Term-I

SOLID STATE

Syllabus

- ***Classification of solids based on different binding forces: molecular, ionic, covalent and metallic solids, amorphous and crystalline solids (elementary idea). Unit cell in two dimensional and three dimensional lattices, calculation of density of unit cell, packing in solids, packing efficiency, voids, number of atoms per unit cell in a cubic unit cell, point defects.***

STAND ALONE MCQs

[1 Mark each]

Q. 1. Which of the following is not true about the ionic solids?

(A) Bigger ions form the close packed structure.

(B) Smaller ions occupy either the tetrahedral or the octahedral voids depending upon their size.

(C) Occupation of all the voids is not necessary.

(D) The fraction of octahedral or tetrahedral voids occupied depends upon the radii of the ions occupying the voids.

Ans. Option (B) is correct.

Explanation: In ionic solids, smaller ions occupy the voids, and this depends on stoichiometry of the compounds not on the radius of ions.

AI **Q. 2.** Solid A is very hard electrical insulator in solid as well as in molten state and melts at an extremely high temperature. What type of solid is it?

(A) Ionic solid **(B)** Molecular solid

(C) Covalent solid **(D)** Metallic solid

Ans. Option (C) is correct.

Explanation: Covalent solids are generally hard, act as insulators and melting points of such solids are extremely high.

AI **Q. 3.** Which of the following is a network solid?

(A) SO_2 (solid) **(B)** I_2

(C) Diamond **(D)** H_2O (ice)

Ans. Option (C) is correct.

Explanation: A network solid consists of a network atoms of same or different elements connected to each other by covalent bonds. So, diamond is a network solid as it contains network of carbon atoms .

Q. 4. Graphite cannot be classified as _____.

(A) Conducting solid **(B)** Network solid

(C) Covalent solid **(D)** Ionic solid

Ans. Option (D) is correct.

Explanation: Graphite is a conducting solid, network or covalent solid but it cannot be classified as ionic solid.

Q. 5. Which of the following statements is not true about amorphous solids?

(A) On heating they may become crystalline at certain temperature.

(B) They may become crystalline on keeping for long time.

(C) Amorphous solids can be moulded by heating.

(D) They are anisotropic in nature.

Ans. Option (D) is correct.

Explanation: Amorphous solids are isotropic in nature, i.e., there is no long-range order, and arrangement is irregular along all the directions.

AI **Q. 6.** Which of the following is an amorphous solid?

(A) Graphite (G) **(B)** Quartz glass (SiO_2)

(C) Chrome alum **(D)** Silicon carbide (SiC)

Ans. Option (B) is correct.

Explanation: Quartz glass (SiO_2) is an amorphous solid as it has no long-range order.

Q. 7. The sharp melting point of crystalline solids is due to _____.

(A) a regular arrangement of constituent particles observed over a short distance in the crystal lattice.

(B) a regular arrangement of constituent particles observed over a long distance in the crystal lattice.

(C) same arrangement of constituent particles in different directions.

(D) different arrangements of constituent particles in different directions.

Ans. Option (B) is correct.

Explanation: The sharp melting point of crystalline solids is due to a regular arrangement of constituent particles observed over a long distance in the crystal lattice.

Q. 8. Which of the following conditions favours the existence of a substance in the solid state?

(A) High temperature

(B) Low temperature

(C) High thermal energy

(D) Weak cohesive forces

Ans. Option (B) is correct.

Explanation: At low temperature substance exists in solid state. It is due to the decrease in molecular movement which leads to strong cohesive force, that is, the force which tightly holds the constituent particles together.

AI **Q. 9.** A compound is formed by two elements M and N. The element N forms ccp lattice and atoms of M occupy two atoms an Mercury $1/3^{rd}$ of tetrahedral voids. What is the formula of the compound

(A) MN_2 **(B)** M_2N_3

(C) M_3N_2 **(D)** M_2N_2

Ans. Option (B) is correct.

