(1) 241.5 pm (2) 165.7 pm
(3) 275.1 pm (4) 322.5 pm

53. A unit cell is obtained by closed packing layers of atoms in ABAB …… pattern. The total number of tetrahedral and octahedral voids in the unit cell are respectively
(1) 6, 12 (2) 8, 4
(3) 4, 8 (4) 12, 6

54. Number of unit cells in 10 g NaCl is
(1) $\frac{1.5}{58.5}\times10^{24}$ (2) $\frac{2.5}{58.5}\times10^{23}$
(3) $\frac{5.6}{58.5}\times10^{20}$ (4) $\frac{5.6}{58.5}\times10^{21}$

55. Which is true about Piezoelectric crystals?
(1) They produce an electric current on heating
(2) They produce on electric current when mechanical stress is applied
(3) They are insulators
(4) They are magnetic in nature

forms fcc packing, B occupies all octahedral voids and C occupies all tetrahedral voids. If all the particles along one body diagonal are removed, then the formula of the crystal would be
(1) ABC_2 (2) A_2BC_2
(3) $A_8B_4C_5$ (4) $A_5B_4C_8$

58. The minimum distance between an octahedral void and a tetrahedral void in FCC lattice is
(1) $a\sqrt{3}$ (2) $\frac{a\sqrt{3}}{2}$
(3) $\frac{a\sqrt{3}}{3}$ (4) $\frac{a\sqrt{3}}{4}$

59. A crystalline solid AB has NaCl type structure with radius of B^- ion as 250 pm. Which of the following cation can be made to slip into tetrahedral site of crystals of A^+B^-?
(1) P^+ (radius = 180 pm)
(2) Q^+ (radius = 56 pm)
(3) R^+ (radius = 200 pm)
(4) S^+ (radius = 150 pm)

60. The number of octahedral void(s) per atom present in a cubic close-packed structure is
(1) 2 (2) 4
(3) 1 (4) 3

61. Ferromagnetism arises because of the spontaneous alignment of the magnetic moments due to unpaired electrons as
(1) ↑↑↑↑↑ (2) ↑↑↑↓↓
(3) ↑↓↑↓ (4) ↑↑↓↑↑

62. If the anions (A) form hexagonal close packing and cations (B) occupy only 2/3 rd octahedral voids in it, then the general formula of the compound is:
(1) AB (2) A_2B
(3) A_3B_2 (4) AB_2

63. If Z is the number of atoms in the unit cell that represents the closest packing sequence ….ABC ABC…., the number of tetrahedral voids in the unit cell is equal to:
(1) Z (2) 2Z
(3) Z/2 (4) Z/4

64. 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:
(1) X_4Y_3 (2) X_2Y_3
(3) X_2Y (4) X_3Y_4

65. The Ca^{2+} and F^- ions are located in CaF_2 crystal, respectively at face-centred cubic lattice points and in:
(1) tetrahedral voids
(2) half of tetrahedral voids
(3) octahedral voids
(4) half of octahedral voids

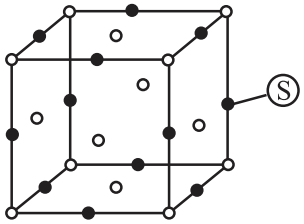
66. For tetrahedral coordination, the radius ratio (r^+/r^-) should be:
(1) 0.155 to 0.225
(2) 0.225 to 0.414
(3) 0.414 to 0.732
(4) 0.732 to 1.000

67. Fraction of total volume occupied by atoms in a simple cube is:
(1) $\frac{\pi}{2}$ (2) $\frac{\sqrt{3}\,\pi}{8}$
(3) $\frac{\sqrt{2}\,\pi}{6}$ (4) $\frac{\pi}{6}$

68. The most unsymmetrical and symmetrical systems are, respectively:
(1) tetragonal, cubic
(2) triclinic, cubic
(3) rhombohedral, hexagonal
(4) orthorhombic, cubic

69. In NaCl crystal each Cl^- ion is surrounded by:
(1) 6 Na^+ ions
(2) 2 Na^+ ions
(3) 5 Na^+ ions
(4) 3 Na^+ ions

70. For the structure given below the site marked as S is a:



(1) Tetrahedral void
(2) Cubic void
(3) Octahedral void
(4) None of these

71. Due to Frenkel defect, the density of ionic solids:
(1) Decreases
(2) Increases
(3) Does not change
(4) May increase or decrease

