

EXERCISE - O

Definition in solid state

1. Which of the following statements is incorrect about amorphous solids?
(A) They are anisotropic
(B) They are rigid and incompressible
(C) They melt over a wide range of temperature
(D) There is no orderly arrangement of particles
CSS093
2. Which of the following features are shown by quartz glass
(a) This is a crystalline solid
(b) This has definite Heat of fusion
(c) This is also called super cooled liquid
(d) Refractive index is same in all the directions.
Correct answer is :-
(A) a and b (B) a, b and c (C) c and d (D) a, b, c and d
CSS094
3. A match box exhibits -
(A) Cubic geometry (B) Monoclinic geometry
(C) Tetragonal geometry (D) Orthorhombic geometry
CSS095
4. Crystal system in which maximum number of Bravais lattices are possible is
(A) Cubic (B) Triclinic (C) Orthorhombic (D) Rhombohedral
CSS096
5. The most unsymmetrical crystal system is :
(A) Cubic (B) Triclinic (C) Orthorhombic (D) Rhombohedral
CSS097
6. The correct option for the number of body centred unit cells in all 14 types of Bravais lattice unit cells is :
(A) 7 (B) 5 (C) 2 (D) 3
CSS098
7. Which of the following solids are not correctly matched with the bonds found between the constituent particles :
(A) Solid CO₂ : Vander Waal's (B) Graphite : Covalent and Vander Waal
(C) Grey Cast Iron : Ionic (D) Metal alloys : ions-delocalised electrons
CSS099
8. Which of the following is not correct for ionic crystals :
(A) They possess high melting point and boiling point
(B) All are electrolyte
(C) Exhibit the property of isomorphism
(D) Exhibit directional properties of the bond
CSS100

9. The smallest repeating pattern which when repeated in three dimensions results in the crystal of the substance is called
 (A) Space lattice (B) Crystal lattice
 (C) Unit cell (D) coordination number

CSS101

10. Which of the following is/are pseudo solids?
 I. KCl II. Barium chloride dihydrate
 III. Rubber IV. Solid cake left after distillation of coal tar
 (A) I, III (B) II, III (C) III, IV (D) III

CSS102

11. Match the column
 Column I Column II
 (A) Tetragonal and Hexagonal (P) are two crystal systems
 (B) Cubic and Rhombohedral (Q) $a = b \neq c$
 (C) Monoclinic and Triclinic (R) $a \neq b \neq c$
 (D) Cubic and Hexagonal (S) $a = b = c$
 (A) (A) $\rightarrow$ Q ; (B) $\rightarrow$ P, S ; (C) $\rightarrow$ P ; (D) $\rightarrow$ P (B) (A) $\rightarrow$ Q, P ; (B) $\rightarrow$ S ; (C) $\rightarrow$ P, R ; (D) $\rightarrow$ P
 (C) (A) $\rightarrow$ P, Q ; (B) $\rightarrow$ P, S ; (C) $\rightarrow$ S ; (D) $\rightarrow$ R (D) (A) $\rightarrow$ P, Q ; (B) $\rightarrow$ P, S ; (C) $\rightarrow$ P, R ; (D) $\rightarrow$ P

CSS103

Unit Cell

12. The correct relation between edge length (a) and radius of atom (r) in simple cubic unit cell is –
 (A) $a = r$ (B) $a = 2r$ (C) $a = \frac{r}{2}$ (D) None of these

CSS105

13. The packing efficiency of simple cubic unit cell is-
 (A) 0.68 (B) 0.74 (C) 0.52 (D) 0.32

CSS106

14. The second coordination number of atom in simple cubic unit cell is-
 (A) 4 (B) 6 (C) 8 (D) 12

CSS107

15. What percentage of space is vacant in simple cubic unit cell ?
 (A) 32% (B) 48% (C) 18% (D) None of these

CSS108

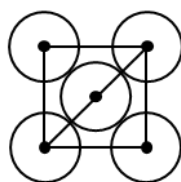
16. The third coordination number of atom in simple cubic unit cell is-
 (A) 4 (B) 6 (C) 8 (D) 12

CSS109

17. Packing fraction in 2-D hexagonal arrangement -
 (A) $\frac{\pi}{3\sqrt{2}}$ (B) $\frac{\pi}{3\sqrt{3}}$ (C) $\frac{\pi}{2\sqrt{3}}$ (D) $\frac{\pi}{6}$

CSS110

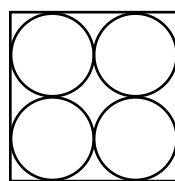
18. The packing efficiency of the two-dimensional square unit cell shown below is



- (A) 39.27% (B) 68.02% (C) 74.05% (D) 78.54%

CSS111

19. Identical 4 spheres are taken and are arranged in a layer of square packing touching each other as shown



The percentage of vacant space is

- (A) $100\left(1 - \frac{3\pi}{8}\right)$ (B) $100\left(1 - \frac{\pi}{6}\right)$ (C) $100 - \frac{3\pi}{8}$ (D) $\frac{\pi}{6}$

CSS112

Understanding Unit Cell

20. Number of atoms at second nearest position from a given atom in a BCC structure is
(A) 8 (B) 6 (C) 12 (D) 4

CSS115

21. Lithium forms body centred cubic structure. The length of the side of its unit cell is 351 pm. Atomic radius of the lithium will be :-
(A) 152 pm (B) 75 pm (C) 300 pm (D) 240 pm

CSS116

22. A cubic solid is made up of two elements 'A' and 'B'. Atoms 'B' are at the corners of the cube and 'A' at the body centre. The simplest formula of compound
(A) AB (B) A₂B (C) AB₂ (D) A₂B₃

CSS117

23. In the body-centred cubic unit cell & face centred cubic unit cell, the radius of atom in terms of edge length (a) of the unit cell is respectively:

- (A) $\frac{a}{2}, \frac{a}{2\sqrt{2}}$ (B) $\frac{a}{2\sqrt{2}}, \frac{\sqrt{3}a}{4}$ (C) $\frac{\sqrt{3}a}{4}, \frac{a}{2\sqrt{2}}$ (D) $\frac{\sqrt{3}a}{2}, \frac{a}{2\sqrt{2}}$

