CHEMISTRY
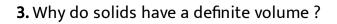
BOOKS - BETTER CHOICE PUBLICATION

THE SOLID STATE

Question Bank

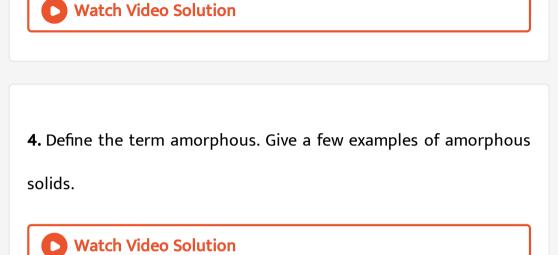**1.** Define solids. Give important properties of solid state.
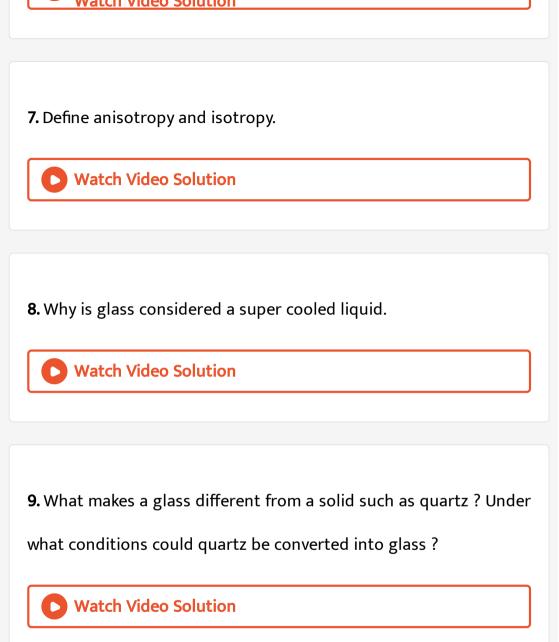
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2. Why are solids rigid ?

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3. Why do solids have a definite volume ?

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4. Define the term amorphous. Give a few examples of amorphous solids.

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5. What are crystalline solids ? Give a few examples of crystalline solids.

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6. Give one difference between crystalline and amorphous solids.

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7. Define anisotropy and isotropy.

8. Why is glass considered a super cooled liquid.

9. What makes a glass different from a solid such as quartz ? Under what conditions could quartz be converted into glass ?

10. What is the difference between glass and quartz. While both are made up of SiO_4 tetrahedra.

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11. Ionic solids conduct electricity in the molten state but not in the solid state. Explain.

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12. Why do ionic solids conduct electricity in aqueous solutions but not in the solid state ?

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13. Write two differences between covalent and metallic solids.

14. Give two differences between ionic solids and covalents solids.
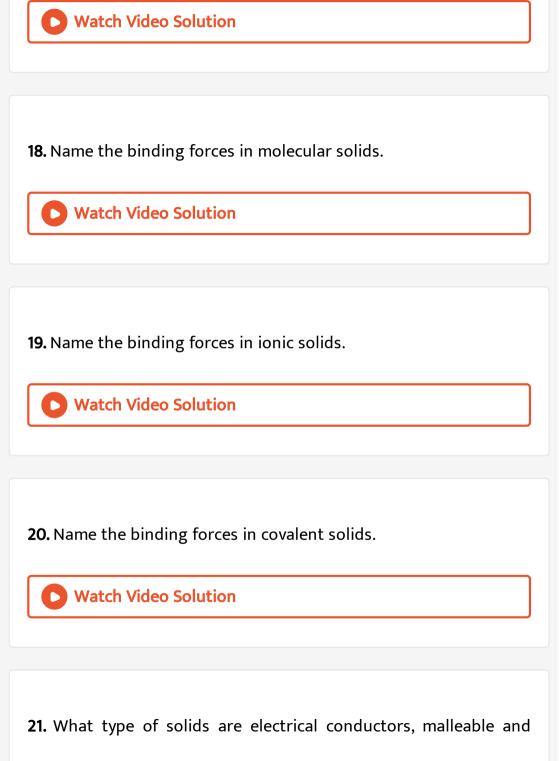
15. Write two differences between molecular solids and covalent solids .