72. Which of the following crystals does not exhibit Frenkel defect?
(1) AgBr (2) AgCl
(3) KBr (4) ZnS

73. Which of the following expression is correct in the case of a sodium chloride unit cell?
(1) $r^+ + r^- = a$
(2) $r^+ + r^- = a/2$
(3) $r^+ + r^- = 2a$
(4) $r^+ + r^- = \sqrt{2}\,a$

74. A binary solid (A^+B^-) has a zinc blende structure with B^- ions constituting the lattice and A^+ ions occupying 25% tetrahedral holes. The formula of solid is:
(1) AB (2) A_2B
(3) AB_2 (4) AB_4

75. The 8 : 8 type of packing is present in:
(1) CsCl (2) NaCl
(3) KCl (4) MgF_2

76. Which of the following arrangements shows schematic alignment of magnetic moments of antiferromagnetic substances?

(1) ↑ ↑ ↑ ↑ ↑ ↑

(2) ↓ ↓ ↓ ↓ ↓ ↓

(3) ↑ ↑ ↓ ↑ ↑ ↓

(4) ↑ ↓ ↑ ↓ ↑ ↓

77. What are the characteristics of monoclinic crystal system?

(1) $a \neq b \neq c ; \alpha = \beta = \gamma = 90^o$

(2) $a = b = c ; \alpha = \beta = \gamma \neq 90^o$

(3) $a = b \neq c ; \alpha = \beta = \gamma = 90^o$

(4) $a \neq b \neq c ; \alpha = \gamma = 90^o, \beta \neq 90^o$

78. In crystal structure of sodium chloride, the arrangement of Cl^- ion is:

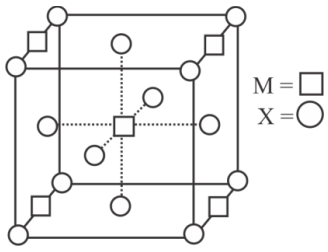
(1) fcc

(2) Both fcc and bcc

(3) hcp

(4) None of these

79. A compound M_pX_q has cubic close packing (ccp) arrangement of X. Its unit cell structure is shown in the following figure. The empirical formula of the compound is:



(1) MX (2) MX_2

(3) M_2X (4) M_5X_{14}

80. The radius of Ag^+ ion is 126 pm while of I^- ion is 216 pm. The co-ordination number of Ag in AgI is:

(1) 2 (2) 4

(3) 6 (4) 8

81. How many square voids can be formed by 6 identical spheres in a two-dimensional close packing?

(1) 3 (2) 4

(3) 6 (4) 2

82. A metal with atomic radius 'r' crystallizes in fcc structure. Edge length of cube is 'a', then correct relation for the structure is:

(1) $r = \frac{a\sqrt{2}}{4}$ (2) $r = \frac{a}{2}$

(3) $r = \frac{a}{2\sqrt{2}}$ (4) $r = \frac{a\sqrt{3}}{4}$

83. Number of face centred particles present in a body centred unit cell is:

(1) 3 (2) 2

(3) 4 (4) Zero

84. Two liquids A and B have vapour pressure in the ratio $P_A^o : P_B^o = 3:1$ at a certain temperature. Assume A and B form an ideal solution and the ratio of mole fractions of A to B in the vapour phase is 3 : 4. The mole fraction of B in the solution at the same temperature is:

(1) 1/5 (2) 2/3

(3) 4/5 (4) 1/4

85. What is the concentration of sugar ($C_{12}H_{22}O_{11}$) in mol L^{-1} if its 20 g are dissolved in enough water to make a final volume up to 2 L?

(1) 0.029 mol L^{-1} (2) 0.058 mol L^{-1}

(3) 0.055 mol L^{-1} (4) 0.011 mol L^{-1}

SECTION - B

86. Percentage of weight by volume of 0.6 M $AgNO_3$ (aq) is:
(Molar mass of $AgNO_3$ = 170 g/mol)

(1) 8.6 % (2) 5.1 %

(3) 17 % (4) 10.2 %

87. The vapour pressure of a mixture of 2 moles of volatile component A (P_A^o = 100 mm Hg) and 3 moles of volatile component B (P_B^o = 80 mm Hg) is 90 mm Hg. For such a case:

