SOLID STATE

MM :101

1 Lithium has a bcc structure. Its density is 530 kg m^{-3} and its atomic mass is 6.94 g mol^{-1}. Calculate the edge length of unit cell of lithium metal. (N_A = 6.02 × 10^{23} mol^{-1}). (a) 527 pm (b) 264 pm (c) 154 pm (d) 352 pm

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2 A metal crystallises in a face centred cubic structure. If the edge length of its unit cell is 'a', the closest approach between two atoms in metallic crystal will be

(a) $2a$ (b) $2\sqrt{2}\,a$

(c) $\sqrt{2}\,a$ (d) $\dfrac{a}{\sqrt{2}}$

(a) $\dfrac{4}{3}\pi r^3$ (b) $\dfrac{8}{3}\pi r^3$

(c) $\dfrac{16}{3}\pi r^3$ (d) $\dfrac{64 r^3}{3\sqrt{3}}$

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3 In fcc, what is volume occupied?

4 An element crystallises in bcc lattice has an edge length 500 pm. If its density is 4 cm^{-3}, the atomic mass of the element is g mol^{-1} is [N_A = 6 × 10^{23} mol^{-1}] (a) 100 (b) 250 (c) 125 (d) 150

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5 Which of the following crystals has unit cell such that a ≠ b ≠ c, α ≠ β ≠ γ ≠ 90 (a) $K_2Cr_2O_7$ (b) $NaNO_3$ (c) KNO_3 (d) A_8B_7

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6 Which of the following is wrong statement for cubic close packed (ccp) in three dimensional structure is (are) (a) the number of nearest neighbours of an atom present in the top most layer is 12. (b) the efficiency 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.

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7 Which of the following solids is not an electrical conductor? (A) Mg(s) (B) TiO(s) (C) I_2(s) (D) H_2O(s) (a) (A) only (b) (B) Only (c) (C) and (D) (d) (B), (C) and (D)

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8 In which pair most efficient packing is present? (a) hcp and bcc (b) hcp and ccp (c) bcc and ccp (d) bcc and simple cubic cell

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9 What is number of atoms present in 200 g of an element having bcc structure having edge length 300 pm and density 70 g cm^{-3}? (a) 8.12 × 10^{23} (b) 6.12 × 10^{22} (c) 2.12 × 10^{24} (d) 4.12 × 10^{25}

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10 Which of the following is not true about the voids formed in 3-dimensional hexagonal close packed structure? (a) A tetrahedral void is formed when a sphere of the second layer is present above triangular void in the first layer. (b) All the triangular voids are not covered by the spheres of the second layer. (c) Tetrahedral voids are formed when the triangular voids in the second layer lie above the triangular voids in the first layer and the triangular shapes of these voids do not overlap. (d) Octahedral voids are formed when the triangular voids in the second layer exactly overlap with similar voids in the first layer.

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11 Under the influence of electric field, which of the following statements is true about the movement of electrons and holes in a p-type semiconductor? (a) Electron will move towards the positively charged plate through electron holes. (b) Holes will appear to be moving towards the negatively charged plate. (c) Both electrons and holes appear to move towards the positively charged plate. (d) Movement of electrons is not related to the movement of holes.   1

12 Match the defects given in Column I with the statements in given Column II.

Column I	Column II
(a) Simple vacancy defect	(i) shown by non-ionic solids and increases density of the solid.
(b) Simple interstitial defect	(ii) shown by ionic solids and decreases density of the solid.
(c) Frenkel defect	(iii) shown by non- ionic solids and density of
(d) Schottky defect	(iv) shown by ionic solids and density of the solid remains the same.

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13 What is maximum possible coordination number of an atom in an hcp crystal structure of an element?   1

14 Which stoichiometric defect in crystals increases the density of a solid?   1

15 What is the nature of crystal defect produced when sodium chloride is doped with $MgCl_2$?   1

16 What is meant by the term 'forbidden zone' in reference to band theory of solids?   1

17 Solid solutions of group 13 or 15 impurities with group 14 elements are found to exhibit unusual electrical properties. Why?   1

18 On heating a crystal of KCl in potassium vapour, the crystal starts exhibiting a violet colour. What is this due to?   1

19 Give an example of an ionic compound which shows Frenkel defect.   1

20 Which of the following oxides behaves as conductor or insulator depending upon temperature? (a) TiO (b) SiO_2 (c) TiO_3 (d) MgO   1

21 Which of the following is true about the charge acquired by p-type semiconductors? (a) positive (b) neutral (c) negative (d) depends on concentration of p impurity   1