Explanation: Suppose the atoms N in the $ccp = a$

$\therefore$ No. of tetrahedral voids $= 3a$

$$\text{No. of atoms M} = \frac{2a}{3} : a = 2:3$$

Hence compound as $M_2: N_3$

Q. 10. Silver crystallises in f.c.c. lattice. It edge length of the unit cells is 4.07×10^{-8} cm density and is $10.5 g\ cm^{-3}$. Calculate the atomic mass of silver.

(A) 144 g/mol **(B)** 125 g/mol

(C) 106.6 g/mol **(D)** 213 g/mol

Ans. Option (C) is correct.

Explanation:

$$d = \frac{Z \times M}{a^3 \times N_A}$$

$$M = \frac{d \times N_A \times a^3}{Z}$$

$$= \frac{10.5 \times 6.022 \times 10^{23} \times \left(4.07 \times 10^{-8}\right)^3 g\ cm^{-3}}{4}$$

$$= 106.6\ g\ mol^{-1}$$

Q. 11. The correct order of the packing efficiency in different types of unit cells is _____.

(A) *fcc* < *bcc* < simple cubic

(B) *fcc* > *bcc* > simple cubic

(C) *fcc* < *bcc* > simple cubic

(D) *bcc* < *fcc* = simple cubic

Ans. Option (B) is correct.

Explanation: The correct order of the packing efficiency in different types of unit cells is given below:

Unit Cell	Packing efficiency
fcc	74%
bcc	68%
Simple cubic	52.4%

fcc > *bcc* > simple cubic

AI **Q. 12.** The total number of tetrahedral voids in the face centred unit cell is _____.

(A) 6 **(B)** 8

(C) 10 **(D)** 12

Ans. Option (B) is correct.

Explanation: The total number of tetrahedral voids in the face centred unit cell is 8.

Q. 13. The lattice site in a pure crystal cannot be occupied by _____.

(A) Molecule **(B)** Ion

(C) Electron **(D)** Atom

Ans. Option (C) is correct.

Explanation: Each point in a lattice is known as lattice point which can be either atom, molecule or ion. It is joined together by a straight line to bring out geometry of lattice in pure crystal constituents. They are arranged in fixed stoichiometric ratio. Hence, existences of free electrons are not possible.

AI **Q. 14.** Which of the following statements is not true about the hexagonal close packing?

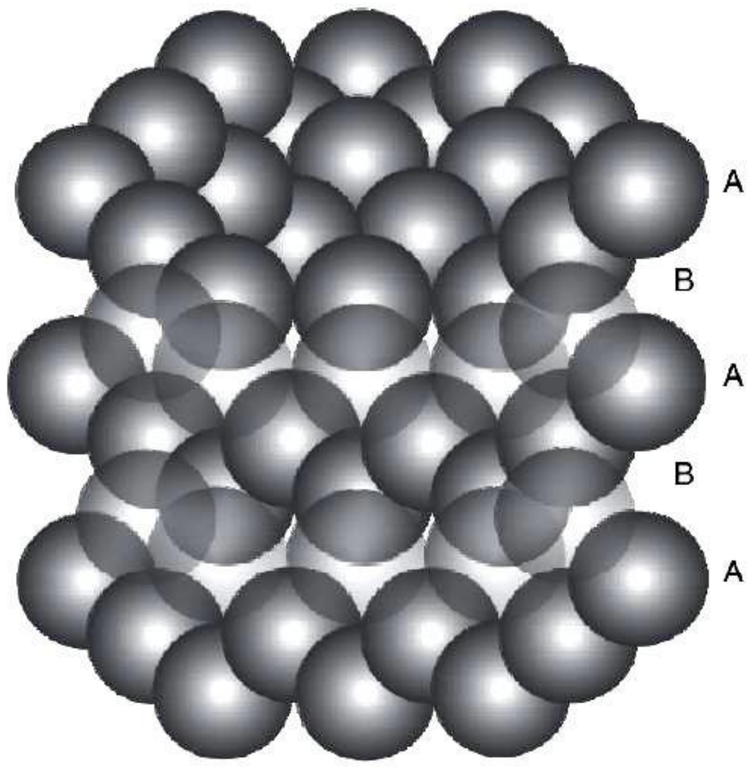
(A) The coordination number is 12.