(1) there is positive deviation from Raoults' law

(2) boiling point has been lowered

(3) force of attraction between A and B is smaller than that between A and A or between B and B

(4) all are correct

88. A sample of toothpaste weighing 500 g, on analysis was found to contain 0.2 g of fluorine. The concentration of fluorine is:

(1) 4×10^2 ppm

(2) 4×10^1 ppm

(3) 4×10^3 ppm

(4) 2×10^2 ppm

89. A solution is prepared by adding 2 g of a substance A to 18 g of water. Calculate the mass percent of the solute.

(1) 20 % (2) 10 %
(3) 30 % (4) 15 %

90. A solution of acetone in ethanol shows:

(1) shows positive deviation from Raoult's law
(2) shows negative deviation from Raoult's law
(3) obeys Raoult's law
(4) behaves like an ideal solution

91. The mole fraction of solute in one molal aqueous solution is:

(1) 0.018 (2) 0.009
(3) 0.027 (4) 0.036

92. Statement I: 10 ml of a liquid A is mixed with 20 ml of liquid B, total volume of the solution is 30 ml.
Statement II: Liquid A and liquid B will form an ideal solution.

(1) Statement I is true but statement II is false
(2) Statement II is true but statement I is false
(3) Statement I and statement II is both are false
(4) Statement I and II both are true and statement II is the correct explanation of statement II

93. The vapour pressure of a given liquid will increase if:

(1) Surface area of liquid is increased
(2) Temperature is increased
(3) Volume of the vapour phase is decreased
(4) Volume of liquid in the container is increased

94. Statement I: Sum of mole fraction of all the components in a mixture is 1.
Statement II: Mole fraction is a temperature dependent mode of concentration.

(1) Statement I and statement II both are incorrect
(2) Statement I and statement II both are correct
(3) Statement I is correct but statement II is incorrect
(4) Statement I is incorrect but statement II is correct

95. If two liquids A (P_A^o = 100 torr) and B (P_B^o = 200 torr) are completely immiscible with each other, are present in a closed vessel. The total vapour pressure of the system will be:

(1) 300 torr
(2) greater than 200 torr
(3) between 100 to 200 torr
(4) less than 100 torr

96. Van't Hoff factor more than unity indicates that the solute in solution has

(1) Dissociated
(2) Associated
(3) Both (1) and (2)
(4) Cannot say anything

97. K_f for water is 1.86 K-kg-mol^{-1}. If your automobile radiator holds 1.0 kg of water, how many grams of ethylene glycol ($C_2H_6O_2$) must you add to get the freezing point of the solution lowered to –2.8°C?

(1) 93 g
(2) 39 g
(3) 27 g
(4) 72 g

98. Which of the following is incorrect?

(1) Relative lowering of vapour pressure depends on van't hoff factor
(2) The relative lowering of vapour pressure is a colligative property.
(3) Vapour pressure of a solution is lower than the vapour pressure of the solvent.
(4) The relative lowering of vapour pressure is directly proportional to the original pressure.

99. If α is the degree of dissociation of Na_2SO_4 the van't Hoff factor (i) used for calculating the molecular mass is

(1) 1 – 2 α
(2) 1 + 2 α
(3) 1– α
(4) 1 + α

100. In the case of osmosis, solvent molecules move from:

(1) Higher vapour pressure to lower vapour pressure
(2) Higher concentration to lower concentration
(3) Lower vapour pressure to higher vapour pressure
(4) Higher osmotic pressure to lower osmotic pressure

55. **(2)**

Piezoelectric crystals produce electric current on applying mechanical stress.

56. **(2)**

$$\text{No.of ions 'A'} = \underset{\text{corners}}{8\times\left(\frac{1}{8}\right)} + \underset{\text{alternate edges}}{4\times\left(\frac{1}{4}\right)}$$

$$= 1 + 1 = 2$$

$$\text{No. of ions 'B'} = 6\times\frac{1}{2} = 3$$

Formula of compound $\Rightarrow A_2B_3$

57. **(4)**

Body diagonal includes

2 corner atoms 'A'

1 'B' atom [octahedral void]