16. Write two differences between molecular solids and ionic solids.

17. Write two differences between ionic solids and metallic solids.

18. Name the binding forces in molecular solids.

19. Name the binding forces in ionic solids.

20. Name the binding forces in covalent solids.

21. What type of solids are electrical conductors, malleable and ductile ?

22. Solid which is very hard, electrical insulator in solid as well as in molten state and melts at extremely high temperature. What type of solid is it ?
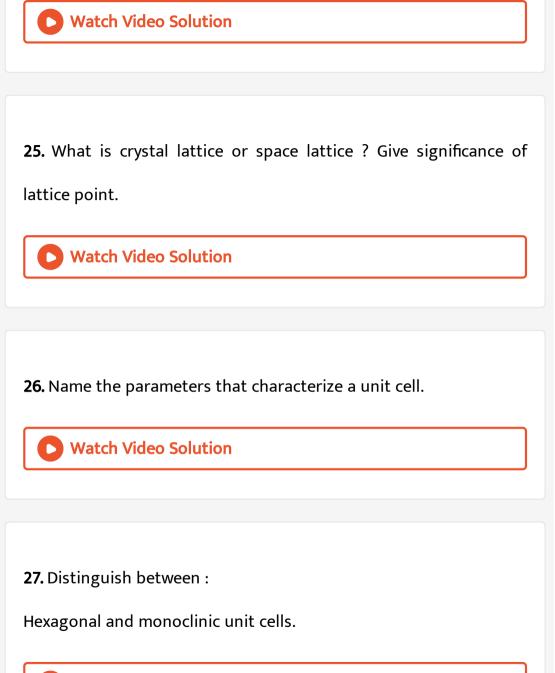
23. Explain :

The basis of similarities and differences between metallic and ionic crystal.

24. Explain :

Ionic crystals are hard and brittle.

25. What is crystal lattice or space lattice ? Give significance of lattice point.

26. Name the parameters that characterize a unit cell.

27. Distinguish between :

Hexagonal and monoclinic unit cells.

28. Distinguish between :

Face-centred and end-centred unit cells.

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29. Distinguish between :

Cubic and Tetragonal unit cell.

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30. How can you distinguish between crystal lattice and unit cell.

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31. Write two differences between crystal lattice and unit cell.

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32. State two characteristics of crystal lattice.

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33. A match box or a brick represents which type of unit cell.

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34. How many types of cubic unit cells are possible ?

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35. Why NaCl show octahedral geometry?

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36. Why the geometry of zinc blend is tetrahedral?

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37. How many lattice point are there in one unit cell of each of the following lattices ?

face-centred tetragonal

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38. How many lattice point are there in one unit cell of each of the following lattices ?

body-centred cubic

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39. The fraction of volume occupied by atoms in a body centered cubic unit cell is:

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40. What is meant by the term 'coordination number' ?

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41. Define co-ordination number

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42. What is the coordination number of atoms.

In a cubic close packed structure ?

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43. What would be the effective number of atoms per unit cell in end centred cubic uit cel, if this type of unit cell exist in nautre?

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44. What is the two dimensional co-ordination number of a molecule in

A square packed layer ?

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45. What is the two dimensional coordination number of a molecule in a hexagonal packed layer.

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46. What is the two dimensional co-ordination number of a molecule in

A square packed layer ?

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47. How will you distinguish between the following pairs of term ?

