SELECT THE CORRECT ALTERNATIVE (ONLY ONE CORRECT ANSWER)

1. A solid has a structure in which W atoms are located at the corners of a cubic lattice, O atom at the centre of the eges and Na atom at centre of the cubic. The formula for the compound is :-

(A) $NaWO_2$ (B) $NaWO_3$ (C) Na_2WO_3 (D) $NaWO_4$

2. Which of the following statements is correct in the rock-salt structure of an ionic compounds?

(A) coordination number of cation is four whereas that of anion is six.

(B) coordination number of cation is six whereas that of anion is four.

(C) coordination number of each cation and anion is four.

(D) coordination number of each cation and anion is six.

3. The coordination number of cation and anion in Fluorite CaF_2 and CsCl are respectively :-

(A) 8 : 4 and 6 : 3 (B) 6 : 3 and 4 : 4 (C) 8 : 4 and 8 : 8 (D) 4 : 2 and 2 : 4

4. 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

5. The tetrahedral voids formed by ccp arrangement of Cl^- ions in rock salt structure are :-

(A) occupied by Na^+ ions (B) occupied by Cl^- ions

(C) occupied by either Na^+ or Cl^- ions (D) vacant

6. The number of nearest neighbours around each particle in a face-centred cubic lattice is :-

(A) 4 (B) 6 (C) 8 (D) 12

7. The intermetallic compound LiAg crystallizes in cubic lattice in which both lithium and silver have coordination number of eight. The crystal class is :-

(A) simple cubic (B) body centred cubic (C) face centred cubic (D) none

8. 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^-

9. In the closest packing of atoms A (radius : r_a), the radius of atom B that can be fitted into tetrahedral voids is :-

(A) 0.155 r_a (B) 0.225 r_a (C) 0.414 r_a (D) 0.732 r_a

10. Which of the following will show schottky defect :-

(A) CaF_2 (B) Zns (C) AgCl (D) CaCl

11. 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. What is the formula of compound.

(A) AB(B) AB_2 (C) A_2B (D) None

12. A compound alloy of gold and copper crystallizes in a cubic lattice in which gold occupy that lattice point at corners of the cube and copper atom occupy the centres of each of the cube faces. What is the formula of this compound.

(A) $AuCu_6$ (B) AuCu (C) $AuCu_3$ (D) None

13. KF crystallizes in the NaCl type structure. If the radius of K^+ ions 132 pm and that of F^- ion is 135 pm, what is the closet K–K distance ?

(A) Can not say (B) 534 pm (C) 755 pm (D) 378 pm

14. AgCl has the same structure as that of NaOH. The edge length of unit cell of AgCl is found to be 555 pm and the density of AgCl is 5.561 g cm^{-3}. Find the percentage of sites that are unoccupied.

(A) 0.24% (B) 2.4% (C) 24% (D) None

15. The two ions A^+ and B^- have radii 88 and 200 pm respectively. In the closed packed crystal of compound AB, predict the co-ordination number of A^+ .

(A) 6 (B) 8 (C) 4 (D) None

16. The effective radius of the iron atom is 1.42 Å. It has FCC structure. Calculate its density (Fe = 56 amu).

(A) 2.87 gm/cm^3 (B) 11.48 gm/cm^3 (C) 1.435 gm/cm^3 (D) 5.74 gm/cm^3

CHECK YOUR GRASP — ANSWER KEY — EXERCISE -1

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	D	C	C	D	D	B	A	B	D	A	C	D	A	A
Que.	16														
Ans.	D														

SELECT THE CORRECT ALTERNATIVES (ONE OR MORE THEN ONE CORRECT ANSWERS)

1. The density of CaF_2 (fluorite structure) is 3.18 g/cm^3. The length of the side of the unit cell is :-

(A) 253 pm (B) 344 pm (C) 546 pm (D) 273 pm

2. If the anions (A) form hexagonal closest packing and cations (C) occupy only 2/3 octahedral voids in it, then the general formula of the compound is :-

(A) CA (B) CA_2 (C) C_2A_3 (D) C_3A_2

3. A solid is formed and it has three types of atoms X, Y, Z. X forms a FCC lattice with Y atoms occupying all the tetrahedral voids and Z atoms occupying half the octrahedral voids. The formula of the solid is :-

(A) X_2Y_4Z (B) XY_2Z_4 (C) X_4Y_2Z (D) X_4YZ_2

4. A compound XY crystallizes in BCC lattice with unit cell edge length of 480 pm. If the radius of Y^- is 225 pm, then the radius of X^+ is :-

(A) 127.5 pm (B) 190.68 pm (C) 225 pm (D) 255 pm

5. Which one of the following schemes of ordering closed packed sheets of equal sized spheres do not generate close packed lattice.

