Chemistry

Chapterwise Practise Problems (CPP) for JEE (Main & Advanced)

Chapter - Solid State

Level-1

SECTION - A

Straight Objective Type

This section contains multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

1. In a hypothetical solid, C atoms are found to form cubical close packed lattice. A atoms occupy all tetrahedral voids and B atoms occupy all octahedral voids.

A and B atoms are of appropriate size, so that there is no distortion in CCP lattice of C atoms. Now if a plane as shown in the following figure is cut, then the cross section of this plane will look like :



2. Identify the correct combination of true and false of the given three statements:

STATEMENT-1 : On increasing the temperature 8 : 8 coordination of CsCl changes to 6 : 6

STATEMENT-2 : The most probable structure if Rb^+ is 1.46 Å & I⁻ is 2.16 Å resemble ZnS.

STATEMENT-3 : AgBr can show both Frenkel and Schottky defect.

(C) T, T, T (D) F, F, F

3. Analysis show that nickel oxide consist of nickel ion with 96% ions having d⁸ configuration and 4% having d⁷ configuration. Which amongst the following best represents the formula of the oxide ?

(A) Ni _{1.02} O _{1.00}	(B) Ni _{0.96} O _{1.00}
(C) Ni _{0.98} O _{0.98}	(D) Ni _{0.98} O _{1.00}

4. In a solid, S^{2–} ions are packed in fcc lattice. Zn²⁺ occupy half of the tetrahedral voids in an alternating arrangement. Now if a plane is cut (as shown) then the cross-section would be :



5. In a bcc-arrangement which of the marked planes have maximum packing efficiency



- 6. A lattice is defined as
 - (A) the amount of energy required, per mole, to separate the ions from their lattice positions to an infinite distance in the gas phase
 - (B) the distance separating the cations and anions
 - (C) a set of all points with identical environments within the crystal
 - (D) the arrangement of electrons in various every levels
- 7. Which one of the following doping will produce ntype semiconductor?
 - (a) Silicon doped with arsenic
 - (b) Germanium doped with phosphorus
 - (c) Silicon doped with boron
 - (d) Germanium doped with aluminium
 - (A) a & b (B) Only b
 - (C) c & d (D) a, b, c & d
- 8. Find the wrong statement:
 - (A) In Frenkel defect dielectric constant of crystal decreases
 - (B) Lattice energy decreases both in Frenkel defect as well as in Schottky defect
 - (C) Steel is an interstitial alloy
 - (D) Frenkel defect is found in compounds with dominating covalent character

SECTION - B

Multiple Correct Answer Type

This section contains multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

- 9. Which of the following is/are correct with respect to zinc blende structure?
 - (A) Zn²⁺ ions are present at the corners and at the centres of each face.
 - (B) Only alternate tetrahedral holes are occupied by Zn²⁺ ions.
 - (C) The coordination number of Zn²⁺ and S²⁻ is 4 each.
 - (D) The number of ZnS units in a unit cell is 4.
- 10. Which of the following statement(s) is/are true?
 - (A) In an anti-fluorite structure, anions form fcc lattice and the cations occupy all the tetrahedral voids.

- (B) If the radius of cations and anions are 0.2 Å and 0.95 Å, then the coordination number of cation in the crystal is 4.
- (C) An ion is transferred from a lattice site to an interstitial position in Frenkel defect.
- (D) Density of crystal always increases due to substitution (impurity) defect.
- 11. The correct statement/s is/are
 - (A) CsCl crystal is likely to show Schottky defect.
 - (B) CsCl crystal is likely to show Frenkel defect.
 - (C) Photosensitivity of AgBr is due to the presence of Frenkel defect in it.
 - (D) Crystals having F-centres are coloured and paramagnetic.
- 12. Which of the following statements are true regarding tetrahedral voids in fcc lattice?
 - (A) Tetrahedral voids are formed by one corner spheres and three adjacant face centre spheres.
 - (B) Two tetrahedral voids can exist on one body diagonal in fcc lattice.
 - (C) Tetrahedral voids are equal to number of spheres involved in lattice.
 - (D) Volume of tetrahedral voids are half of the octahedral voids.
- The statement(s) that is/are true about NaCl crystal unit cell
 - (A) all Na⁺ ions are FCC packed in a typical unit cell
 - (B) the co-ordination number of Na⁺ and Cl⁻ are 6:6 respectively
 - (C) Next nearest neighbours of Cl⁻ are 12 in number
 - (D) the unit cell formula is Na_4Cl_4
- 14. Which of the following statement/s is/are not correct for a close-packed structure?
 - (A) Each octahedral void is surrounded by six spheres and each sphere is surrounded by six octahedral voids.
 - (B) Each octahedral void is surrounded by six spheres and each sphere is surrounded by three octahedral voids.
 - (C) Each octahedral void is surrounded by two spheres and each sphere is surrounded by eight voids.
 - (D) Each tetrahedral void is surrounded by eight spheres and each sphere is surrounded by eight voids.