Hexagonal close packing and cubic close packing in three dimensions.
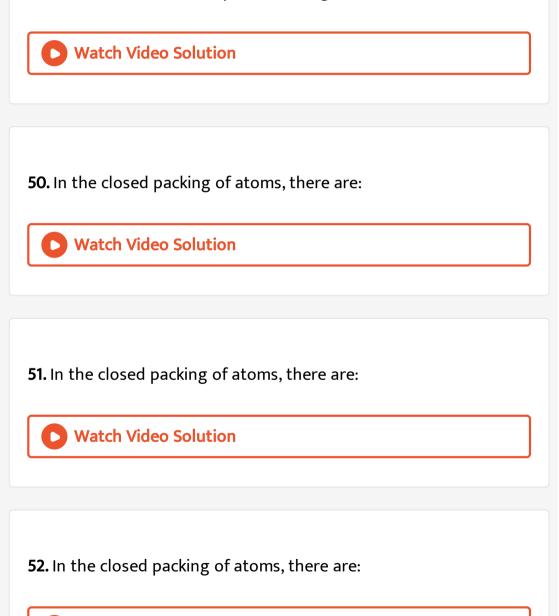
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48. How will you distinguish between the following pairs of term ?

Tetrahedral void and octahedral void.

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49. What are interstitial sites ? Discuss tetrahedral and octrahedral interstitial sites in a close packed arrangment.

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50. In the closed packing of atoms, there are:

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51. In the closed packing of atoms, there are:

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52. In the closed packing of atoms, there are:

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53. What is the difference between f.c.c. and c.c.p. types of arrangements ?

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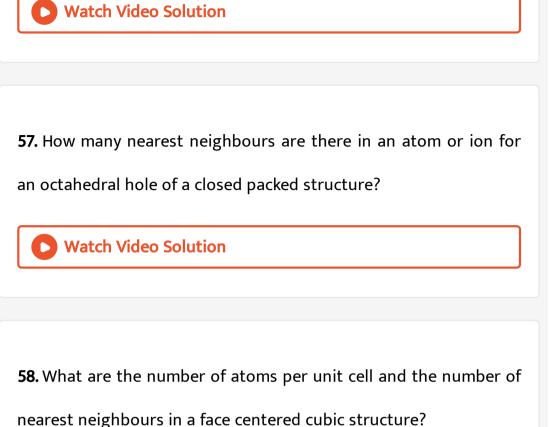**54.** Define radius ratio.

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55. If the radius of the octahedral void is r and the radius of the atoms in the packing is R, derive relationship between r and R.

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56. What is the co-ordination number of an atom or ion occupying a Tetrahedral hole ?

57. How many nearest neighbours are there in an atom or ion for an octahedral hole of a closed packed structure?

58. What are the number of atoms per unit cell and the number of nearest neighbours in a face centered cubic structure?

59. packing fraction of a unit cell is drfined as the fraction of the total volume of the unit cell occupied by the atom(s).

$$P.E = \frac{\text{Volume of the atoms(s) present in a unit cell}}{\text{Volume of unit cell}} = \frac{Z \times \frac{4}{3}\pi r^3}{a^3}$$

and $\%$ of empty space = $100 - P.F. \times 100$

where Z= effective number of stoms in s cube .

r= radius of a an atoms

a = edge lenght of the cube

Packing fraction in face centered cubic unit cell is :

60. What is the two dimensional co-ordination number of a molecule in

A square packed layer ?

61. The cordination number of a metal crystallising in a hexagonal close-packed structure is:

62. packing fraction of a unit cell is drfined as the fraction of the total volume of the unit cell occupied by the atom(s).

$$P.\,E = \frac{\text{Volume of the atoms(s) present in a unit cell}}{\text{Volume of unit cell}} = \frac{Z \times \frac{4}{3}\pi r^3}{a^3}$$

and % of empty space = $100 - P.\,F. \times 100$

where Z= effective number of stoms in s cube .

r= radius of a an atoms

a = edge lenght of the cube

Packing fraction in face centered cubic unit cell is :

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63. The packing fraction of a simple cubic crystal with an interstitial atom exactly fitting at the body center is :

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64. packing fraction of a unit cell is drfined as the fraction of the total volume of the unit cell occupied by the atom(s).

$$P.E = \frac{\text{Volume of the atoms(s) present in a unit cell}}{\text{Volume of unit cell}} = \frac{Z \times \frac{4}{3}\pi r^3}{a^3}$$

and % of empty space $= 100 - P.F. \times 100$

where Z= effective number of stoms in s cube .

r= radius of a an atoms

a = edge lenght of the cube

Packing fraction in face centered cubic unit cell is :

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65. How can you determine the atomic mass of an unknown metal if you know its density and the dimensions of its unit cell ? Explain your answer.