(B) It has 74% packing efficiency.

(C) Tetrahedral voids of the second layer are covered by the spheres of the third layer.

(D) In this arrangement spheres of the fourth layer are exactly aligned with those of the first layer.

Ans. Option (D) is correct.



Explanation: Hexagonal close packing (hcp) can be arranged by two layers A and B one over another which can be diagrammatically represented as:

In the above figure the first layer and fourth are not exactly aligned. Thus, statement (D) is not correct while other statements, i.e., (A), (B) and (C) are true.

AI **Q. 15.** In which of the following structures coordination number for cations and anions in the packed structure will be same?

(A) Cl^- ion form fcc lattice and Na^+ ions occupy all octahedral voids of the unit cell.

(B) Ca^{2+} ions form fcc lattice and F^- ions occupy all the eight tetrahedral voids of the unit cell.

(C) O^{2-} ions form fcc lattice and Na^+ ions occupy all the eight tetrahedral voids of the unit cell.

(D) S^{2-} ions form fcc lattice and Zn^{2+} ions go into alternate tetrahedral voids of the unit cell.

Ans. Option (A) is correct.

Explanation: NaCl unit cell has a fcc structure of Cl^- ions, and Na^+ ions occupy octahedral voids. The radius ratio of 0.524 for NaCl suggests an octahedral void.

Q. 16. What is the coordination number in a square close packed structure in two dimensions?

(A) 2 **(B)** 3

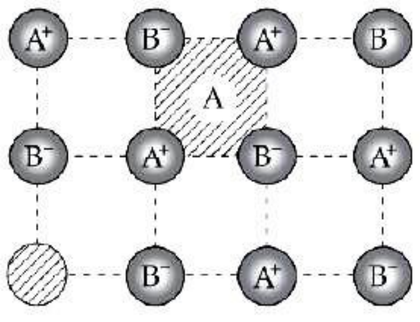
(C) 4 **(D)** 6

Ans. Option (C) is correct.

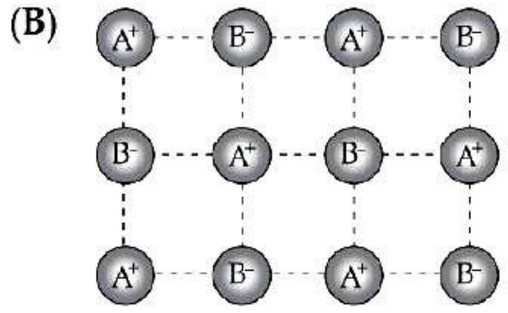
Explanation: In square close packing in two dimensions each sphere is in contact with four of its neighbours. Thus, its coordination number is 4.

Q. 17. The crystal showing defect is:

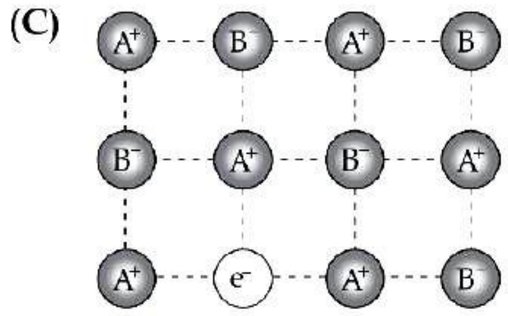
(A)



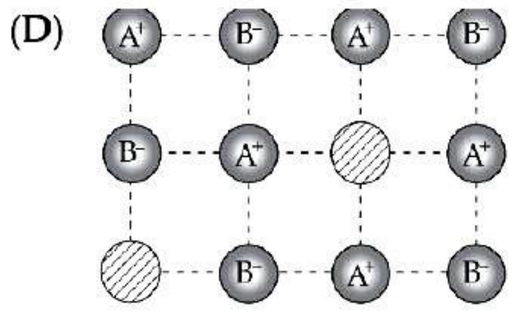
(B)



(C)



(D)



[CBSE, SQP 2020-21]

Ans. Option (A) is correct.