CSS118

24. Percentage area of each face covered by atoms in an FCC unit cell is -
(A) 60.4% (B) 68% (C) 74% (D) 78.5%

CSS119

25. Correct sequence of the coordination number in SCC, FCC & BCC is-
(A) 6, 8, 12 (B) 6, 12, 8 (C) 8, 12, 6 (D) 8, 6, 12

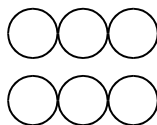
CSS120

26. In which of the following arrangement distance between two nearest neighbours is maximum, considering identical sized atoms in all arrangements ?
 (A) Simple cubic (B) BCC (C) FCC (D) equal in all CSS121
27. The ratio of densities if same element undergoes FCC as well as simple cubic packing will be (assume same atomic radius in both crystals)
 (A) $\sqrt{2} : 1$ (B) $1 : \sqrt{2}$ (C) $1 : 1$ (D) $\sqrt{2} : 3$ CSS122
28. Platinum crystallizes in a face centred cubic crystal with a unit cell length 'a'. The distance between nearest neighbours is:
 (A) a (B) $\frac{a\sqrt{3}}{2}$ (C) $\frac{a\sqrt{2}}{2}$ (D) $\frac{a\sqrt{2}}{4}$ CSS123

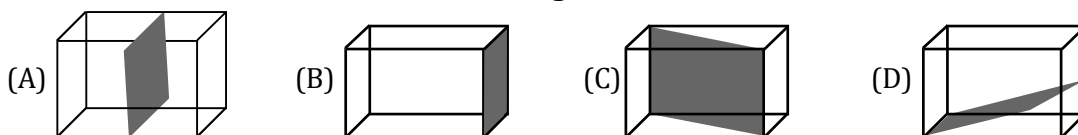
HCP Unit Cell

30. The coordination number of a metal crystallising in an HCP structure is
 (A) 12 (B) 4 (C) 8 (D) 6 CSS129
30. What is not true regarding hexagonal close packing (HCP)-
 (A) packing fraction is 0.74
 (B) coordination number is 12
 (C) ABC ABC.....type packing
 (D) Containing both tetrahedral and octahedral voids CSS130
31. Which one of the following schemes of ordering closest packed sheets of equal sized spheres do not generate close packed lattice.
 (A) ABCABC (B) ABACABAC (C) ABBAABBA (D) ABCBCABCBC CSS131
32. HCP crystal is made of A ions, and B ions are arranged in $\frac{2}{3}$ rd of octahedral voids. The simplest formula of compound is
 (A) A_4B_6 (B) A_6B_4 (C) A_2B_3 (D) A_3B_2 CSS132
33. All noble gases crystallise in the CCP structure except
 (A) Helium (B) Neon (C) Argon (D) Krypton CSS133
34. The ABAB close packing and ABC ABC close packing are respectively called :
 (A) hexagonal close packing (hcp) and cubic close packing (ccp)
 (B) ccp and hcp
 (C) body centred cubic (bcc) packing and hexagonal close packing (hcp)
 (D) hcp and bcc CSS134

35. Which of the following shaded plane in FCC lattice contains arrangement of atoms as shown by circles :



Figure



CSS135

Voids in Lattice

36. The size of an octahedral void formed in a closest packed lattice as compared to tetrahedral void is
(A) Equal (B) Smaller (C) Larger (D) Not definite

CSS141

37. Copper metal crystallizes in FCC lattice. Edge length of unit cell is 362 pm. The radius of largest atom that can fit into the voids of copper lattice without disturbing it is
(A) 53 pm (B) 45 pm (C) 93 pm (D) 87 pm

CSS142

38. In FCC unit cell smallest distance between octahedral void & tetrahedral void is -
(a = edge length of unit cell)

(A) $\frac{a}{\sqrt{2}}$ (B) $\frac{\sqrt{3}a}{2}$ (C) a (D) $\frac{\sqrt{3}a}{4}$

CSS143

39. A cubic solid is made by atoms 'A' forming close pack arrangement, 'B' occupying one-fourth of tetrahedral void and C occupying half of the octahedral voids. What is the formula of compound ?
(A) A_2BC (B) AB_2C (C) ABC_2 (D) ABC

CSS144

40. For ABC ABC ABC packing, distance between two successive tetrahedral voids is X and distance between two successive octahedral voids is y in a unit cell, then $\frac{y\sqrt{2}}{X}$ is

(A) 1 (B) 2 (C) 3 (D) 4

CSS145

41. An element 'M' crystallizes in ABAB....type packing. If adjacent layer A & B are $10\frac{\sqrt{2}}{\sqrt{3}}$ pm apart, then radius of largest sphere which can be fitted in the void without disturbing the lattice arrangement will be (Given : $\sqrt{2}=1.414$)

(A) 1.7 pm (B) 2.9 pm (C) 2.07 pm (D) 3.5 pm

CSS146

42. Distance between two nearest tetrahedral voids in FCC unit cell is -

(A) $\sqrt{2}a$ (B) $\frac{a}{\sqrt{2}}$ (C) $\frac{a}{2}$ (D) $\frac{a}{\sqrt{3}}$

CSS147

43. If the radius of Mg^{2+} ion, Cs^+ ion, O^{2-} ion, S^{2-} ion and Cl^- ion are 0.65 Å, 1.69 Å, 1.40 Å, 1.84 Å, and 1.81 Å respectively, the co-ordination numbers of the cations in the crystals of MgS, MgO and CsCl are respectively
 (A) 4, 6, 8 (B) 6, 4, 8 (C) 8, 6, 4 (D) 8, 4, 6

CSS148

44. The two ions A^+ and B^- have radii 88 pm and 200 pm respectively. In the closed packed crystal of compound AB, the co-ordination number of A^+
 (A) 2 (B) 4 (C) 6 (D) 8

CSS149

45. An ionic compound AB has ZnS type structure. If the radius of A^+ is 22.5 pm, then the ideal radius of B^- would be
 (A) 54.35 pm (B) 100 pm (C) 145.16 pm (D) none of these

CSS150

46. If a unit cell of FCC lattice is divided into eight identical small cubes, then
 (A) Each small cube contains one octahedral void.
 (B) Every alternate small cube contains one octahedral void.
 (C) Each small cube contains one tetrahedral void.
 (D) Every alternate small cube contains one tetrahedral void.