(A) ABCABC (B) ABACABAC (C) ABBAABBA (D) ABCBCABCBC

6. An ionic compound AB has ZnS type structure. If the radius 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

7. NH_4Cl crystallizes in a body - centred cubic type lattice with a unit cell edge length of 387 pm. The distance between the oppositively charged ions in the lattice is :-

(A) 335.1 pm (B) 83.77 pm (C) 274.46 pm (D) 137.23 pm

8. r_{Na^+} = 95 pm and r_{Cl^-} = 181 pm in NaCl (rock salt) structure. What is the shortest distance between Na^+ ions ?

(A) 778.3 pm (B) 276 pm (C) 195.7 pm (D) 390.3 pm

9. In diamond, carbon atom occupy FCC lattice points as well as alternate tetrahedral voids. If edge length of the unit cell is 356 pm, then radius of carbon atom is :-

(A) 77.07 pm (B) 154.14 pm (C) 251.7 pm (D) 89 pm

10. Give the correct order of initials T (true) or F (False) for following statements :

I. In an anti-fluorite structure anions 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 cation 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 substitutinal impurity defect.

(A) TFFF (B) FTTF (C) TFFT (D) TFTF

11. 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) $A_4B_4C_2$ (B) $A_4B_2C_4$ (C) A_4BC (D) $A_4B_2C_2$

12. What is the percent by mass of titanium in rutile, a mineral that contain titanium and oxygen, if structure can be described as a closet packed array of oxide ions, with titanium in one half of the octahedral holes. What is the oxidation number of titanium ?

(A) ≈ 30%, +4 (B) $\tilde{-}$ 60%, +2 (C) $\tilde{-}$ 60%, +4 (D) $\tilde{-}$ 30%, +2

13. Spinel is a important class of oxides consisting of two types of metal ions with the oxide ions arranged in CCP pattern. The normal spinel has one - eight of the tetrahedral holes occupied by one type of metal ion and one half of the octahedral hole occupied by another type of metal ion. Such a spinel is formed by Zn^{2+}, Al^{3+}, O^{2-}, with Zn^{2+} in the tetrahedral holes. Given the formula of spinel.

(A) $ZnAl_2O_4$ (B) Zn_2AlO_4 (C) $Zn_2Al_2O_4$ (D) None

14. Calculate the density of diamond from the fact that it has face centered cubic structure with two atoms per lattice point and unit cell edge length of 3.569 Å.

(A) 7 gm/cm^3 (B) 1.75 gm/cm^3 (C) 3.5 gm/cm^3 (D) None

15. 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 atoms on one of its body diagonals. If the volume of this unit cell is 24 10^{24} cm^3 and density of element is 7.2 g cm^{-3}, calculate the number of atoms present in 200 g of element.

(A) 1.1513 10^{24} (B) 3.472 10^{24} (C) 10.416 10^{24} (D) None

16. Silver has an atomic radius of 144 pm and the density of silver is 10.6 cm^{-3}. To which type of cubic crystal, silver belongs ?

(A) HCP (B) BCC (C) Simple cubic (D) FCC

17. Xenon crystallises in the face-centred cubic lattice and the edge of the unit cell is 620 pm. What is the next nearest neighbour distance ?

(A) 738.5 pm (B) 620 pm (C) 438.5 pm (D) 310 pm

18. CsCl has the bcc arrangement and its unit cell edge length is 400 pm. Calculate the interionic distance in CsCl.

(A) 141.42 pm (B) 282.84 pm (C) 346.4 pm (D) 173.2 pm

19. 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.

(A) 5 m/cm^3 (B) 30 gm/cm^3 (C) 10 gm/cm^3 (D) 20 gm/cm^3

20. If the length of the body diagonal for CsCl which crystallises into a cubic structure with Cl^- ions at the corners and Cs^+ ions at the centre of the unit cells is 7 Å and the radius of the Cs^+ ion is 1.69 Å. What is the radii for Cl^- ion ?