1

22 Match the items given in Column I with the items given in Column II.

Column I	Column II
(a) Mg in solid state	(i) p-Type semiconductor
b) $MgCl_2$ in molten state	(ii) n-Type semiconductor
(c) Silicon with phosphorus	(iii) Electrolytic conductors
(d) Germanium with boron	(iv) Electronic conductors

23 Match the type of packing given in Column I with the items given in Column II.

Column I	Column II
(a) Square close packing in two dimensions (b) Hexagonal close packing in two dimensions (c) Hexagonal close packing in three dimensions (d) Cubic close packing in three dimensions	(i) Triangular voids (ii) Pattern of spheres is repeated in every fourth layer (iii) Coordination number 4 (iv) Pattern of sphere is repeated in alternate layers

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24 In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

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(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion. (c) Assertion is correct statement but reason is wrong statement. (d) Assertion is wrong statement but reason is correct statement. Assertion: The packing efficiency is maximum for the fcc structure. Reason: The coordination number is 12 in fcc structures.

25 In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

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(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion. (c) Assertion is correct statement but reason is wrong statement. (d) Assertion is wrong statement but reason is correct statement. Assertion: Semiconductors are solids with conductivities in the

intermediate range from $10^{-6} - 10^4$ ohm^{-1}m^{-1}. Reason: Intermediate conductivity in semiconductor is due to partially filled valence band.

26 Copper is conducting as such while copper sulphate is conducting only in molten state or in aqueous solution, why?   1

27 Name the type of binding forces present in dry ice.   1

28 Why do some glass objects from ancient civilization found to be milky?   1

29 Atoms of element B form hcp lattice and those of the element A occupy 2/3rd of tetrahedral voids. What is the formula of the compound formed by these elements A and B?   1

30 Express the relationship between atomic radius (r) and edge length (a) in fcc unit cell.   1

31 In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(a) Assertion and reason both are correct statements and reason is correct explanation for assertion.   3

(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion. (c) Assertion is correct statement but reason is wrong statement. (d) Assertion is wrong statement but reason is correct statement. Assertion: The total number of atoms present in a simple cubic unit cell is one. Reason: Simple cubic unit cell has atoms at its corners, each of which is shared between eight adjacent unit cells.

32 In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices. (a) Assertion and reason both are correct statements and reason is correct explanation for assertion. (b) Assertion and reason both are correct statements but reason is not correct explanation for assertion. (c) Assertion is correct statement but reason is wrong statement. (d) Assertion   3
is wrong statement but reason is correct statement. Assertion: Graphite is a good conductor of electricity however diamond belongs to the category of insulators. Reason: Graphite is soft in nature on the other hand diamond is very hard and brittle.

33   In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices. (a) Assertion and reason both are correct statements and reason is correct explanation for assertion. (b) Assertion and reason both are correct statements but reason is not correct explanation for assertion. (c) Assertion is correct statement but reason is wrong statement. (d) Assertion   3
is wrong statement but reason is correct statement. Assertion: Total number of octahedral voids present in unit cell of cubic close packing including the one that is present at the body centre, is four. Reason: Besides the body centre there is one octahedral void present at the centre of each of the six faces of the unit cell and each of which is shared between two adjacent unit cells.

34 Iron(II) oxide has a cubic structure and each side of unit cell is 5 Å. If density of the oxide is 4 g cm^{-3}, calculate the number of Fe^{2+} and O^{2-} ions present in each unit cell. [Atomic mass of Fe = 56 u, O = 16 u, NA = 6.023 × 10^{23} mol^{-1}]   3

35 An element occurs in bcc structure. It has a cell edge length of 250 pm. Calculate the molar mass if its density is 8.0 g cm^{-3}. Also, calculate the radius of an atom of this element.   3

36 Iron has a body-centred cubic unit cell with a cell edge of 286.65 pm. The density of iron is 7.874 g cm^{-3}. Use this information to calculate Avogadro's number. (At. mass of iron = 56 g mol^{-1})   3

37 Examine the given defective crystal:

Answer the following questions:

X$^+$	Y$^-$	X$^+$	Y$^-$	X$^+$
Y$^-$	O	Y$^-$	X$^+$	Y$^-$
X$^+$	Y$^-$	X$^+$	O	X$^+$
Y$^-$	X$^+$	Y$^-$	X$^+$	Y$^-$

(i)   Is the above defect stoichiometric or non-stoichiometric?   3
(ii)   Write the term used for this type of defect.
(iii)   Give an example of the compound which shows this type of defect.
(iv)   How does this defect affect the density of the crystal?
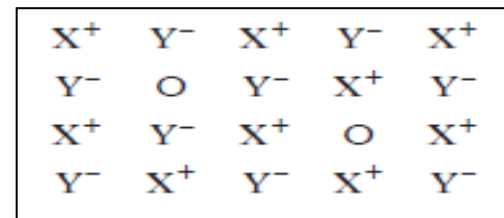
38 Tungsten crystallizes in body-centred cubic unit cell. If the edge of the unit cell is 316.5 pm, what is the radius of tungsten atom?   3