CSS151

47. In which of the following arrangement regular octahedral voids are formed?
 (a) BCC (b) FCC (c) HCP (d) SC
 Correct answer is
 (A) b and d (B) a and c (C) a, b and c (D) b and c

CSS152

Defects in Solid

48. Which of the following is the most likely to show Schottky defect ?
 (A) CaF_2 (B) ZnS (C) AgCl (D) CsCl

CSS153

49. In the Schottky defect, in AB type ionic solids
 (A) cations are missing from the lattice sites and occupy the interstitial sites
 (B) equal number of cations and anions are missing
 (C) anions are missing and electrons are present in their place
 (D) equal number of extra cations and electrons are present in the interstitial sites

CSS154

50. The measured density of AgI is 6.94 g/cm^3 and the theoretical density is 5.67 g/cm^3 . These data indicate that solid AgI has -
 (A) Schottky defect (B) Frenkel defect
 (C) Interstitial impurities defect (D) Both (A) and (B)

CSS155

51. Which of the following statement is CORRECT ?
 (A) A metal can show only non- stoichiometric defects
 (B) Schottky defect reduces the density of a solid due to significant increase in volume.
 (C) Impurity defect always change the density.
 (D) Solids having F-centres may have metal excess defect due to missing anions.

CSS156

52. Statement-1 : Due to Frenkel defect, there is no effect on the density of the crystalline solid.
Statement-2 : In Frenkel defect, no cation or anion leaves the crystal.
(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.
(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.
(C) Statement-1 is true, statement-2 is false.
(D) Statement-1 is false, statement-2 is true.

CSS157

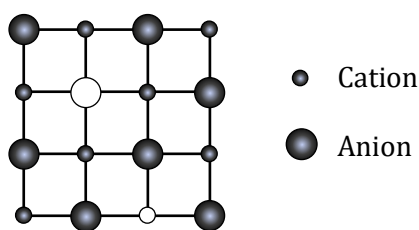
53. Due to Frenkel defect, the density of the ionic solids
(A) Increases (B) Decreases (C) Does not change (D) Changes

CSS158

54. Which of the following has Frenkel defect?
(A) Sodium chloride (B) Graphite (C) Silver bromide (D) Diamond

CSS159

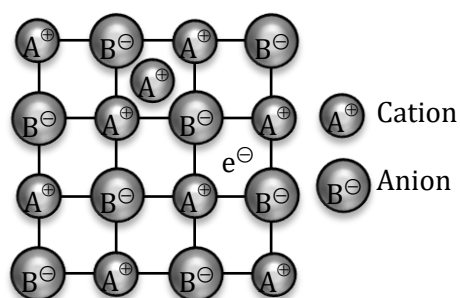
55. The structure shown here represents



- (A) Schottky defect (B) Frenkel defect (C) Metal excess defect (D) None

CSS160

56. The structure shown here represents



- (A) Schottky defect
(B) Frenkel defect
(C) Metal excess defect because of absent anion
(D) Metal excess defect because of excess cation

CSS161

57. In AgCl, the Ag^+ ions are displaced from their lattice position to an interstitial position. Such a defect is called
(A) Schottky defect (B) Frenkel defect (C) F-centre defect (D) Metal excess defect

CSS162

58. NaCl shows Schottky defect and AgCl shows Frenkel defect. Their electrical conductivity is due to the
 (A) Motion of electrons and not the motion of ions
 (B) Motion of ions and not the motion of electrons
 (C) Lower coordination number of NaCl
 (D) Higher coordination number of AgCl

CSS163

59. Due to Frenkel defect
 (A) Density of the crystal decreases (B) Conductivity increases
 (C) Conductivity decreases (D) Crystal becomes charged electrically

CSS164

Solid state (Miscellaneous)

60. A metal crystallises into two cubic phases, FCC and BCC whose unit cell lengths are 3.5 and 3.0 Å respectively. Calculate the ratio of densities of FCC and BCC.
 (A) 1.259 (B) 1.558 (C) 1.359 (D) 1.650

CSS165

61. In a solid "AB" having NaCl structure "A" atoms occupy the corners of the cubic unit cell. If all the face-centred atoms along one of the axes are removed, then the resultant stoichiometry of the solid is
 (A) AB₂ (B) A₂B (C) A₄B₃ (D) A₃B₄

CSS166

62. A substance A_xB_y crystallises in an FCC lattice in which atoms "A" occupy each corner of the cube and atoms "B" occupy the centres of each face of the cube. Identify the correct composition of the substance A_xB_y.
 (A) AB₃ (B) A₄B₃
 (C) A₃B (D) composition cannot be specified

CSS167

63. Which of the following FCC structure contains cations in alternate tetrahedral voids?
 (A) NaCl (B) ZnS (C) Na₂O (D) CaF₂

CSS168

64. If we mix a pentavalent impurity in a crystal lattice of germanium, what type of semiconductor formation will occur?
 (A) p-type (B) n-type (C) Both (A) and (B) (D) None of these

CSS169

65. Silicon doped with group 13 and group 15-member elements is, respectively, called semiconductor
 (A) p-type, n-type (B) n-type, p-type (C) p-type (D) n-type

CSS170

66. The electrical conductivity of semiconductor is
 (A) 10⁸ ohm⁻¹ cm⁻¹ (B) 10⁻²² ohm⁻¹ cm⁻¹
 (C) In the range of 10⁻⁹ to 10² ohm⁻¹ cm⁻¹ (D) None of the above

CSS171

67. Silicon and germanium are
(A) Conductors (B) Insulators (C) Semiconductors (D) None of the above
CSS172
68. To get n-type doped semiconductor, impurity to be added to silicon should have the following number of valence electrons
(A) 2 (B) 5 (C) 3 (D) 1
CSS173
69. A semiconductor of Ge can be made p-type adding
(A) Trivalent impurity (B) Tetravalent impurity
(C) Pentavalent impurity (D) Divalent impurity
CSS174
70. Which of the following metal oxide is anti-ferromagnetic in nature?
(A) MnO (B) TiO₂ (C) VO₂ (D) CrO₂
CSS175

MULTIPLE CORRECT TYPE QUESTIONS**Definition in solid state**

71. Which of the following statements is/are false.
(A) It is the isotropic nature of amorphous solids that all the bonds are of equal strength.
(B) Entropy of a crystalline solid is higher than that of an amorphous solid.
(C) Amorphous solids have definite volume but not definite shape.
(D) Amorphous solids can become crystalline on slow heating (annealing).
CSS104