(A) 1.81 Å (B) 5.31 Å (C) 3.62 Å (D) none

BRAIN TEASERS — ANSWER KEY — EXERCISE -2

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	C	A	B	C	B	A	D	A	D	D	C	A	C	B
Que.	16	17	18	19	20										
Ans.	D	B	C	D	A										

EXERCISE–03 MISCELLANEOUS TYPE QUESTIONS

TRUE / FALSE

1. Crystalline solids are isotropic.
2. Rhombohedral, triclinic and hexagonal are the unit cells, which have only primitive arrangement possible.
3. Packing fraction of FCC and HCP units cells are same.
4. The minimum void fraction for any unit cell in any shape having only one type of atom and all voids unfilled is 0.26.
5. Packing fraction of a lattice structure depends on the radius of the atom crystallizing in it.
6. The location of tetrahedral voids in FCC units cell are the centres of 8 minicubes forming a large cube.
7. Effective number of octahedral voids in a unit cell is equal to the effective number of atoms in the unit cell.
8. Radius ratio for co-ordination number 4 having tetrahedral and square planar geometry is same.
9. The radius ratio value for co-ordination number 4 having square planar geometry and co-ordination number 6 having octahedral geometry is same.
10. A metallic element crystallises into a lattice containing a sequence of layers AB AB AB ..... Any packing of spheres leaves out voids in the lattice. 26% percent by volume of this lattice is empty space.

FILL IN THE BLANKS

1. The relation between edge length (a) and radius of atom (r) for BCC lattice is ..... .
2. The relation between edge length (a) and radius of atom (r) for FCC lattice is ..... .
3. ABCABC ..... layering pattern is called ..... packing, found in ..... lattice.
4. ABABAB..... layering pattern is called ..... packing, found in ..... lattice.
5. Height (c) of the hexagonal primitive unit cell in term of radius of atom (r) is ..... .
6. Anions would be in contact with each other only if the cation to anion radius for a given co-ordination number is ..... .
7. The number of tetrahedral voids in hexagonal primitive unit cell is ..... .
8. The limiting radius for co-ordination number 8 is ..... .
9. For cesium chloride structure, the interionic distance (in terms of edge length, a) is equal to ..... .
10. Density of a crystal ..... due to Schottky defect and ..... due to Frankel defect.

MATCH THE COLUMN

1.

Column-I		Column-II	
(A)	68% occupy of space	(p)	Simple cubic lattice
(B)	CsCl	(q)	Diamond
(C)	Hexagonal close packing in three dimensions	(r)	Na_2O
(D)	Antifluorite structure	(s)	AB AB type of close packing
(E)	Covalent crystal	(t)	Body centred cubic lattice.

2.

Column-I		Column-II	
(A)	Spinel structure	(p)	Framework silicate
(B)	Glass	(q)	$ZnFe_2O_4$
(C)	Quartz	(r)	NaCl crystal
(D)	Metallic crystal	(s)	Pseudo solid
(E)	Co-ordination number 6	(t)	Melleable and ductile

ASSERTION & REASON

These questions contains, Statement I (assertion) and Statement II (reason).

(A) Statement-I is true, Statement-II is true ; Statement-II is correct explanation for Statement-I.

(B) Statement-I is true, Statement-II is true ; Statement-II is NOT a correct explanation for statement-I

(C) Statement-I is true, Statement-II is false

(D) Statement-I is false, Statement-II is true

1. **Statement-I :** Crystalline solids can cause X-rays to diffract.
   Because
   Statement-II : Interatomic distance in crystalline solids is of the order of 0.1 nm.

2. **Statement-I :** Graphite is an example of tetragonal crystal system.
   Because
   Statement-II : For a tetragonal system $a = b \neq c$, $\alpha = \beta = 90^\circ$, $\gamma = 120^\circ$

COMPREHENSION BASED QUESTIONS

Comprehension # 1

Packing refers to the arrangement of constituent units in such a way that the forces of attraction among the constituent particles is maximum and the constituents occupy the maximum available space. In two dimensions, there are square close packing and hexagonal close packing. In three dimensions, however, there are hexagonal close packing, cubic close packing and body-centred cubic packing.

(i) hcp : AB AB AB AB . . . arrangement
Coordination no. = 12
% occupied space = 74

(ii) ccp : ABC ABC . . . arrangement
Coordiantion no. = 12
% occupied space = 74

(iii) bcc : 68% space is occupied
Coordination no. = 8

Answer the following questions :

1. The empty space left in hcp in three dimensions is :
   (A) 26% (B) 74% (C) 52.4% (D) 80%

2. In closed packed lattice containing 'n' particles, the numbers of tetrahedral and octahedral voids are :
   (A) n, 2n (B) n, n (C) 2n, n (D) 2n, n/2

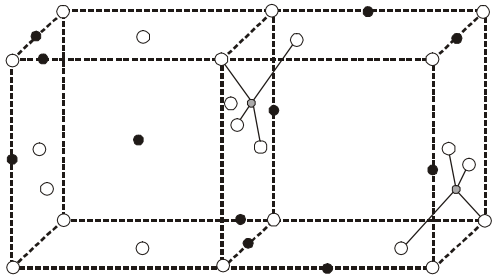
3. The pattern of successive layers of ccp arrangement can be designated as :
   (A) AB AB AB . . . (B) AB ABC AB ABC . . .
   (C) ABC ABC ABC . . . (D) AB BA AB BA . . .