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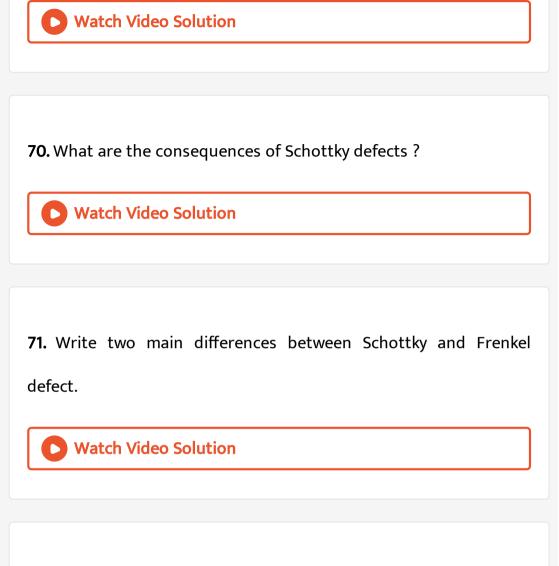**66.** What do you understand by imperfections in ionic crystals ? Name the type of imperfections which occur in ionic crystals.

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67. Define point defects.

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68. Why the Schottky defect and Frenkel defects are called as Thermodynamic or intrinsic defects ?

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69. What type of defect can arise when a solid is heated ? Which physical property is affected by it and in what way ?

70. What are the consequences of Schottky defects ?

71. Write two main differences between Schottky and Frenkel defect.

72. Write two main differences between Schottky and Frenkel defect.

73. Define the following :

Vacancy defect

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74. Define the following :

Interstitial defect

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75. Which point defect lowers the density of crystal ?

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76. Which point defect does not lowers density of a crystal.

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77. Which point defect lowers the density of crystal ?

▶ **Watch Video Solution**

78. Which point defect does not lowers density of a crystal.

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79. Why Frenkel defect does not change the density of AgCl crystal ?

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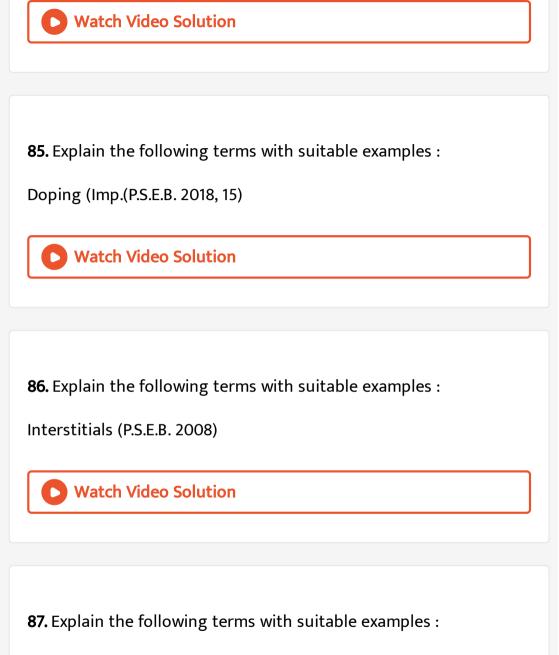**80.** Why is Frenkel defect not found in pure alkali metal halides ?

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81. What type of stoichiometric defect is shown by ZnS?

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82. What type of stoichiometric defect is shown by ZnS?

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83. Explain how vacancies are introduced in an ionic solid when a cation of higher valence is added as an impurity in it.

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84. Ionic solids, which have anionic vacancies due to metal excess defect, develop colour. Explain with the help of a suitable example.