Understanding Unit Cell

72. In a body centred unit cell containing only one type of atom. (R = Radius of atom)
(A) The edge length is equal to $\frac{4R}{\sqrt{3}}$.
(B) The edge length is equal to $\sqrt{2R^2 + 2R^2}$.
(C) The edge length is equal to $\frac{2d}{\sqrt{3}}$, where d = nearest neighbour distance.
(D) Shortest distance between next nearest neighbour atoms is $\frac{4R}{\sqrt{3}}$.
CSS124

HCP Unit Cell

73. Select the correct statements about three-dimensional HCP system.
(A) Number of atoms in HCP unit cell is six. (B) The volume of HCP unit cell is $24\sqrt{2} r^3$.
(C) The empty space in HCP unit cell is 26%. (D) The base area of HCP unit cell is $6\sqrt{3} r^2$.
CSS136

74. The HCP and CCP structure of a given element. (Given radius of element is same in both structures)
- (A) have same density
 - (B) have same distance between two consecutive layers (A & B)
 - (C) have same co-ordination number
 - (D) have same fraction of unoccupied space.

CSS137

Solid state (Miscellaneous)

75. Which of the following is/are true ?
- (A) Ratio of nearest neighbours in simple cubic cell to next nearest neighbours in face centred cubic cell is 1.
 - (B) Packing efficiency of a unit cell in which atoms are present at each corner and each edge centre is about 26 % in metallic crystal.
 - (C) Distance between two planes in FCC or HCP arrangement is same for a metal existing in both forms, with same atomic radius.
 - (D) If number of unit cell along one edge are 'x', then total number of unit cell in cube = x^3 .

CSS176

EXERCISE - S

1. Marbles of diameter 10 mm each are to be arranged on a flat surface so that their centres lie within the area enclosed by four lines of length each 40 mm. Sketch the arrangement that will give the maximum number of marbles per unit area, that can be enclosed in this manner and deduce the expression to calculate it.
CSS113
2. An element X (atomic wt. = 125) crystallises in simple cubic structure. If diameter of the largest atom which can be placed without disturbing unit cell is 366 pm. Find the density of pure element X in g/cm^3 .
[Given: $\sqrt{3} = 1.732$, $N_A = 6 \times 10^{23}$]
[Fill your answer by multiplying it with 300.]
CSS114
3. Xenon crystallises in the face-centred cubic lattice and the edge length of the unit cell is $438\sqrt{2}$ pm. What is the nearest neighbour distance and what is the radius of xenon atom?
CSS125
4. The effective radius of the iron atom is $\sqrt{2}$ Å. It has FCC structure. Calculate its density. (Fe = 56 amu, $N_A = 6 \times 10^{23}$)
CSS126
5. In FCC unit cell, what fraction of edge is not covered by atoms?
CSS127
6. Potassium has body-centred cubic structure with the nearest neighbour distance $260\sqrt{3}$ pm. Its density (in kg/m^3) would be
 $(\frac{1}{(5.2)^3} = 0.007, N_A = 6 \times 10^{23}, K = 39)$
CSS128
7. Graphite having hcp arrangement of carbon atoms if distance between two consecutive layers is 1.6 Å.
Calculate density of graphite in $\frac{\text{g}}{\text{cm}^3}$ ($N_A = 6 \times 10^{23}$) $(\frac{\sqrt{2}}{\sqrt{3}} = 0.8)$
(Write your answer by multiplying with $\sqrt{2}$)
CSS138
8. Element A crystallizes in HCP. Total number of tetrahedral voids in 24 micrograms of A are 6×10^x , the value of x ($N_A = 6 \times 10^{23}$, Atomic mass of A = 48)
CSS139
9. Find packing fraction of three-dimensional unit cell of AAAAAA.....type hypothetical arrangement in which hexagonal packing is taken in layer.
CSS140

10. An element (atomic weight = 125) crystallises in simple cubic structure. Diameter of the largest atom which can be placed without disturbing unit cell is 366 pm. If the density of element 'x' gm/cm³, the value of $\left(\frac{6x}{5}\right)$ is -

[Given : $\rho = 1.732$, $N_A = 6 \times 10^{23}$]

CSS177

11. The density of diamond from the fact that it has face centred cubic structure with two atoms per lattice point and unit cell edge length of 3.6 Å, is 'x' gm / cm³, then the value of (1.458x) is ($N_A = 6 \times 10^{23}$)

CSS178

12. Iron crystallizes in several modifications. At about 910°C, the body-centred cubic ' α ' form undergoes a transition to the face-centred cubic ' γ ' form. Assuming that the distance between nearest neighbours is the same in the two forms at the transition temperature, the ratio of the density of γ iron to that of α iron at the transition temperature, $x : 1$, then the value of $(3\sqrt{6}x)$ is.

CSS179

13. What are the percent by mass of titanium in rutile, a mineral that contain titanium and oxygen, if structure can be described as a closest packed array of oxide ions, with titanium in one half of the octahedral holes. What is the oxidation number of titanium? (Ti = 48)

CSS180

14. An element crystallizes into a structure which may be described by a cubic type of unit cell having one atom on each corner of the cube and two extra atoms on one of its body diagonals. If the volume of this unit cell is 2.4×10^{-23} cm³ and density of element is 7.2 g cm⁻³, calculate the number of atoms present in 288 g of element.

CSS181

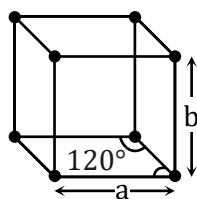
15. What will be packing fraction of solid in which atoms are present at corners and cubic void is occupied. The insertion of the sphere into void does not disturb simple cubic lattice.

[Given : $(\sqrt{3} - 1)^3 = 0.39$]

CSS182

16. Ice crystallizes in a hexagonal lattice. At the low temperature at which the structure was determined, the lattice constants where $a = 5$ Å, and $b = 3.5\sqrt{3}$ Å. How many molecules are contained in the given unit cell?