4. The space occupied by spheres in bcc arrangement is :
   (A) 74% (B) 70% (C) 68% (D) 60.4%

5. A certain oxide of metal M crystallises in such a way that O^{2-} ions occupy hcp arrangement following AB AB . . . pattern. The metal ions, however, occupy $\frac{2}{3}$rd of the octahedral voids. The formula of the compound is

(A) M_2O_3 (B) M_3O (C) $M_{8/3}O_3$ (D) MO_2

Comprehension # 2



Answer the following questions :

1. The space lattice given in the figure refers to :

(A) fluoride structure (B) rock salt structure (C) spinel structure (D) inverse spinel structure

2. O^{2-} ions are present in :

(A) bcc arrangement (B) fcc arrangement

(C) simple cubic arrangement (D) hcp arrangement

3. The formula of the compound is :

(A) ABO_2 (B) A_2BO_3 (C) AB_2O_4 (D) A_2BO_4

4. Fraction of the total octahedral voids occupied will be :

(A) $\frac{1}{2}$ (B) $\frac{1}{4}$ (C) $\frac{1}{8}$ (D) $\frac{1}{6}$

5. B^{3+} and A^{2+} ions are present in :

(A) tetrahedral voids (B) octahedral, tetrahedral voids

(C) tetrahedral, octahedral voids (D) octahedral cubic voids

MISCELLANEOUS TYPE QUESTION **ANSWER KEY** EXERCISE -3

- ***True / False***

1. F **2.** T **3.** T **4.** T **5.** F **6.** T **7.** T

8. F **9.** T **10.** T

- ***Fill in the Blanks***

1. $\sqrt{3}a = 4r$ **2.** $\sqrt{2}a = 4r$ **3.** cubic close, FCC **4.** Hexagonal close, HCP

5. $c = 4r\sqrt{\frac{2}{3}}$ **6.** least or minimum **7.** 12 **8.** 0.732

9. $\frac{\sqrt{3}a}{2}$ **10.** decreases, remains constant

- ***Match the Column***

1. (A) → t; (B) → p ; (C) → s ; (D) → r ; (E) → q **2.** (A) → q; (B) → s ; (C) → p ; (D) → t ; (E) → r

- ***Assertion - Reason Questions***

1. C **2.** D

- ***Comprehension Based Questions***

Comprehension # 1 : 1. (A) **2.** (C) **3.** (C) **4.** (C) **5.** (A)

Comprehension #2 : 1. (C) **2.** (B) **3.** (C) **4.** (A) **5.** (B)

