 14 element). Thus, a hole will be created and the semiconductor generated will be a *p*-type semiconductor.

28. Gold (atomic radius = 0.144 nm) crystallises in a face-centred unit cell. What is the length of a side of the cell?

Ans. For a face-centred unit cell:a= $22\sqrt{r}$

It is given that the atomic radius, *r*= 0.144 nm

So, $a = 22\sqrt{\times 0.144} nm$

= 0.407 nm

Hence, length of a side of the cell = 0.407 nm

29. In terms of band theory, what is the difference

(i) Between a conductor and an insulator

(ii) Between a conductor and a semiconductor

Ans. (i) The valence band of a conductor is partially-filled or it overlaps with a higher energy, unoccupied conduction band.

On the other hand, in the case of an insulator, the valence band is fully- filled and there is a large gap between the valence band and the conduction band.

(ii) In the case of a conductor, the valence band is partially-filled or it overlaps with a higher energy, unoccupied conduction band. So, the electrons can flow easily under an applied electric field.

On the other hand, the valence band of a semiconductor is filled and there is a small gap between the valence band and the next higher conduction band. Therefore, some electrons can jump from the valence band to the conduction band and conduct electricity.

30. How many lattice points are there in one unit cell of each of the following lattice?

(i) Face-centred cubic

(ii) Face-centred tetragonal

(iii) Body-centred

Ans. (i) There are 14 (8 from the corners + 6 from the faces) lattice points in face-centred cubic.

(ii) There are 14 (8 from the corners + 6 from the faces) lattice points in face-centred tetragonal.

(iii) There are 9 (1 from the centre + 8 from the corners) lattice points in body-centred cubic.

31. Explain

(i) The basis of similarities and differences between metallic and ionic crystals.

(ii) Ionic solids are hard and brittle.

Ans. (i) The basis of similarities between metallic and ionic crystals is that both these crystal types are held by the electrostatic force of attraction. In metallic crystals, the electrostatic force acts between the positive ions and the electrons. In ionic crystals, it acts between the oppositely-charged ions. Hence, both have high melting points.

The basis of differences between metallic and ionic crystals is that in metallic crystals, the electrons are free to move and so, metallic crystals can conduct electricity. However, in ionic crystals, the ions are not free to move. As a result, they cannot conduct electricity. However, in molten state or in aqueous solution, they do conduct electricity.

(ii) The constituent particles of ionic crystals are ions. These ions are held together in three-dimensional arrangements by the electrostatic force of attraction. Since the electrostatic force of attraction is very strong, the charged ions are held in fixed positions. This is the reason why ionic crystals are hard and brittle.

32. Define the term 'amorphous'. Give a few examples of amorphous solids.

Ans. Amorphous solids are the solids whose constituent particles are of irregular shapes and have short range order. These solids are isotropic in nature and melt over a range of temperature. Therefore, amorphous solids are sometimes called pseudo solids or super cooled liquids. They do not have definite heat of fusion. When cut with a sharp-edged tool, they cut into two pieces with irregular surfaces. Examples of amorphous solids include glass, rubber, and plastic.

33. What makes a glass different from a solid such as quartz? Under what conditions could quartz be converted into glass?

Ans. The arrangement of the constituent particles makes glass different from quartz. In glass, the constituent particles have short-range order, but in quartz, the constituent particles have both long range and short range orders.

Quartz can be converted into glass by heating and then cooling it rapidly.

34. Classify the following as amorphous or crystalline solids:

Polyurethane, naphthalene, benzoic acid, teflon, potassium nitrate, cellophane, polyvinyl chloride, fibre glass, copper.

Ans. Amorphous solids: Polyurethane, teflon, cellophane, polyvinyl chloride, fibre glass

Crystalline solids: Naphthalene, benzoic acid, potassium nitrate, copper

35. (i) What is meant by the term 'coordination number'?

(ii) What is the coordination number of atoms:

(a) in a cubic close-packed structure?

(b) in a body-centred cubic structure?

Ans. **(i)** The number of nearest neighbours of any constituent particle present in the crystal lattice is called its coordination number.

(ii) The coordination number of atoms

(a) in a cubic close-packed structure is 12, and

(b) in a body-centred cubic structure is 8