[density (ice) = $\frac{16}{17.5}$ gm/cm³]



CSS183

17. The mineral hawleyite, one form of CdS, crystallizes in one of the cubic lattices, with edge length $5.87 \text{ \AA}$. The density of hawleyite is 4.63 g cm^{-3} . (Cd = 112)
 (i) In which cubic lattice does hawleyite crystallize?
 (ii) Find the Schottky defect in g cm^{-3} .

CSS184

18. KCl crystallizes in the same type of lattice as does NaCl. Given that $\frac{r_{\text{Na}^{\oplus}}}{r_{\text{Cl}^{\ominus}}} = 0.5$ and $\frac{r_{\text{Na}^{\oplus}}}{r_{\text{K}^{\oplus}}} = 0.7$
 Calculate:
 (a) The ratio of the sides of unit cell for KCl to that for NaCl and
 (b) The ratio of densities of NaCl to that for KCl.

$$\left(\left(\frac{8}{7} \right)^3 = 1.5, \frac{74.5}{58.5} = 1.25 \right)$$

CSS185

19. A cubic unit cell contains manganese ions at the corners and fluoride ions at the center of each edge.
 (a) What is the empirical formula of the compound?
 (b) What is the co-ordination number of the Mn ion?
 (c) Calculate the edge length of the unit cell, if the radius of Mn ion is $0.65 \text{ \AA}$ and that of F^- ion is $1.36 \text{ \AA}$.

CSS186

20. Potassium crystallizes in a body-centred cubic lattice with edge length, $a = 5.2 \text{ \AA}$.
 (a) What is the distance between nearest neighbours?
 (b) What is the distance between next-nearest neighbours?
 (c) How many nearest neighbours does each K atom have?
 (d) How many next-nearest neighbours does each K atom have?
 (e) What is the density of crystalline potassium?
 (Given : $K = 39$, $(5.2)^3 = 140$)

CSS187

21. An element X (atomic weight = 24 gm/mole) forms a face centred cubic lattice. If the edge length of the lattice is $4 \times 10^{-8} \text{ cm}$ and the observed density is $2.40 \times 10^3 \text{ kg/m}^3$, calculate the percentage occupancy of lattice points by X element. (Given : $N_A = 6 \times 10^{23}$)

CSS188

22. Calculate the density (in gm/cm^3) of NaCl type ionic solid (Molar mass = 75 gm/mol) if distance between two nearest cations is $250\sqrt{2} \text{ pm}$ (Avogadro number = 6×10^{23})

CSS189

23. The olivine series of minerals consists of crystals in which Fe and Mg ions may substitute for each other causing substitutional impurity defect without changing the volume of the unit cell. In olivine series of minerals, oxide ion exists as FCC with Si^{4+} occupying $1/4^{\text{th}}$ of octahedral voids and divalent ions occupying $1/4^{\text{th}}$ of tetrahedral voids. The density of forsterite (magnesium silicate) is 3.0 g/cc and that of fayalite (ferrous silicate) is 4.0 g/cc . Find the formula of forsterite and fayalite minerals and the mass percentage of fayalite in an olivine with a density of 3.5 g/cc .

CSS190

EXERCISE - JEE (Advanced) PYQ

- In a solid "AB" having NaCl structure "A" atoms occupy the corners of the cubic unit cell. If all the face-centred atoms along one of the axes are removed, then the resultant stoichiometry of the solid is
 (A) AB_2 (B) A_2B (C) A_4B_3 (D) A_3B_4
[JEE (Advanced) 2000]
 CSS071
- The coordination number of a metal crystallising in a HCP structure is
 (A) 12 (B) 4 (C) 8 (D) 6
[JEE (Advanced) 2000]
 CSS072
- A substance A_xB_y crystallises in an FCC lattice in which atoms "A" occupy each corner of the cube and atoms "B" occupy the centres of each face of the cube. Identify the correct composition of the substance A_xB_y .
 (A) AB_3 (B) A_4B_3
 (C) A_3B (D) composition cannot be specified
[JEE (Advanced) 2002]
 CSS073
- AB crystallizes in a rock salt structure with $A : B = 1 : 1$. The shortest distance between A and B is $Y^{1/3}$ nm. The formula mass of AB is 6.023 Y amu where Y is any arbitrary constant. Find the density in $kg\ m^{-3}$.
[JEE (Advanced) 2004]
 CSS074
- An element crystallises in FCC lattice having edge length 400 pm. Calculate the maximum diameter which can be placed in interstitial sites without disturbing the structure.
[JEE (Advanced) 2005]
 CSS075
- Which of the following FCC structure contains cations in alternate tetrahedral voids?
 (A) NaCl (B) ZnS (C) Na_2O (D) CaF_2
[JEE (Advanced) 2005]
 CSS076
- The edge length of unit cell of a metal having atomic weight 75 g/mol is 5 Å which crystallizes in cubic lattice. If the density is 2 g/cc then find the radius of metal atom. ($N_A = 6 \times 10^{23}$). Give the answer in pm.
[JEE (Advanced) 2006]
 CSS077
- Match the crystal system / unit cells mentioned in Column I with their characteristic features mentioned in Column II. Indicate your answer by darkening the appropriate bubbles of the 4×4 matrix given in the ORS.

Column I	Column II
(A) simple cubic and face-centred cubic	(P) have these cell parameters $a = b = c$ and $\alpha = \beta = \gamma$
(B) cubic and rhombohedral	(Q) are two crystal systems
(C) cubic and tetragonal	(R) have only two crystallographic angles of 90°
(D) hexagonal and monoclinic	(S) belong to same crystal system.

[JEE (Advanced) 2007]
 (A) $A \rightarrow P, S; B \rightarrow P, Q; C \rightarrow Q; D \rightarrow Q, R$ (B) $A \rightarrow P, S; B \rightarrow Q, P; C \rightarrow Q; D \rightarrow Q$
 (C) $A \rightarrow S, R; B \rightarrow P, Q; C \rightarrow Q; D \rightarrow Q, R$ (D) $A \rightarrow P, S; B \rightarrow S, P; C \rightarrow Q; D \rightarrow Q$
 CSS078

Paragraph for Question No. 9 to 11

In hexagonal systems of crystals, a frequently encountered arrangement of atoms is described as a hexagonal prism. Here, the top and bottom of the cell are regular hexagons and three atoms are sandwiched in between them. A space-filling model of this structure, called hexagonal close-packed (HCP), is constituted of a sphere on a flat surface surrounded in the same plane by six identical spheres as closely as possible. Three spheres are then placed over the first layer so that they touch each other and represent the second layer. Each one of these three spheres touch three spheres of the bottom layer. Finally, the second layer is covered with a third layer that is identical to the bottom layer in relative position. Assume radius of every sphere to be 'r'.