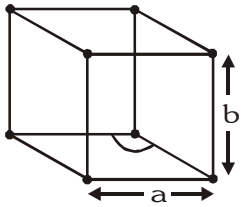
1. A closed packed structure of uniform spheres has the edge length of 534 pm. Calculate the radius of sphere, if it exist in :-
   (a) simple cubic lattice (b) BCC lattice (c) FCC lattice
2. Gold crystallizes in a face centred cubic lattice. If the length of the edge of the unit cell is 407 pm, calculate the density of gold as well as its atomic radius assuming it to be spherical. Atomic mass of gold = 197 amu:-
3. The density of KBr is 2.75 g cm^{-3}. The length of the edge of the unit cell is 654 pm. Show the KBr has face centered cubic structure.
4. A crystal of lead (II) sulphide has NaCl structure. In this crystal the shortest distance between Pb^{+2} ion and S^{2-} ions is 297 pm. What is the length of the edge of the unit cell in lead sulphide ? Also calculate the unit cell volume.
5. Iron has body centred cubic lattice structure. The edge length of the unit cell is found to be 286 pm. What is the radius of an iron atom ?
6. Cesium chloride forms a body centred cubic lattice. Cesium and chloride ions are in contact along the body diagonal of the unit cell. The length of the side of the unit cell is 412 pm and Cl^- ion has a radius of 181 pm. Calculate the radius of Cs^+ ion.
7. In a cubic closed packed structure of mixed oxides the lattice is made up of oxide ions, one eight of tetrahedral voids are occupied by divalent ions (A^{2+}) while one half of the octahedral voids occupied trivalent ions (B^{3+}). What is the formula of the oxide ?
8. A solid A^+ and B^- has NaCl type closed packed structure. If the anion has a radius of 250 pm, what should be the ideal radius of the cation ? Can a cation C^+ having a radius of 180 pm be slipped into the tetrahedral site of the crystal of A^+B^- ? Give reasons for your answer.
9. Calculate the value of Avogadro's number from the following data :
   Density of NaCl = 2.165 cm^{-3}
   Distance between Na^+ and Cl^- in NaCl = 281 pm.
10. 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 1.81Å respectively. Calculate the co-ordination numbers of the cations in the crystals of MgS, MgO and CsCl.
11. Iron occurs as bcc as well as fcc unit cell. If the effective radius of an atom of iron is 124 pm. compute the density of iron in both these structures.
12. KCl crystallizes in the same type of lattice as does NaCl. Given that $\frac{r_{Na^+}}{r_{Cl^+}} = 0.5$ and $\frac{r_{Na^+}}{r_{K^+}} = 0.7$. 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.
13. An element A(Atomic weight = 100) having bcc structure has unit cell edge length 400 pm. Calculate the density of A and number of unit cells and number of atoms in 10 gm of A.
14. Prove that the void space percentage in zinc blende structure is 25%.
15. A unit cell of sodium chloride has four formula units. The edge of length of the unit cell is 0.564 nm. What is the density of sodium chloride.
16. In a cubic crystal of CsCl (density = 3.97 gm/cm^3) the eight corner are occupied by Cl^- ions with Cs^+ ions at the centre. Calculate the distance between the neighbouring Cs^+ and Cl^- ions.
17. The composition of a sample of wustite is $Fe_{0.93}O_{1.0}$. What percentage of iron is present in the form of Fe(II)?
18. RbI crystallizes in bcc structure in which each Rb^+ is surrounded by eight iodide ions each of radius 2.17 Å.

Find the length of one side of RbI unit cell.

19. If NaCl is dopped with 10^{-3} mol % $SrCl_2$, what is the number of cation vacancies?

20. NaH crystallizes in the same structure as that NaCl. The edge length of the cubic unit cell of NaH is 4.88 Å.
(a) Calculate the ionic radius of H^-, provided the ionic radius of Na^+ is 0.95 Å.
(b) Calculate the density of NaH.

21. Ice crystallizes in a hexagonal lattice. At the low temperature at which the structure was determined, the lattice constants were a = 4.53Å, and b = 7.60Å (see figure). How many molecules are contained in a given unit cell? [density (ice) = 0.92 gm/cm^3]



22. Using the data given below, find the type of cubic lattice to which the crystal belongs.

	Fe	V	Pb
a in pm	286	301	388
ρ in gm cm^{-3}	7.86	5.96	12.16

23. Prove that void space in fluoride structure per unit volume of unit cell is 0.243.

24. A compound formed by elements X & Y. Crystallizes in a cubic structure, where X is the at corners of the cube and Y is at six face centres. What is the formula of the compound ? If side length is 5Å, estimate the density of the solid assuming atomic weight of X and Y as 60 and 90 respectively.

25. The metal nickel crystallizes in a face centred cubic structure. Its density is 8.9 gm/cm^3. Calculate
(a) the length of the edge of the unit cell.
(b) the radius of the nickel atom. [Atomic weight of Ni = 58.89]

CONCEPTUAL SUBJECTIVE EXERCISE — ANSWER KEY — EXERCISE-4(A)

1. 267 pm, 231.2 pm, 188.8 pm
2. 19.4 g/cm^3 , 143.9 pm
3. N = 6.023 10^{23} mol^{-1}, At. mass : K = 39, Br = 80
4. a = 5.94 10^{-8} cm, V = 2.096 10^{-22} cm^{-3}
5. 123.84 pm
6. 175.8 pm
7. AB_2O_4
8. 103.4 pm, No
9. 6.01 10^{23}
10. 4, 6, 8
11. 7.887 g/cc, 8.59 gm/cm^3
12. (a) 1.143, (b) 1.172
13. 5.188 gm/cm^3, 6.023 10^{22} atoms of A, 3.0115 10^{22} unit cells
15. 2.16 gm/cm^3
16. 3.57 Å
17. 15.053
18. 4.34 Å
19. 6.02 10^{18} mol^{-1}
20. (a) 1.49 Å, (b) 1.37 g/cm^3
21. 4 molecules of H_2O
22. for Fe is bcc, for V is bcc, for Pd is face centred
24. XY_3, 4.38 g/cm^3
25. (a) 3.52 Å, (b) 1.24 Å

EXERCISE–04 [B] BRAIN STORMING SUBJECTIVE EXERCISE

1. The element chromium exists as a bcc lattice whose unit cell edge is 2.88 Å. The density of chromium is 7.20 g/cc. How many atom does 52.0 g of chromium contain ?