Explanation: The Frenkel defect is formed when an atom or smaller ion (usually cation) leaves its place in the crystal lattice, creating a vacancy, and becomes an interstitial by lodging in a nearby location.

AI **Q. 18.** Which stoichiometric defect does not change the density of the crystal?

(A) Frenkel defect **(B)** Schottky defect

(C) Interstitial defect **(D)** F-centres

Ans. Option (A) is correct.

Explanation: In Frenkel defect, one of the ion is missing from its lattice site and occupies an interstitial site. So, density of the crystal does not change.

AI **Q. 19.** Which of the following defects is also known as dislocation defect?

(A) Frenkel defect

(B) Schottky defect

(C) Non-stoichiometric defect

(D) Simple interstitial defect

Ans. Option (A) is correct.

Explanation: Frenkel defect is also known as dislocation defect because in this defect one of the ion is missing from its lattice site and occupies an interstitial site.

Q. 20. Interstitial compounds are formed when small atoms are dropped under the curved lattice of metals. Whether the following is not the characteristics property of interstitial compounds?

(A) They have high melting points in to pure metals

(B) They are very hard

(C) They retain metallic conductivity

(D) They are chemically very reactive

Ans. Option (D) is correct.

> *Explanation:* Interstitial compounds are usually non-stoichiometric and are neither typically ionic nor covalent. Hence, interstitial compounds are chemically inert.

AI **Q. 21.** Examine the given defective crystal

A^+ B^- A^+ B^- A^+
B^- 0 B^- A^+ B^-
A^+ B^- A^+ 0 A^+
B^- A^+ B^- A^+ B^-

How is the density of the crystal affected by this defect?

(A) Density increases
(B) Density decreases
(C) No effect on density
(D) Density first increases then decreases

Ans. Option (B) is correct.

> *Explanation:* The given defective crystal shows that there is missing of one cation and one anion from their lattice positions which is Schottky defect. Due to missing of ions, density of the crystal decreases.

ASSERTION AND REASON BASED MCQs [1 Mark each]

Directions: In the following questions, A statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as.

(A) Both A and R are true and R is the correct explanation of A
(B) Both A and R are true but R is NOT the correct explanation of A
(C) A is true but R is false
(D) A is false and R is True

Q. 1. Assertion (A): Most of the solids possess high melting point.
Reason (R): They have strong intermolecular forces of attraction.

Ans. Option (A) is correct.

> *Explanation:* Most of the solids possess high melting point due to the presence of intermolecular forces of attraction between their particles.

AI **Q. 2. Assertion (A):** Amorphous solids possess a long-range order in the arrangement of their particles.
Reason (R): The formation of amorphous solids involves very rapid cooling.

Ans. Option (D) is correct.

> *Explanation:* Amorphous solids do not possess a long-range order in the arrangement of their particles because their formation involves rapid cooling.

AI **Q. 3. Assertion (A):** Crystalline solids are anisotropic in nature.
Reason (R): Some of their physical properties show same electrical and optical properties in different directions in the same crystal.

Ans. Option (C) is correct.

> *Explanation:* Crystalline solids are anisotropic in nature as some of their physical properties show different electrical and optical properties in different directions in the same crystal.

AI **Q. 4. Assertion (A):** Graphite is a good conductor of electricity; however, diamond belongs to the category of insulators.
Reason (R): Graphite is soft in nature, on the other hand diamond is very hard and brittle.

Ans. Option (B) is correct.