2 'C' atoms [tetrahedral voids]

$$\text{A} : \text{B} : \text{C}$$

$$\left[6\times\frac{1}{8}+6\times\frac{1}{2}\right] : \left[12\times\frac{1}{4}+0\right] : 6\times1$$

$$\left[\frac{3}{4}+3\right] : 3 : 6$$

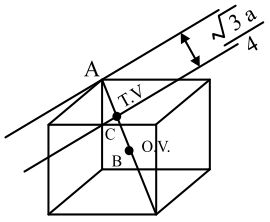
$$\frac{15}{4} : 3 : 6$$

$$\Rightarrow \left[\frac{5}{4} : 1 : 2\right]\times 4$$

$\Rightarrow 5 : 4 : 8$

Formula of crystal $\Rightarrow A_5B_4C_8$

58. **(4)**



O.V. = at body centre

$$AB = \frac{\sqrt{3}a}{2}$$

T.V.$\Rightarrow$ on body diagonal at $\frac{1}{4}$ distance from corner

$$AC = \frac{\sqrt{3}a}{4}$$

Distance b/w T.V. & O.V. (BC) = AB – AC

$$= \frac{\sqrt{3}a}{4}$$

59. **(2)**

For tetrahedral void radius ratio is in the range 0.225 – 0.414

$$\frac{r_{A^+}}{r_{B^-}} = 0.225$$

$r_{A^+} = 250 \times 0.225 = 56.25$ pm

Cation of radius 56.2 pm will fit into tetrahedral void.

But cation Q^+ having radius 56 pm will slip into void.

60. **(3)**

Number of octahedral voids in CCP = 4 for Z = 4 atoms

O.V. per atom will be 1.

61. **(1)**

In ferromagnetic substance all the magnetic moments are aligned in same direction

62. **(3)**

According to question;

No. of anions A = 6 (in HCP)

Hence O.V. = 6 and T.V. = 12

$$\text{No. of cations B} = \frac{2}{3}\text{ of O.V.} = \frac{2}{3}\times 6 = 4$$

Hence,

A	B
6	4
3	2

Hence, formula of the compound is A_3B_2

63. **(2)**

Since, the number of atoms in the unit cell = Z

Hence, O.V. = Z

and T.V. = 2 O.V. = 2Z

64. **(1)**

According to question;

$$\text{No. of Y atoms} = 8\times\frac{1}{8} + 6\times\frac{1}{2} = 4$$

Hence O.V. = 4 and T.V. = 8

$$\text{No. of X atoms} = \frac{2}{3}\text{ of T.V.} = \frac{2}{3}\times 8 = \frac{16}{3}$$

Hence,

X	Y
$\frac{16}{3}$	4
$\frac{16}{3}\times 3$	4 × 3
16	12
4	3

Hence, formula of the compound is X_4Y_3

65. **(1)**

In CaF_2 (fluorite structure) Ca^{2+} ions form ccp lattice and F^- ions are present in all T.V.

66. **(2)**

For tetrahedral coordination, the radius ratio (r^+/r^-) is 0.225 to 0.414

67. **(4)**

For scp Z = 1 and a = 2r

P.F. in simple cubic unit cell

$$= \frac{Z \times V \text{ of 1 sphere}}{V \text{ of unit cell}} = \frac{1 \times \frac{4}{3}\pi r^3}{a^3}$$

$$= \frac{1 \times \frac{4}{3}\pi r^3}{(2r)^3} = \frac{1 \times \frac{4}{3}\pi r^3}{8r^3}$$

$$= \frac{4\pi r^3}{24r^3}$$

$$= \frac{\pi}{6}$$

68. **(2)**

The most unsymmetrical system is Triclinic i.e.

$a \neq b \neq c$ and $\alpha \neq \beta \neq \gamma \neq 90^o$

The most symmetrical systems Cubic i.e.

$a = b = c$ and $\alpha = \beta = \gamma = 90^o$

69. **(1)**

In NaCl crystal each Cl^- ion is surrounded by 6 Na^+ ions and each Na^+ ion is surrounded by 6 Cl^- ions.

70. **(3)**

In the given figure, site S represents edge centre where octahedral voids are present.

71. **(3)**

Due to Frenkel defect, the density of ionic solids does not change because no any ion is removed or added. This is a called dislocation defect.

72. **(3)**

KBr exhibits Schottky defect having highly ionic characters.

AgCl, AgBr, AgI, ZnS etc shows Frenkel defect.

73. **(2)**

In case of NaCl;

$$r^+ + r^- = \frac{a}{2}$$

74. **(3)**

In ZnS type structure, anions (B^-) form ccp lattice and cations (A^+) are present in half of T.V.