2. 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_{Cl^-} = 1.8173 Å).

3. A cubic unit cell contains manganese ions at the corners and fluoride ions at the centre of each edge.
   (a) What is the empirical formula ?
   (b) What is the C.N. of the Mn ion?
   (c) Calculate the edge length of the unit cell if the radius of a Mn ions is 0.65 Å and that of F^- ion is 1.36Å.
   (d) Calculate the density of the compound (Mn = 55, F = 19).

4. Silver crystallises in fcc lattice. If edge length of the cell is 4.077 10^{-8} cm and density is 10.5 g cm^{-3}, calculate the atomic mass of silver.

5. Formula mass of NaCl is 58.45 g mol^{-1} and density of its pure form is 2.167 g cm^{-3}. The average distance between adjacent sodium and chloride ions in the crystal is 2.814 10^{-8} cm. Calculate Avogadros constant.

6. Thallium chloride, TlCl (240 g mol^{-1}) crystallises in either a simple cubic lattice or a face centered cubic lattice Cl^- ions with Ti^+ ions in the holes. If the density of the solid is 9.00 g cm^{-3} and edge of the unit cell is 3.85 10^{-8} cm, what is the unit geometry ?

7. KF has NaCl structure. What is the distance between K^+ and F^- in KF, if the density is 2.48 g cm^{-3} ?

8. $BaTiO_3$ crystallizes in the prevoskite structure. The structure may be described as a cubic lattice with barium ions occupying the corner of the unit cell, oxide ions occupying the face-centers and titanium ion occupying the center of the unit cell.
   (a) If titanium is described as occupying holes in BaO lattice, what type of holes does it occupy ?
   (b) What fraction of this type hole does it occupy ?

9. Find the size of largest sphere that will fit in octahedral void in an ideal FCC crystal as a function of atomic radius 'r'. The insertion of this sphere into void does not distort the FCC lattice. Calculate the packing fraction of FCC lattice when all the octahedral voids are filled by this sphere.

10. Metallic gold crystallises in fcc lattice. The length of the cubic unit cell is a = 4.07 Å.
   (a) What is the closest distance between gold atoms.
   (b) How many "nearest neighbours" does each gold atom have at the distance calculated in (a).
   (c) What is the density of gold?
   (d) Prove that the packing fraction of gold is 0.74.

11. Potassium crystallizes in a body-centered cubic lattice with edge length, a = 5.2 Å.
   (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-neighbours does each K atom have?
   (e) What is the calculated density of crystalline potassium?

12. The olivine series of minerals consists of crystals in which Fe and Mg ions many substitute for each other causing substitutional impurity defect without changing the volume of the unit cell. In olivine series of minerals, oxide ion exist as FCC with Si^{4+} occupying $\frac{1}{4}$ th of octahedral voids and divalent ions occupying $\frac{1}{4}$ th of tetrahedral voids. The density of forsterite (magnesium silicate) is 3.21 g/cc and that of fayalite (ferrous silicate) is 4.43 g/cc. Find the formula of forsterite and fayalite minerals and the percentage of fayalite in an olivine with a density of 3.88 g/cc.

13. The mineral hawleyite, one form of CdS, crystallizes in one of the cubic lattices, with edge length 5.87 Å. The density of hawleyite is 4.63 g cm^{-3}.

(i) In which cubic lattice does hawleyite crystallize?

(ii) Find the Schottky defect in g cm^{-3}.

14. A strong current of trivalent gaseous boron passed through a germanium crystal decreases the density of the crystal due to part replacement of germanium by boron and due to interstitial vacancies created by missing Ge atoms. In one such experiment, one gram of germanium is taken and the boron atoms are found to be 150 ppm by weight, when the density of the Ge crystal decreases by 4%. Calculate the percentage of missing vacancies due to germanium, which are filled up by boron atoms.