9. The number of atoms in this HCP unit cells is [JEE (Advanced) 2008]
(A) 4 (B) 6 (C) 12 (D) 17

CSS079

10. The volume of this HCP unit cell is [JEE (Advanced) 2008]
(A) $24\sqrt{2}r^3$ (B) $16\sqrt{2}r^3$ (C) $12\sqrt{2}r^3$ (D) $\frac{64}{3\sqrt{3}}r^3$

CSS080

11. The empty space in this HCP unit cell is [JEE (Advanced) 2008]
(A) 74% (B) 47.6 % (C) 32% (D) 26%

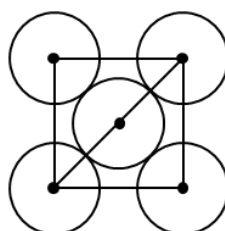
CSS081

12. The correct statement(s) regarding defects in solid is (are) [JEE (Advanced) 2009]
(A) Frenkel defect is usually favoured by a very small difference in the sizes of cation and anion.
(B) Frenkel defect is a dislocation defect
(C) Trapping of an electron in the lattice leads to the formation of F-center.
(D) Schottky defects have no effect on the physical properties of solids.

CSS082

13. The packing efficiency of the two-dimensional square unit cell shown below is

[JEE (Advanced) 2010]

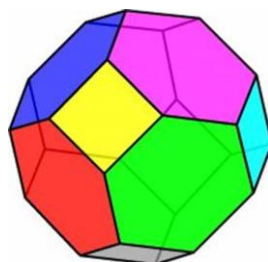


- (A) 39.27% (B) 68.02% (C) 74.05% (D) 78.54%

CSS083

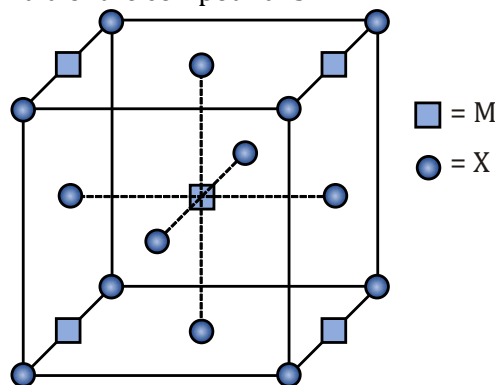
14. The number of hexagonal faces that present in a truncated octahedron is.

[JEE (Advanced) 2011]



CSS084

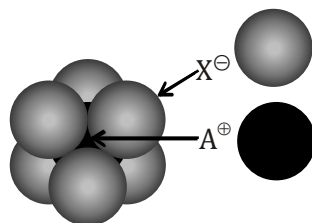
15. A compound M_pX_q has cubic close packing (CCP) arrangement of X. Its unit cell structure is shown below. The empirical formula of the compound is : [JEE (Advanced) 2012]



- (A) MX (B) MX_2 (C) M_2X_4 (D) M_5X_{14}

CSS085

16. The arrangement of $X^\ominus$ ions around $A^\oplus$ ion in solid AX is given in the figure (not drawn to scale). If the radius of $X^\ominus$ is 250 pm, the radius of $A^\oplus$ is - [JEE (Advanced) 2013]



- (A) 104 pm (B) 125 pm (C) 183 pm (D) 57 pm

CSS086

17. The **CORRECT** statement(s) for cubic close packed (CCP) three-dimensional structure is (are) [JEE (Advanced) 2016]
- (A) The number of the nearest neighbours of an atom present in the topmost layer is 12
 (B) The efficiency of atom packing is 74%
 (C) The number of octahedral and tetrahedral voids per atom are 1 and 2, respectively
 (D) The unit cell edge length is $2\sqrt{2}$ times the radius of the atom

CSS087

18. A crystalline solid of a pure substance has a face-centred cubic structure with a cell edge of 400 pm. If the density of the substance in the crystal is 8 g cm^{-3} , then the number of atoms present in 256g of the crystal is $N \times 10^{24}$. The value of N is [JEE (Advanced) 2017]

CSS088

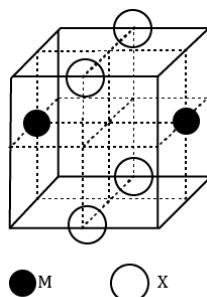
19. Consider an ionic solid MX with NaCl structure. Construct a new structure (Z) whose unit cell is constructed from the unit cell of MX following the sequential instructions given below. Neglect the charge balance. [JEE (Advanced) 2018]
- (i) Remove all the anions (X) except the central one
 (ii) Replace all the face centred cations (M) by anions (X)
 (iii) Remove all the corner cations (M)
 (iv) Replace the central anion (X) with cation (M)

The value of $\left(\frac{\text{number of anions}}{\text{number of cations}} \right)$ in Z is ____.

CSS089

20. The cubic unit cell structure of a compound containing cation M and anion X is shown below. When compared to the anion, the cation has smaller ionic radius. Choose the correct statement(s).

[JEE Advanced 2020]



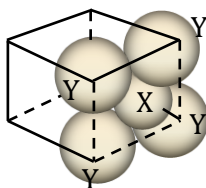
- (A) The empirical formula of the compound is MX.
 (B) The cation M and anion X have different coordination geometries.
 (C) The ratio of M-X bond length to the cubic unit cell edge length is 0.866.
 (D) The ratio of the ionic radii of cation M to anion X is 0.414.