85. Explain the following terms with suitable examples :

Doping (Imp.(P.S.E.B. 2018, 15)

86. Explain the following terms with suitable examples :

Interstitials (P.S.E.B. 2008)

87. Explain the following terms with suitable examples :

F-centres (P.B.E.B. 2003)

88. What are non-stoichiometric compounds ?

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89. Zinc salts on heating become, yellow, on cooling they again become white. Explain why.
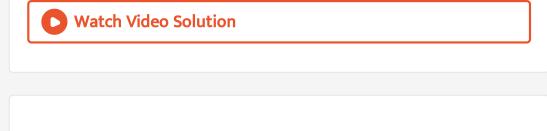
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90. Describe the two main types of semiconductors.

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91. Identify each of the following as being a p-type and n-type semi-conductor.

Ge doped with In

92. Identify each of the following as being a p-type and n-type semi-conductor.

Si doped with As

93. A Group 14 element is to be converted into n-type semiconductor by doping it with a suitable impurity. To which group should this impurity belong ?

94. How n-type semiconductor differ from p-type semiconductor ?

95. In terms of band theory, what is the difference: between a conductor and an insulator

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96. In terms of band theory, what is the difference: between a condutor and a semiconductor?

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97. Explain the following with suitable examples. 12-16 and 13-15 group compounds.

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98. What is the effect of temperature on electrical conductivity of a semiconductor?

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99. Electrical conductance of metals decreases with increase in temperature.

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100. Why does conductivity of a semiconductor increase with rise in temperature?

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101. Write one property of paramagnetic substances.

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102. Explain the following with suitable examples: Ferromagnetism

103. Define the following :

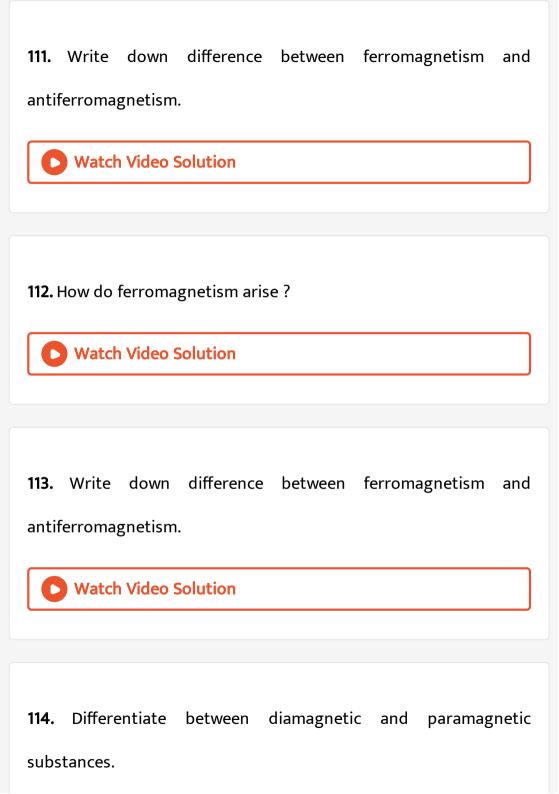ferromagnetic and ferrimagnetic crystals.

104. Define the following :

Antiferromagnetic substances and antiferromagnetism

105. What type of substances would make better permanent magnets, ferromagnetic or ferrimagnetic. Justify your answer.

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106. Write down difference between ferromagnetism and antiferromagnetism.

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107. Write down difference between ferromagnetism and antiferromagnetism.

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108. Write down difference between ferromagnetism and antiferromagnetism.

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109. Write down difference between ferromagnetism and antiferromagnetism.

▶ **Watch Video Solution**

110. What is the difference between ferromagnetic and paramagnetic substances ?

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111. Write down difference between ferromagnetism and antiferromagnetism.

▶ **Watch Video Solution**

112. How do ferromagnetism arise ?

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113. Write down difference between ferromagnetism and antiferromagnetism.

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114. Differentiate between diamagnetic and paramagnetic substances.

Numerical Problems

1. A compound is formed by two elements X and Y. Atoms of the element Y (as anions) make ccp and those of the element X (as cations) occupy all the octahedral voids. What is the formula of the compund?