- 15. Which statement is/are true about extrinsic conductor ?
 - (A) Addition of phosphorus as impurities in silicon makes n type semi conductor
 - (B) Addition of AI as impurities in silicon makes p type semi conductor
 - (C) In n-type semi conductor charge is carried by the hole
 - (D) In p-type semi conductor charge is carried by the electron
- If radius of anion is 0.20 nm, the maximum radius of cations which can be filled in respective voids are correctly matched in :
 - (A) $r^+ = 0.0828$ nm for tetrahedral void
 - (B) r⁺ = 0.45 nm triangular void
 - (C) $r^+ = 0.1464$ nm for octahedral void
 - (D) None of the above
- 17. Crystal systems in which no two axial lengths are equal are :
 - (A) tetragonal (B) orthorhombic
 - (C) monoclinic (D) triclinic
- 18. The density of KBr is 2.75 g/cm³. The length of the unit cell is 654 pm. Atomic mass of K = 39, Br = 80. Then what is true about the predicted nature of the solid?
 - (A) It has 4 K⁺ and 4 Br[−] ions per unit cell
 - (B) It is face centred
 - (C) It has rock salt type structure
 - (D) It can have schottky defects
- 19. Which of the following statements are correct?
 - (A) The coordination number of each type of ion in CsCl crystal is 8.
 - (B) A metal that crystallizes in bcc structure has coordination number of 12.

- (C) A unit cell of an ionic crystal shares some of its ions with other unit cells.
- (D) The length of the unit cell in NaCl is 522 pm $(r_{Na+} = 95 \text{ pm}, r_{Cl-} = 181 \text{ pm})$

SECTION - C

Linked Comprehension Type

This section contains paragraphs. Based upon this paragraph, some multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

Paragraph for Question Nos. 20 and 21



If figure (I) and figure (II) are the top view of two different unit cell then answer following

20. Fig-I represents

(A) CaF ₂	(B) NaCl
(C) CsCl	(D) Na ₂ O

21. Fig-II represents

(A) CaF ₂	(B) KC
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(C) Csl	(D) K ₂ C
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Paragraph for Question Nos. 22 to 25

Silicon carbide (SiC) and diamond are covalent solids which crystallise in cubic structures. In SiC, carbon atoms occupy lattice points of the fcc lattice and silicon atoms occupy half of the tetrahedral voids available. In diamond, the same tetrahedral voids are occupied by carbon atoms. The densities of SiC and diamond are 3.2 and 3.6 gm/cm³, respectively. (Si = 28)

22. The radius of carbon atom is (approx)

(A) 0.76 Å	(B) 1.12 Å
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(C) 3.2 Å (D) 3.6 Å

23. The radius of silicon atom is (approx)

(A) 0.76 Å	(B) 1.12 Å
(C) 3.2 Å	(D) 3.6 Å

- 24. Which of the following will not change the density of solid SiC ?
 - (A) Substitution of some Si-atoms by some C-atoms
 - (B) Schottky defect
 - (C) Interchange of position of Si and C-atoms
 - (D) Decrease in temperature of solid
- 25. If the similar volume of SiC and diamond are considered, which of the following is the true statement ?
 - (A) The number of Si-atoms in SiC is 3.75 times the number of C-atoms in diamond
 - (B) The number of C-atoms in diamond is 3.75 times the number of Si-atoms in SiC
 - (C) The number of SiC formula units is 3.75 times the number of C-atoms in diamond
 - (D) The number of C-atoms in diamond is 3.75 times the number of SiC formula units

SECTION-D

Matrix-Match Type

This **Section D** have "match the following" type question. Question contains two columns, **Col-I** and **Col-II**. Match the entries in **Col-I** with the entries in **Col-II**. One or more entries in **Col-I** may match with one or more entries in **Col-II**.