> *Explanation:* Diamond is a bad conductor of electricity because all valence electrons of carbon are involved in bonding. In graphite, however 3 out of 4 valence electrons are involved in bonding and the fourth electron remains free between adjacent layers which makes it a good conductor. Graphite is soft because parallel layers are held together by week vander Waals forces. However, diamond is hard due to compact three-dimensional network of bonding.

Q. 5. Assertion (A): Total number of octahedral voids present in unit cell of cubic packing including the one that is present at the body centre is four.
Reason (R): Besides the body centre these is one octahedral void present at the centre of each of the 4 faces of the unit cell and each of which is shared between two adjacent unit cells.

Ans. Option (C) is correct.

> *Explanation:* Total number of octahedral voids present in unit cell of cubic packing including the one i.e., present at the body centre, is four.

Q. 6. Assertion (A): A two dimensional arrangement where each sphere is in contact with four of its neighbour and has a 2-D coordination number 4 is square close packing arrangement.
Reason (R): In such arrangement, if centres of the neighbouring spheres are joined, a square is formed.

Ans. Option (A) is correct.

> *Explanation:* In square close packing arrangement in two dimension, each sphere is in contact with 4 spheres and if the centres of neighbouring spheres are joined a square is formed.

AI **Q. 7. Assertion (A):** The packing efficiency of simple cubic lattice is 52.4%.

Reason (R): The number of atoms per unit cell is 2.

Ans. Option (C) is correct.

> *Explanation:* For simple cubic lattice $a = 2r$
> Number of atoms per unit cell = 1

AI **Q. 8. Assertion (A):** The packing efficiency is maximum for the fcc structure.

Reason (R): The coordination number is 12 in fcc structure.

Ans. Option (B) is correct.

> *Explanation:* Both ccp and hcp are highly efficient lattice; in terms of packing. The packing efficiency of both types of close packed structure is 74%, i.e., 74% of the space in hcp and ccp is filled. The hcp and ccp structures are equally efficient; in terms of packing. The packing efficiency of simple cubic lattice is 52.4% and the packing efficiency of body-centred cubic lattice (bcc) is 68%.

AI **Q. 9. Assertion (A):** Density of the crystal decreases in Frenkel defect.

Reason (R): In this defect, one of the ion is missing from lattice position and occupies interstitial site.

Ans. Option (A) is correct.

> *Explanation:* Density of the crystal does not decreases in Frenkel defect as no ion is missing from the crystal.

Q. 10. Assertion (A): Schottky defect arises when a non-ionic solid is heated.

Reason (R): It happens because some of the lattice sites are vacant in the crystal.

Ans. Option (D) is correct.

> *Explanation:* Vacancy defect arises when a non-ionic solid is heated. It happens because some of the lattice sites are vacant in the crystal.

CASE-BASED MCQs

I. Read the passage given below and answer the following questions:

All real structures are three dimensional structures. They can be obtained by stacking two dimensional layers one above the other while placing the second square close packed layer above the first we follow the same rule that was followed when one row was placed adjacent to the other. The second layer is placed over the first layer such that the spheres of the upper layer are exactly above there of the first layer. In his arrangement spheres of both the layers are perfectly aligned horizontally as well as vertically. A metallic element crystallise into a lattice having a ABC ABC pattern and packing of spheres leaves out voids in the lattice.

Q. 1. What type of structure is formed by this arrangement?

(A) ccp **(B)** hcp
(C) ccp/fcc **(D)** none of the above

Ans. Option (C) is correct.

AI **Q. 2.** Name the non-stoichiometric point defect responsible for colour in alkali metal halides.

(A) Frenkel defect
(B) Interstitial defect
(C) Schottky defect
(D) F-centres

Ans. Option (D) is correct.

Q. 3. What is the total volume of atoms in a face centred cubic unit cell of a metal? (r is atomic radius).

(A) $16/3\ \pi r^3$
(B) πr^3
(C) $24/3\ \pi r^3$
(D) $12/3\ \pi r^3$

Ans. Option (A) is correct.