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

3. In a face centered cubic arrangement of A and B atoms whose A atoms are at the corner of the unit cell and B atoms at the face centers. One of the B atoms missing from one of the face in unit cell. The simplest formula of compounding is:

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4. A unit cell consists of a cube in which there are anions Y at each corner and cations X at the centre of alternate faces of the unit cell. What is the simplest formula of the compound ?

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5. If three elements P, Q and R crystalline in a cubic solid lattice with P atoms of the corners, Q atoms at the cube centres and R

atoms at the centre of the edges, then write the formula of the compound.

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6. A cube solid is made up of two elements P and Q. Atoms Q are present at the corners of the cubic and atom P at the body centre. What is the formula of the compound ? What are the co-ordination numbers of P and Q ?

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7. Gold (atomic radius=0.144nm) crystallises in a face-centred unit cell what is the length of a side of the cell?

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8. Aluminium crystallises in a cubic close packed structure. Its metallic radius is 125 pm.

What is the length of the side of the unti cell ?

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9. Aluminium crystallises in a cubic close packed structure. Its metallic radius is 125 pm.

How many unit cells are there in 100 cm^3 of aluminium ?

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10. Silver crystallisaes in fcc lattice. If the edge length of th cell is 4×10^{-8} cm and density is 11.2 g cm^{-3}, calculate the atomic mass of silver.

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11. Copper crystallizes into a fcc lattice with edge length 3.61×10^{-8} cm. Show that the calculate density is in agreement with is measured value of 8.92 g cm^{-3}. (At mass of copper = 63.5)

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12. An element with molar mass 2.7×10^{-2} kg mol^{-1} forms a cubic unit cell with edge length 405 pm. If its density is 2.7×10^{3} kgm^{-3}, what is the nature of the cubic unit cell ?

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13. Silver crystallisaes in fcc lattice. If the edge length of th cell is 4×10^{-8} cm and density is 11.2 g cm^{-3}, calculate the atomic mass of silver.

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14. Silver forms cpp lattice and X-ray studies of its crystals show that the edge length of its unit cell is 408.6 pm. Calculate density of silver (Atomic mass 107.9 n).
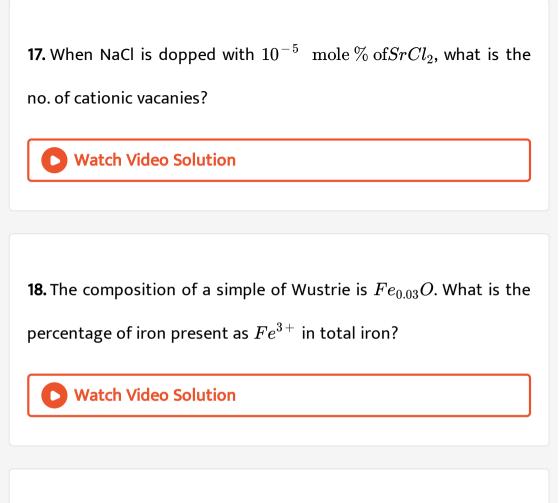
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15. Sodium has a b.c.c. structure with nearest neighbour distance 365.9 pm, calculate its density. (Atomic mass of sodium = 23)

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16. Analysis shows that nickel oxide has the formula $Ni_{0.98}O$. What fractions of the nickel exist as Ni^{2+} and Ni^{3+} ions ?

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17. When NaCl is dopped with 10^{-5} mole % of $SrCl_2$, what is the no. of cationic vacanies?

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18. The composition of a simple of Wustrie is $Fe_{0.03}O$. What is the percentage of iron present as Fe^{3+} in total iron?

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19. A metal having atomic mass 50 g mol^{-1} has a body centred cubic crystal structure.

The density of the metal is 596 g cm^{-1}. Find the volume of unit cell ?

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20. An element has a body-centred cubic (bbc) structure with a cell edge of 288 pm. The density of the element is $7.2\frac{g}{c}m^3$. How many atoms are present in 208 g of the element?