26. Match the column:

	Column I	Column II
(A)	Rock salt structure	(p)Coordination number of cation is 4
(B)	Zinc blende structure	(q)0.433 a = r⁺ +r⁻
(C)	Fluorite structure	(r) Coordination number of cation and anion are same
		(s)Distance between two nearest anion is 0.707 a

27. Match the column:

	Column I	Column II
(A)	Rock salt	(p)Fraction of voids occupied = 1/3
(B)	Zinc blende	(q)Anions constitute lattice
(C)	Anti-fluorite	(r) Cations in tetrahedral voids
(D)	CsCl type	(s) C o o r d i n a t i o n number of cation and anion is same

SECTION-E

Integer Answer Type

This section contains Integer type questions. The answer to each of the questions is a single digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y and Z(say) are 6, 0 and 9, respectively, then the correct darkening of bubbles will look like the following :



28. A solid crystal is composed of X, Y and Z atoms. Y atoms are occupying 50% of octahedral voids, whereas X atoms are occupying the 100% tetrahedral void where as Z atoms in ccp arrangement. Then the number of Y atoms present per unit cell is

- 29. Potassium crystallizes in a body-centered cubic lattice, with a unit cell length a = 5.20 Å: What is the ratio of number of third nearest neighbours to the number of second nearest neighbours ?
- 30. A compound alloy of gold and copper crystallises in a cubic lattice in which gold atoms occupy the lattice points at the corners of each cube and

copper atoms occupy the centres of each cubic faces. Find the number of total atoms per unit cell.

31. Ice crystallizes in a hexagonal lattice having volume of the unit cell as 132×10^{-24} cm³. If density is 0.92 g cm⁻³ at a given temperature, then find the number of H₂O molecules per unit cell.

Level-2

SECTION - A

Straight Objective Type

This section contains multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

- Fe_xO (x < 1) is electrical conductor in solid state because
 - (A) it is an ionic solid
 - (B) it has cationic vacancies
 - (C) it has anionic vacancies
 - (D) it has Schottky defect
- Sulphide of cobalt metal has a cubic structure with four formula units per unit cell. If density is 4.269 g/cc and edge length of unit cell is 6.93Å, determine mass of sulphur required to produce 1.5 kg of this compound. (Molecular weight of Co = 58.94 and S = 32 amu)
 - (A) 1 kg (B) 0.673 kg
 - (C) 0.827 kg (D) 0.94 kg
- What fraction of the Ca atoms lies on the surface of a cubic crystal that is 1.0 cm in length, if the radius of Ca atom is 96 pm and it crystallizes in Body Centered Cubic arrangement.
 - (A) 1.11 × 10⁻⁸ (B) 2 × 10⁻⁶
 - (C) 3×10^{-4} (D) 2×10^{-7}
- Find the wrong statement:
 - (A) Both Schottky and Frenkel defect increases with increase in temperature
 - (B) Aragonite is a polymorph of calcite
 - (C) At 0 K, pure Si or Ge act as insulator
 - (D) Ionic liquids have very high pressure at room temperature

SECTION - B

Multiple Correct Answer Type

This section contains multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

- 5. Which of the following statement(s) is/are correct?
 - (A) The lattice positions left vacant by anion and occupied by electrons are called F-centres
 - (B) The presence of F-centres make the lattice electrically neutral and diamagnetic
 - (C) The presence of F-centres give colour to the crystals
 - (D) F-centres contain unpaired electrons

- 6. The h.c.p. and c.c.p. structures for a given crystal system of equal-sized spheres are expected to have
 - (A) the same volume
 - (B) the same number of particles within the given unit cell
 - (C) the same ratio, 0.74, of the total sphere volume to the unit-cell volume
 - (D) all of the above
- Which of the following is/are correct statement(s) about Fe₃O₄ crystal?
 - (A) Fe²⁺ ions occupy octahedral voids
 - (B) Fe³⁺ ions occupy tetrahedral voids only
 - (C) Fe³⁺ ions occupy octahedral as well as tetrahedral voids
 - (D) O²⁻ ions are present at the corner as well as the centre of alternate faces

SECTION - C

Linked Comprehension Type

This section contains paragraphs. Based upon this paragraph, some multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