39 Silver crystallizes in face-centred cubic unit cell. Each side of this unit cell has a length of 400 pm. Calculate the radius of the silver atom. (Assume the atoms just touch each other on the diagonal across the face of the unit cell. That is, each face atom is touching the four corner atoms.)   3

40 (a) What type of semiconductor is obtained when silicon is doped with boron?

(b) What type of magnetism is shown in the following alignment of magnetic moments?

⬆ ⬆ ⬆ ⬆ ⬆ ⬆   3
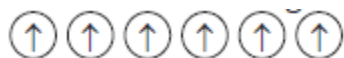
Or What type magnetism is shown by a substance if magnetic moments of domains are arranged in same direction? (c) What type of point defects are produced when AgCl is doped with CdCl$_2$?

41 The compound CuCl [Formula mass 99 g mol^{-1}] has fcc structure like ZnS. Its density is 3.4 g cm^{-3}. What is the length of the edge of unit cell? (NA = 6.02 × 10^{23} mol^{-1})   3

42 In terms of band theory, what is difference between insulator and semiconductor? Give two difference.   3

43 An element X (molar mass = 60 g mol^{-1}) has a density of 6.23 g cm^{-3}. Identify the type of cubic unit cell, if the edge length of the unit cell is 4 × 10^{-8} cm.   3

44 The well-known mineral fluorite is chemically calcium fluoride. It is known that in one unit cell of this mineral, there are 4 Ca^{2+} ions and 8 F$^-$ ions and that Ca^{2+} ions are arranged in a fcc lattice. The F$^-$ ions fill all tetrahedral holes in the face-centred cubic lattice of Ca^{2+} ions. The edge of the unit cell is 5.46 × 10^{-8} cm in length. The density of the solid is 3.18 g cm^{-3}. Use this information to calculate Avogadro's number. (Molar mass of CaF$_2$ = 78.08 g mol^{-1})   3

45 An element has a body centred cubic (bcc) structure with a cell edge of 288 pm. The density of the element is 7.2 g cm^{-3}. How many atoms are present in 208 g of the element?   3

46 Assign reasons for the following: 3

(i) Phosphorus doped silicon is a semiconductor.

(ii) Schottky defect lowers the density of a solid.

(iii) Some of the very old glass objects appear slightly milky instead of being transparent.

47 The density of copper is 8.95 g cm^{-3}. It has face-centred cubic structure. What is radius of copper atom? [Atomic mass of Cu = 63.5 g mol^{-1}, N_A = 6.02 × 10^{23} mol^{-1}]   3

48 Refractive index of a solid is observed to have the same value along all directions. Comment on nature of this solid. Would it show cleavage property?   2

49 Express the relationship between atomic radius(r) and the edge length (a) in the bcc unit cell.   2

50 Which type of ionic substances show Schottky defect in solids?   2

51 Conductivity of silicon increases on doping it with phosphorus. Why?   2

52 An element with molar mass 27 g mol^{-1} forms a cubic unit cell with edge length 4.05 × 10^{-8} cm. If the density is 2.7 g cm^{-3}, what is the nature of cubic unit cell?   2

53 An element with density 11.2 g cm^{-3} forms a fcc lattice with edge length of 4 × 10^{-8} cm. Calculate the atomic mass of the element. (Given: N_A = 6.022 × 10^{23} mol^{-1})   2

54 An alloy of gold and cadmium crystallises with a cubic structure in which gold atoms occupy the corners and cadmium atoms fit into the face centre. Assign formula for this alloy.   2

55 Copper crystallizes into an fcc lattice with edge length 3.61 × 10^{-8} cm. Calculate the density of copper. [Given: Cu = 63.5 g mol^{-1}, N_A = 6.022 × 10^{23} mol^{-1}].   2

56 An element 'X' crystallizes in fcc structure. 208 g of it has 4.2832 × 10^{24} atoms. Calculate the edge length of unit cell, if density of 'X' is 7.2 g cm^{-3}.   2

57 X-ray diffraction studies show that copper crystallizes in an fcc unit cell with cell edge of 3.608 × 10^{-8} cm. In a separate experiment, copper is determined to have a density of 8.92 g/cm3, calculate the atomic mass of the copper.   2