> *Explanation:*
> Number of atoms per unit cell in fcc = 4
> ∴ Total volume of atoms present in fcc unit cell
> $$= 4 \times \frac{4}{3}\pi r^3 = \frac{16}{3}\pi r^3$$

Q. 4. Which of the following statements not true for the amorphous and crystalline solids?

(A) Amorphous solids are isotropic and crystalline solids are anisotropic.
(B) Amorphous solids are short range order and crystalline solids are long range order.
(C) Amorphous solids melt at characteristic temperature while crystalline solids melt over a range of temperature.
(D) Amorphous solids have irregular shape and crystalline solids have a geometrical shape.

Ans. Option (C) is correct.

> *Explanation:* Crystalline solids melt at characteristic temperature while amorphous solids melt over a range of temperature.

OR

Which of the following statements is not true for unit cell?

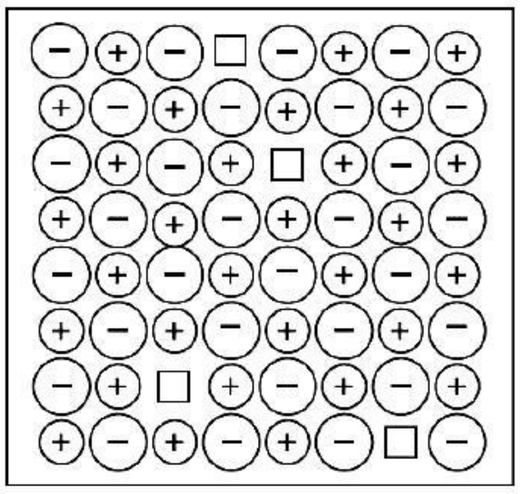
(A) Each cubic unit cell has 8 atoms on its corners the total number of atoms in one unit cell is 1.
(B) A unit cell is characterized by its dimensions along the three edges a, b, c.
(C) Each body centred cube cell has 2 atoms in one unit cell.

(D) Each face centred cubic cell contains only one constituent particle present at the centre of each face.

Ans. Option (D) is correct.

> ***Explanation:*** Each fcc unit cell contains one constituent particle present at the centre of each face, besides the ones that are at its corners.

AI II. Study the diagram given below and answer the following questions:



In these questions, a statement of Assertion followed by a statement of Reason is given. Choose the correct answer out of the following choices.

(A) Both A and R are true and R is the correct explanation of A

(B) Both A and R are true but R is NOT the correct explanation of A

(C) A is true but R is false

(D) A is false and R is True

Q. 1. Assertion (A): The diagram shows Schottky defect.
Reason (R): Schottky defect occurs in ionic solids.

Ans. Option (B) is correct.

> ***Explanation:*** The diagram shows Schottky defect as it has equal number of cationic and anionic vacancies.

Q. 2. Assertion (A): LiCl Crystal is pink.
Reason (R): Pink colour of LiCl crystal is due to excess Lithium.

Ans. Option (A) is correct.

> ***Explanation:*** LiCl crystal is pink due to excess Lithium. It is caused by metal excess defect caused by a anionic vacancies(F-centres).

Q. 3. Assertion (A): The crystal lattice density increases due to the defect shown in the diagram.
Reason (R): Tetrahedral voids are surrounded by 4 constituent particles.

Ans. Option (D) is correct.

> ***Explanation:*** The crystal lattice density decreases due to the defect shown in the diagram-Schottky defect.

Q. 4. Assertion (A): AgCl shows Frenkel defect while NaCl does not.
Reason (R): Frenkel defect is shown when anionic vacancies are occupied by unpaired electrons.

Ans. Option (B) is correct.

> ***Explanation:*** AgCl shows Frenkel defect while NaCl does not as the size of Ag^+ ion is smaller than Na^+ ion. Frenkel defect occurs when the smaller ion dislocates from its normal site to an interstitial site.