21. The edge length of NaCl unit cell is 564 pm. What is the density of NaCl ? The atomic mass of Na and Cl are 23 and 35.5 respectively. NaCL has fcc structure.

22. Lead (II) sulphide crystals has NaCl structure. What is its density ? The edge length of its unit cell is 500 pm. (Atomic mass of Pb = 207 = S = 32).

23. An element occurs in bcc structure with cell edge of 288 pm. Find the density of the element if its atomic mass is 51.7μ.

24. Niobium crystallizes in a body centred cubic structure. If density is 8.55 gcm^{-3}, calculate atomic radius of niobium, given that its atomic mass is 92.9μ.

25. Potassium crystallizes in a body centred cubic lattice. Calculate the number of unit cells in 1g of potassium. Atomic mass of potassium = 39μ.

26. Copper (Cu) crystal has fcc. (face centred cubic) lattice structure. Atomic mass of copper is $63.5u$. Find out density of metallic crystal. Atomic radius of copper atom is 127.8 pm.

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27. Tungsten crystallizes in a body centred cubic lattice. Calculate the number of unit cells in 1.5 g of tungsten. Atomic mass of tungsten = 184μ.

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28. The body centered cubic cell of chronium has an edge lenth of 0.288nm. Calculte the density of chromium (g/cm^3) : (Atomic mass : $Cr = 52.0$)

29. Silver having atomic mass 107.87 crystallizes in faces centred cubic structure. If density is 10.76gcm^{-3} calculate the edge length of unit cell.

30. A cubic solid made up of two elements A and B. Atoms A are present at the corners of the cube of atoms B are at the face centres. What is the formula of the compound ?

31. A cube solid is made up of two elements P and Q. Atoms Q are present at the corners of the cubic and atom P at the body centre.

What is the formula of the compound ? What are the co-ordination numbers of P and Q ?

32. A compound formed by two elements A and B crystallizers in the cubic structure. Atomic B are present at the corners of the cube and atoms A at the centre of opposite faces. What is the formula of the compound ?

33. A unit cell consists of a cube in which there are anions Y at each corner and cations X at the centre of alternate faces of the unit cell. What is the simplest formula of the compound ?

34. A unit cell consists of a cube in which there are anions Y at each corner and cations X at the centre of alternate faces of the unit cell. What is the simplest formula of the compound ?

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35. A unit cell consists of a cube in which there are anions Y at each corner and cations X at the centre of alternate faces of the unit cell. What is the simplest formula of the compound ?

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36. An element 'X' with an atomic mass of 60g/ mol has density of 6.23g cm^{-1}. If the edge length of its unit cell is 400 pm, identity the type of cell. Also calculate the radius of an atom of this element.

37. The density of chromium metal is 7.2 g cm^{-3}. If the unit cell has edge length of 289 pm, determine the type of unit cell. Also calculate the radius of an atom of chromium. (Atomic mass of chromium = 52 a.m.u.)

38. Silver crystallisaes in fcc lattice. If the edge length of th cell is 4×10^{-8} cm and density is 11.2 g cm^{-3}, calculate the atomic mass of silver.

39. Tungsten has body centred cubic lattice. Each edge of the unit is 316 pm and density of the metal is 19.35g cm^{-3}. How many atoms are present in 50 g of the metal ?

40. An element has density $6 \times 8 \text{g cm}^{-3}$ occurs in bcc structure with cell edge of 290 pm. Calculate the number of atoms present in 200 g of the element.

41. An element has a body-centred cubic (bbc) structure with a cell edge of 288 pm. The density of the element is $7.2\dfrac{g}{c}m^3$. How many atoms are present in 208 g of the element?

42. The body centered cubic cell of chronium has an edge lenth of 0.288nm. Calculte the density of chromium $\left(g/cm^3\right)$: (Atomic mass : $Cr = 52.0$)

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43. Calculate the value of Avogadro's number from the following data Density of $NaCl = 2.165\text{g cm}^{-3}$. Distance between Na^+ and Cl^- in NaCl crystal = 281 pm.