CSS090

21. For the given close packed structure of a salt made of cation X and anion Y shown below (ions of only one face are shown for clarity), the packing fraction is approximately

$$\left(\text{packing fraction} = \frac{\text{Packing efficiency}}{100} \right)$$

[JEE Advanced 2021]



- (A) 0.74 (B) 0.63 (C) 0.52 (D) 0.48

CSS091

22. Atom X occupies the fcc lattice sites as well as alternate tetrahedral voids of the same lattice. The packing efficiency (in %) of the resultant solid is closest to

[JEE Advanced 2022]

- (A) 25 (B) 35 (C) 55 (D) 75

CSS092

JEE (Advanced) Practice Paper

SECTION-I

- This section contains **SIX** questions.
 - Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
 - For each question, darken the bubble corresponding to the correct option in the ORS.
 - For each question, marks will be awarded in one of the following categories:
 Full Marks : +3, if only the bubble corresponding to the correct option is darkened.
 Zero Marks : 0, if none of the bubbles is darkened.
 Negative Marks : -1, in all other cases
-
1. The interstitial hole is called tetrahedral because :-
 (A) it is formed by four spheres.
 (B) partly same and partly different
 (C) it is formed by four spheres the centres of which form a regular tetrahedron.
 (D) none of the above three

CSS051
 2. The mass of a unit cell of CsCl corresponds to :-
 (A) 1 Cs⁺ and 1 Cl⁻ (B) 1 Cs⁺ and 6 Cl⁻
 (C) 4 Cs⁺ and 4 Cl⁻ (D) 8 Cs⁺ and 1 Cl⁻

CSS052
 3. Choose the correct option.
 (A) Two adjacent face centred atoms don't touch each other in fcc unit cell because they are not nearest atoms in lattice.
 (B) Number of nearest Na⁺ ions of another Na⁺ in Na₂O crystal will be 24.
 (C) Minimum distance between two cubical voids in simple cubic unit cell lattice will be 'a' where 'a' is length of edge of unit cell
 (D) Due to defects in solids, density of solids either remains constant or decreases but it can never increase.

CSS053
 4. The effective radius of the iron atom is 1.42 Å. It has FCC structure. Calculate its density (Fe = 56 amu).
 (A) 2.87 g/cm³ (B) 11.48 g/cm³ (C) 1.435 g/cm³ (D) 5.74 g/cm³

CSS054
 5. Give the correct order of initials T (true) or F (False) for following statements :
 I. In an anti-fluorite structure anion form FCC lattice and cations occupy all tetrahedral voids.
 II. If the radius of cations and anions are 0.2Å and 0.95Å then coordinate number of cations in the crystal is 4.
 III. An atom/ion is transferred from a lattice site to an interstitial position in Frenkel defect.
 IV. Density of crystal always increases due to substitutional impurity defect.
 (A) TFFF (B) FTTF (C) TFFT (D) TFTF

CSS055

6. An element crystallizes in a structure having FCC unit cell of an edge 200 pm. Calculate the density, if 200 g of this element contains 5×10^{24} atoms. ($N_A = 6 \times 10^{23}$)
 (A) 5 g/cm³ (B) 30 g/cm³ (C) 10 g/cm³ (D) 20 g/cm³

CSS056

SECTION-II

- This section contains **EIGHT** questions.
- Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s).
- For each question, choose the correct option(s) to answer the question.
- Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +4, if only (all) the correct option(s) is (are) chosen.
Partial Marks : +3, if all the four options are correct but ONLY three options are chosen.
Partial Marks : +2, if three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks : +1, if two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks : 0, if none of the options is chosen (i.e. the question is unanswered).
Negative Marks : -2, in all other cases.

7. In a body centred unit lattice of A (Given : R = radius of atom A)
 (A) The edge length is equal to $\frac{4R}{\sqrt{3}}$
 (B) Coordination number of atom is 6
 (C) The edge length is equal to $\frac{2d}{\sqrt{3}}$, where d = nearest neighbour distance
 (D) The square of the edge length is equal to $16R^2$ where R is the radius of atom

CSS057

8. Select the correct statement about FCC (ABCAB...) structure.

- (A) Distance between nearest octahedral void and tetrahedral void is $\frac{\sqrt{3}a}{4}$
 (B) Distance between two nearest octahedral void is $\frac{a}{\sqrt{2}}$
 (C) Distance between two nearest tetrahedral void is $\frac{\sqrt{3}a}{2}$
 (D) Distance between layer A and B is $2r\sqrt{\frac{2}{3}}$

CSS058

9. For an ionic solid in FCC crystal lattice ($M_w = 300$) observed density is 2 g/cm³. What type of defect may be present in to it. (edge length of unit cell = 1 nm) (take $N_A = 6 \times 10^{23}$)
 (A) Schottky defect (B) Frenkel defect
 (C) Non-stoichiometric defect (D) Substitutional impurity defect

CSS059

10. Lead metal has a density of 11.34 g/cm^3 and crystallizes in a face-centred lattice. Choose the correct alternatives. (Atomic weight of Pb = 207)
 (A) the volume of one-unit cell is $1.214 \times 10^{-22} \text{ cm}^3$
 (B) the volume of one-unit cell is $1.214 \times 10^{-19} \text{ cm}^3$
 (C) the atomic radius of lead is 175 pm
 (D) the atomic radius of lead is 155.1 pm
 CSS060
11. Select the correct statement (s) :
 (A) CsCl mainly shows Schottky defect (B) ZnS mainly shows Frenkel defect
 (C) NaCl unit cell contain 4Na^+ and 4Cl^- (D) Truncated octahedron has 24 corners.
 CSS061
12. Select the correct statement(s) –
 (A) The ionic crystal of AgBr has Schottky defect.
 (B) The unit cell having crystal parameters, $a = b \neq c$, $\alpha = \beta = 90^\circ$, $\gamma = 120^\circ$ is hexagonal
 (C) Ionic compounds having Frenkel defect has high r^+/r^- ratio.
 (D) The co-ordination number of Na^+ ion in NaCl is 6
 CSS062
13. A cubic unit cell contains manganese ions at the corners and fluoride ions at the centre of each edge. The radius of Mn ion is $0.65 \text{ \AA}$ and that of F^- ion is $1.36 \text{ \AA}$. (Atomic weight of F = 19, Mn = 55)
 (A) The empirical formula of compound is MnF_3
 (B) The coordination number of the Mn ion is 6
 (C) The edge length of the unit cell is $4.02 \text{ \AA}$
 (D) The density of the compound is 2.86 g/cc
 CSS063
14. In a solid AB having NaCl type structure an atoms occupy the corner of the cubic unit cell and the face centred positions. If all the atoms lying along one of the face-centred axes are removed, choose the correct options:
 (Atomic weight of A = 40, Atomic weight of B = 60, $r_A = 1.4 \text{ \AA}$, $r_B = 2.8 \text{ \AA}$)
 (A) the packing fraction is 0.579 (B) The density of the resultant solid is 0.85 g/cc
 (C) The packing faction is 0.52 (D) The density of the resultant solid is 2.008 g/cc
 CSS064

SECTION-III

- This section contains **TWO** questions.
- Each question has matching lists.** The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**
- For each question, marks will be awarded in one of the following categories :
 Full Marks : +3, if only the bubble corresponding to the correct option is darkened.
 Zero Marks : 0, if none of the bubbles is darkened.
 Negative Marks : -1, in all other cases.