Atomic wt. Ge = 72.6, B = 11

BRAIN STORMING SUBJECTIVE EXERCISE — ANSWER KEY — EXERCISE-4(B)

1. 6.05 10^{23} atoms mol^{-1}

2. r_{k^+} = 1.3227 Å

3. (a) MnF_3 (Mn = 8 $\frac{1}{8}$; F = 6 $\frac{1}{2}$) (b) 6(fcc) (c) 4.02 Å (d) 2.86 g/cm^3

4. 107.09 g mol^{-1}

5. 6.05 10^{23} mol^{-1}

6. simple cubic battice

7. 269 pm

8. (a) octahedral (b) 1/4

9. 0.414 r, 79.3%

10. (a) 2.88 Å (b) 12 (c) 19.4 g/cc

11. (a) 4.5 Å (b) 5.2 Å (c) 8 (d) 6 (e) 0.92 g/cm^3

12. Mg_2SiO_4, Fe_2SiO_4, 59%

13. (i) 3.90 (ii) 0.120 g/cc

14. 2.376 %

Q.1 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 :- **[AIEEE-2012]**

(A) 152 pm (B) 75 pm (C) 300 pm (D) 240 pm

Q.2 In a face centred cubic lattice, atom A occupies the corner positions and atom B occupies the face centre positions. If one atom of B is missing from one of the face centred points, the formula of the compound is :- **[AIEEE-2011]**

(A) A_2B_3 (B) A_2B_5 (C) A_2B (D) AB_2

Q.3 Copper crystallises in fcc lattice with a unit cell edge of 361 pm. The radius of copper atom is:- **[AIEEE-2011]**

(A) 181 pm (B) 108 pm (C) 128 pm (D) 157 pm

Q.4 Percentages of free space in cubic close packed structure and in body centered packed structure are respectively :- **[AIEEE-2010]**

(A) 48% and 26% (B) 30% and 26% (C) 26% and 32% (D) 32% and 48%

Q.5 The edge length of a face centered cubic cell of an ionic substance is 508 pm. If the radius of the cation is 110 pm, the radius of the anion is :- **[AIEEE-2010]**

(A) 144 pm (B) 288 pm (C) 398 pm (D) 618 pm

Q.6 In a compound, atoms of element Y form ccp lattice and those of element X occupy 2/3rd of tetrahedral voids. The formula of the compound will be - **[AIEEE-2008]**

(A) X_4Y_3 (B) X_2Y_3 (C) X_2Y (D) X_3Y_4

Q.7 Total volume of atoms present in a face-centred cubic unit cell of a metal is (r is atomic radius) : **[AIEEE-2006]**

(A) $\frac{24}{3}\pi r^3$ (B) $\frac{12}{3}\pi r^3$ (C) $\frac{16}{3}\pi r^3$ (D) $\frac{20}{3}\pi r^3$

Q.8 Lattice energy of an ionic compound depends upon - **[AIEEE-2005]**

(A) Size of the ion only (B) Charge on the ion only

(C) Charge on the ion and size of the ion (D) Packing of ions only

Q.9 An ionic compound has a unit cell consisting of A ions at the corners of a cube and B ions on the centres of the faces of the cube. The empirical formula of this compound would be-**[AIEEE-2005]**

(A) A_2B (B) AB (C) A_3B (D) AB_3

Q.10 What type of crystal defect is indicated in the diagram below ? **[AIEEE-2004]**

Na^+ Cl^- Na^+ Cl^- Na^+ Cl^-

Cl^- Cl^- Na^+ Na^+

Na^+ Cl^- Cl^- Na^+ Cl^-

Cl^- Na $^+Cl^-$ Na^+ Na^+

(A) Frenkel defect (B) Schottky defect

(C) Interstitial defect (D) Frenkel and Schottky defects

Q.11 How many unit cells are present in a cube-shaped ideal crystal of NaCl of mass 1.00g ?

(A) 1.28×10^{21} unit cells (B) 1.71×10^{21} unit cells **[AIEEE-2003]**

(C) 2.57×10^{21} unit cells (D) 5.14×10^{21} unit cells

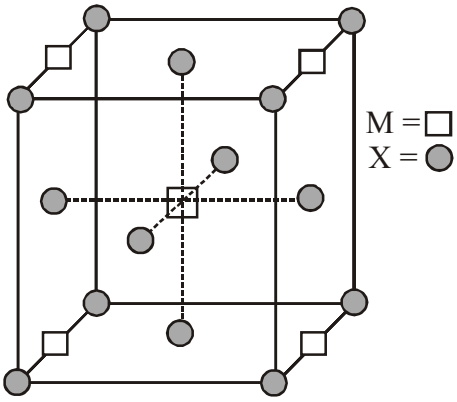
Q.12 The no. of atoms per unit cell in B.C.C. & F.C.C. is respectively : **[AIEEE-2002]**