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44. Calculate the Avogadro number from the following data of AB, when AB has NaCl type structure :

Density of $AB = 2.48\text{g cm}^{-3}$, $m = 58\text{g mol}^{-1}$

Distance between A^+ and B^- in AB = 2.69 pm.

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45. An element having bcc geometry has atomic mass 50. Calculate the density if unit cell edge length is 290 pm.

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46. An element crystallizes in a structure having fcc unit cell of edge 300 pm. Calculate its density if 180 g of this element contain 3.708×10^{24} atoms.

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47. An element crystallizes in a structure having fcc unit cell of edge 300 pm. Calculate its density if 200 g of this element contain $4 \times 12 \times 10^{24}$ atoms.

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48. An element crystallizes in a structure having fcc unit cell of edge 300 pm. Calculate its density if 180 g of this element contain 3.708×10^{24} atoms.

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49. A compound is formed by two elements in M and N. The element N forms ccp and atoms of M occupy 1/3rd of tetrahedral voids. What is the formula of the compound ?

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50. A cubic solid made up of two elements A and B. Atoms A are present at the corners of the cube of atoms B are at the face centres. What is the formula of the compound ?

51. Copper crystallizes in a face centred cubic lattice. Calculate the number of unit cells in 1.2 g of copper. Atomic mass of copper = 63.5μ.

52. A face centered cubic element (atomic mass =60) has edge length of 400pm. What is the density of unit cell

53. The density of KBr is 2.75gm cm^{-3}. The edge length of unit cell is 654 pm. Predict the type of cubic lattice to which unit cell of KBr belongs. $\left(N_0 = 6 \times 023 \times 10^{23} \text{mol}^{-1}\right)$.

Atomic mass of K = 39, Br = 80.

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54. The density of chromium metal is 7.2g cm^{-3}. If the unit cell is cubic with edge length of 289 pm, determine the type of unit cell. Atomic mass of Cr = 52 a.m.u., $N_0 = 6.02 \times 10^{23} \text{mol}^{-1}$.

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55. An element having bcc geometry has atomic mass 50u. Calculate the density of the unit cell if its edge length is 290 pm.

56. An element (at mass 60) havind FCC structure has a density of 6.23g cm^{-3}. What is the edge length of the unit cell ?

57. The compound CuCl has ZnS structure and the edge length of its unti cell is 500 pm. Calculate its density

(At mass Cu = 63, Cl = 35.5, $N_0 = 6.02 \times 10^{23} \text{mol}^{-1}$)

58. An element having a density 11.2g cm^{-3} forms a fcc lattice with edge of 4×10^{-3} cm. Calculate the atomic mass of the element.

59. An element having bcc geometry has atomic mass 50. Calculate the density if unit cell edge length is 290 pm.

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60. An element has a body-centred cubic (bbc) structure with a cell edge of 288 pm. The density of the element is $7.2\dfrac{g}{c}m^3$. How many atoms are present in 208 g of the element?

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61. An element has a body-centred cubic (bbc) structure with a cell edge of 288 pm. The density of the element is $7.2\dfrac{g}{c}m^3$. How many atoms are present in 208 g of the element?

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62. An element has density $6 \times 8\text{g cm}^{-3}$ occurs in bcc structure with cell edge of 290 pm. Calculate the number of atoms present in 200 g of the element.

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63. A solid has NaCl structure. If the radius of cation A is 100 pm. What is the radius of anion B ?

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64. The two ions $A^+ \& B^-$ have radii 88 pm and 200 pm, respectively. In the close packed crystal of AB, predict the coordination number of A^-.

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65. If the radius of Na^+ ion is $95pm$ and that of Cl^- ion is $181pm$, then the coordination number if of Na+

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66. In a metallic oxide, oxide ions are arranged in cubic close packing. One sixth of the tetrahedral voids are occupied by cation P and one third of octahedral voids are occupied by the cation Q. Deduce the formula of the compound.

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