15. Match the column

Column I

- (A) Tetragonal and Hexagonal
 (B) Cubic and Rhombohedral
 (C) Monoclinic and Triclinic
 (D) Cubic and Hexagonal
 (A) $A \rightarrow Q, P; B \rightarrow P, S; C \rightarrow P, R; D \rightarrow S$
 (B) $A \rightarrow P, Q; B \rightarrow P, S; C \rightarrow P, R; D \rightarrow P$
 (C) $A \rightarrow S; B \rightarrow P, S; C \rightarrow P, R; D \rightarrow P$
 (D) $A \rightarrow P, Q; B \rightarrow P, S; C \rightarrow S, Q; D \rightarrow P$

Column II

- (P) are two crystal systems
 (Q) $a = b \neq c$
 (R) $a \neq b \neq c$
 (S) $a = b = c$

CSS065

16. **Column-I**

- (A) Spinel structure
 (B) Glass
 (C) Quartz
 (D) Metallic crystal
 (E) Show Schottky defect
 (A) $A \rightarrow q; B \rightarrow s; C \rightarrow p; D \rightarrow t; E \rightarrow r$
 (B) $A \rightarrow r; B \rightarrow s; C \rightarrow p; D \rightarrow t; E \rightarrow r$
 (C) $A \rightarrow q; B \rightarrow s; C \rightarrow r; D \rightarrow t; E \rightarrow p$
 (D) $A \rightarrow s; B \rightarrow q; C \rightarrow p; D \rightarrow t; E \rightarrow r$

Column-II

- (p) Framework silicate
 (q) ZnFe_2O_4
 (r) NaCl crystal
 (s) Pseudo solid
 (t) Malleable and ductile

CSS066

SECTION-IV

- This section contains a paragraph.
- Based on each paragraph, there are **TWO** questions.
- Each question has **FOUR** options (A), (B), (C) and (D) **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +3, if only the bubble corresponding to the correct answer is darkened.

Zero Marks : 0 in all other cases.

Paragraph for Q.17 & Q.18

Solid balls of radius 17.32 cm crystallises in bcc pattern. During one such crystallisation, some oxygen gas is trapped. This trapped oxygen at 640K creates pressure of 5 atm.

Assume :

- (i) BCC arrangement is not disturbed due to trapping of gas.
 (ii) Gas is uniformly distributed inside unit cell

[Take $R = 0.08 \text{ atm-litre/mole-K}$, $N_A = 6 \times 10^{23}$, Mass of a solid ball = 64 gms]

17. Number of oxygen molecules present in an unit cell is -

- (A) 2.4×10^{24} (B) 1.2×10^{24} (C) 6×10^{23} (D) 3×10^{23}

CSS067

18. Calculate percentage increase in density due to trapping of gas
(A) 16.67 % (B) 33.33 % (C) 100% (D) 50%

CSS068

SECTION-V

- This section contains **TWO** questions.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. 6.25, 7.00, -0.33, -0.30, 30.27, -127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct).
- Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +3, if ONLY the correct numerical value is entered as answer.
Zero Marks : 0, in all other cases.

19. If coordination number of primitive cubic arrangement is 'x', BCC arrangement is 'y' and FCC arrangement is 'z' then give $\frac{x \times z}{y}$.

CSS069

20. The edge length of the unit cell of KCl (NaCl like structure; FCC) is 6.28 Å. Assuming anion-cation contact along the cell edge, calculate the radius of the potassium ion. ($r_{\text{Cl}^-} = 1.82 \text{ Å}$).

CSS070

ANSWER KEY

EXERCISE - O

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	A	C	D	C	B	D	C	D	C	C
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	D	B	C	D	B	C	C	D	B	B
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	A	A	C	D	B	D	A	C	A	C
Que.	31	32	33	34	35	36	37	38	39	40
Ans.	C	D	A	A	C	C	A	D	A	B
Que.	41	42	43	44	45	46	47	48	49	50
Ans.	C	C	A	C	B	C	D	D	B	C
Que.	51	52	53	54	55	56	57	58	59	60
Ans.	D	A	C	C	A	D	B	B	B	A
Que.	61	62	63	64	65	66	67	68	69	70
Ans.	D	A	B	B	A	C	C	B	A	A
Que.	71	72	73	74	75					
Ans.	ABC	ACD	ABCD	ABCD	ABCD					

EXERCISE - S

1. 18 2. 500 3. 438,219 4. 5.83
5. 0.293 6. 910 7. 5 8. 17
9. 0.604 10. 2 11. 5 12. 8
13. 60%, +4 14. 5×10^{24} 15. 0.72 or 0.73 16. 4
17. (i) FCC (ii) 0.116 g/cc 18. (a) 1.14, (b) 1.20
19. (a) MnF_3 , (b) 6, (c) $4.02 \text{ \AA}$
20. (a) $4.5 \text{ \AA}$, (b) $5.2 \text{ \AA}$, (c) 8, (d) 6, (e) 0.929 g/cm^3
21. 96% 22. 4 23. Mg_2SiO_4 , Fe_2SiO_4 , 57.14%

EXERCISE - JEE (Advanced) PYQ

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	D	A	A	5	117.1	B	216	A	B	A
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	D	BC	D	8	B	A	BCD	2	3	AC
Que.	21	22								
Ans.	B	B								

JEE (Advanced) Practice Paper

Section-I	Q.	1	2	3	4	5	6			
	A.	C	A	C	D	D	D			
Section-II	Q.	7	8	9	10	11	12	13	14	
	A.	AC	ABD	B	AC	ABCD	ABD	ABCD	BC	
Section-III	Q.	15	16							
	A.	B	A							
Section-IV	Q.	17	18							
	A.	B	D							
Section-V	Q.	19	20							
	A.	9	1.32							