Paragraph for Question Nos. 8 to 10

Tin metal exists in two allotropic forms $\alpha \& \beta$. β -Sn crystallises with a simple tetragonal unit cell having cell dimensions a = b = 0.302 nm and c = 0.318 nm. (Sn = 120)

8. How many atoms are there per unit cell in the β -form ?

(A) 1		(B) 2
(C) 4		(D) 6
	••	

9. What is the density of β-Sn ?
(A) 6.87 g/cm³
(B) 7.23 g/cm³
(C) 6.19 g/cm³
(D) 6.68 g/cm³

10. What is the molar volume ?

(A) 16.60 mL	(B) 17.47 mL
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(C) 19.39 mL (D) 120 mL

Paragraph for Question Nos. 11 to 14

In the hexagonal close-packed lattice, the height of the

unit cell can be given by c = $\sqrt{\frac{8}{3}}a$, where a is the

edge-length of the base unit. There is an atom at each corner of the unit cell and another atom which can be located by moving one-third the distance along the diagonal of the rhombus base, starting at the lower left-hand corner and moving perpendicular upward c/2. Mg

crystallises in this lattice and has a density of 1.74 g/cm^3 .

- 11. What is the voume of the unit cell ? (A) $4.64 \times 10^{-23} \text{ cm}^3$ (B) $1.37 \times 10^{-22} \text{ cm}^3$ (C) $2.784 \times 10^{-22} \text{ cm}^3$ (D) $9.28 \times 10^{-23} \text{ cm}^3$
- 12. What is a ? (A) 6 4 Å (B) 3 2 Å

(A) 0.4 A	(D) 3.2 A
(C) 1.6 Å	(D) 2.13 Å

13. What is the distance between nearest neighbours ?
 (A) 6.4 Å
 (B) 3.2 Å

(C) 1.6 Å	(D) 2.13 Å
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14. How many nearest neighbours does each atom have ?

(A) 6	(B) 9	(C) 12	(D) 3
(A) 0	(D) 9	(0) 12	(D) 3

SECTION-D

Matrix-Match Type

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15.	Match the column:										
	Column I	Col	umn II								
	(distance in terms of edge length of cubic unit cell, a)										
	(A) 0.866 a	(p)	Shortest distance between cations and anions in CsCl structure								
	(B) 0.707 a	(q)	Shortest distance between two cations in CaF ₂ structure								
	(C) 0.433 a	(r)	Shortest distance between carbon atoms in diamond								
		(s)	Shortest distance between two cations in rock salt structure								

SECTION-E

Integer Answer Type

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16. Edge length of $M^+ X^-$ (fcc structure) is 7.2 Å. Assuming $M^+ X^-$ contact along the cell edge, find

the radius of X⁻ ion in Å. $(r_{m^+} = 1.6 \text{Å})$

- 17. A compound AB has a rock salt type structure with A : B = 4 : 4. The formula weight of AB is 6.023 Y amu and closest A B distance is $Y^{1/3}$ nm, find the density of lattice in kg m⁻³.
- 18. If a geometric structure has 10 corners and 20 edges, the number of faces it has when divided by 2 gives a number that is
- 19. The shaded section of the unit cell contains _____ number of atoms





ANSWERS

LEVEL-1

1.	(C)	2.	(A)	3.	(D)	4.	(B)	5.	(A)	6.	(C)
7.	(A)	8.	(A)	9.	(B,C,D)	10.	(A,C)	11.	(A,C,D)	12.	(A,B)
13.	(A,B,C,D)	14.	(B,C,D)	15.	(A,B)	16.	(A,C)	17.	(B,C,D)	18.	(A,B,C,D)
19.	(A,C)	20.	(B)	21.	(A)	22.	(A)	23.	(B)	24.	(C)
25.	(B,D)	26.	(A-r,s,B-p,q,r,s,C	-q)		27.	(A-p,q,s,B-p,q,r,s	s,C-0	q,r,D-q,s)	28.	(2)
29.	(2)	30.	(4)	31.	(4)						

LEVEL-2

1.	(B)	2.	(B)	3.	(A)	4.	(D)	5.	(A,C,D)	6.	(C)
7.	(A,C)	8.	(A)	9.	(A)	10.	(B)	11.	(B)	12.	(B)
13.	(B)	14.	(C)	15.	(A-p,B-q,s,C-r)	16.	(2)	17.	(5)	18.	(6)
19.	(2)										