(A) 8, 10 (B) 2, 4 (C) 1, 2 (D) 1, 3

JEE-[MAIN] : PREVIOUS YEAR QUESTIONS	ANSWER KEY	EXERCISE -5[A]

Q.1	(A)	Q.2	(B)	Q.3	(C)	Q.4	(C)
Q.5	(A)	Q.6	(A)	Q.7	(C)	Q.8	(C)
Q.9	(D)	Q.10	(B)	Q.11	(C)	Q.12	(B)

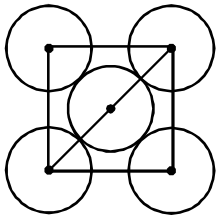
Q.1 A compound M_pX_q has cubic close packing (ccp) arrangement of X. Its unit cell structure is shown below. The empirical formula of the compound is : **[JEE-2012]**



(A) MX (B) MX_2 (C) M_2X (D) M_5X_{14}

Q.2 The number of hexagonal faces that present in a truncated octahedron is. **[JEE-2011]**

Q.3 The packing effeciency of the two-dimensional square unit cell shown below is **[JEE-2010]**



(A) 39.27% (2) 68.02% (C) 74.05% (D) 78.54%

Q.4 The correct statement(s) regarding defects in solid is (are) **[JEE 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.

Paragraph for Question No. 5 to 7

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 touches 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'.

Q.5 The number of atoms in this HCP unit cells is **[JEE 2008]**

(A) 4 (B) 6 (C) 12 (D) 17

Q.6 The volume of this HCP unit cell is **[JEE 2008]**

(A) $24\sqrt{2}\,r^3$ (B) $16\sqrt{2}\,r^3$ (C) $12\sqrt{2}\,r^3$ (D) $\frac{64}{3\sqrt{3}}\,r^3$

Q.7 The empty space in this HCP unit cell is **[JEE 2008]**

(A) 74% (B) 47.6 % (C) 32% (D) 26%

Q.8 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 2007]

Q.9 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 2006]**

Q.10 An element crystallises in FCC lattice having edge length 400 pm. Calculate the maximum diameter which can be placed in interstital sites without disturbing the structure. **[JEE 2005]**

Q.11 Which of the following FCC structure contains cations in alternate tetrahedral voids?

(A) NaCl (B) ZnS (C) Na_2O (D) CaF_2 **[JEE 2005]**

Q.12 (i) 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}.

(ii) If measured density is 20 kg m^{-3}. Identify the type of point defect. **[JEE–2004]**

Q.13 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.

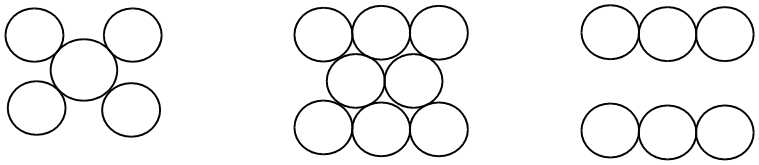
[JEE 2003]

Q.14 A substance A_xB_y crystallises in a 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-2002]**

Q.15 The figures given below show the location of atoms in three crystallographic planes in FCC lattice. Draw the unit cell for the corresponding structure and identify these planes in your diagram. **[JEE-2000]**



Q.16 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-2000]**

Q.17 In any ionic solid [MX] with schottky defects , the number of positive and negative ions are same. **[T/F]** **[JEE-2000]**

Q.18 The coordination number of a metal crystallising in a hcp structure is **[JEE-2000]**

(A) 12 (B) 4 (C) 8 (D) 6

Q.19 A metal cryatallises 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. **[JEE-1999]**

PREVIOUS YEARS QUESTIONS **ANSWER KEY** EXERCISE -5[B]

Q.1	(B)	Q.2	(8)	Q.3	(D)	Q.4	(B,C)
Q.5	(B)	Q.6	(A)	Q.7	(D)		

Q.8 (A) P, S ; (B) -P,Q ; (C) - Q ; (D) - Q,R

Q.9	216.5 pm	Q.10	117.1 pm	Q.11	(B)

Q.12 (i) = 5 kg m^{-3}

(ii) There is huge difference in theoretically calculated density and observed density. It is only possible if some foreign species occupies interstitial space i.e. substitution defect.

Q.13	☺	Q.14	(A)	Q.15	☺	Q.16	(D)
Q.17	True	Q.18	(A)	Q.19	1.259		