According to question;

No. of anions (B^-) = $8\times\frac{1}{8} + 6\times\frac{1}{2} = 4$

Hence O.V. = 4 and T.V. = 8

No. of cations (A^+) = 25% of T.V. = $\frac{1}{4}\times 8 = 2$

Hence,

A	B
2	4
1	2

Hence, formula of the compound is AB_2

75. **(1)**

In a bcc lattice i.e. CsCl type lattice, the coordination number of each ion is 8 hence it has 8 : 8 type of packing.

CsCl	8 : 8
NaCl	6 : 6
KCl	6 : 6
MgF_2	8 : 4

76. **(4)**

(1) ↑ ↑ ↑ ↑ ↑ ↑ : Ferromagnetic

(2) ↓ ↓ ↓ ↓ ↓ ↓ : Ferromagnetic

(3) ↑ ↑ ↓ ↑ ↑ ↓ : Ferrimagnetic

(4) ↑ ↓ ↑ ↓ ↑ ↓ : Antiferromagnetic

77. **(4)**

(1) $a \neq b \neq c$; $\alpha = \beta = \gamma = 90^o$
: Orthorhombic

(2) $a = b = c$; $\alpha = \beta = \gamma \neq 90^o$
: Rhombohedral or Trigonal

(3) $a = b \neq c$; $\alpha = \beta = \gamma = 90^o$
: Tetragonal

(4) $a \neq b \neq c$; $\alpha = \gamma = 90^o, \beta \neq 90^o$
: Monoclinic

78. **(1)**

In NaCl, Cl^- ions form fcc lattice and Na^+ ions are present in all O.V.

79. **(2)**

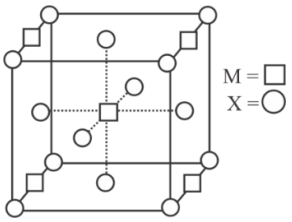
Given diagram indicates that, fcc lattice is formed by X and M are present at 4 edge centres and at body centre.

Hence,

Number of X $= 8 \times \frac{1}{8} + 6 \times \frac{1}{2} = 4$

Number of M $= 4 \times \frac{1}{4} + 1 \times 1 = 2$

Thus, formula of compound is MX_2



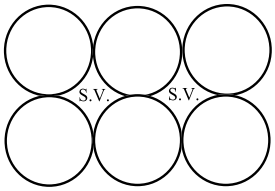
80. (3)

$$\frac{r_+}{r_-} = \frac{126}{216} = 0.583$$

This value lies between 0.414 and 0.732, hence C.N. = 6

81. (4)

In a two-dimensional close packing maximum two square voids can be formed.



82. (1)

For FCC,

Face diagonal, $4r = \sqrt{2}\ a$ or $r = \frac{\sqrt{2}\ a}{4}$

83. (4)

In a body centred unit cell, particles are present only at the corners and at the body centre.

84. (3)

$$\frac{Y_A}{Y_B} = \frac{P_A^o \chi_A}{P_B^o \chi_B} \Rightarrow \frac{3}{4} = \frac{3}{1} \times \frac{\chi_A}{\chi_B}$$

$$\frac{\chi_A}{\chi_B} = \frac{3}{4} \times \frac{1}{3} \Rightarrow \frac{\chi_A}{\chi_B} = \frac{1}{4}$$

$$\frac{1-\chi_B}{\chi_B} = \frac{1}{4} \Rightarrow \chi_B = 4 - 4\chi_B$$

$$5\chi_B = 4$$

$$\chi_B = \frac{4}{5}$$

85. (1)

$$\text{Molarity of solution} = \frac{\text{Moles of solute}}{\text{Volume of solution in L}}$$

$$= \frac{\text{Moles of } C_{12}H_{22}O_{11}}{\text{Volume of solution in L}}$$

$$= \frac{20/342}{2}$$

$$= \frac{20}{342 \times 2}$$

$$= \frac{10}{342}$$

$$= 0.029 \text{ mol } L^{-1}$$

86. (4)

$$\text{Molarity} = \frac{\%\ (w/v) \times 10}{GMM}$$

$$0.6 = \frac{\%\ (w/v) \times 10}{170}$$

$$\%\ (w/v) = \frac{0.6 \times 170}{10}$$

$$= 10.2\ \%$$

87. (4)

$$P_{total} = P_A^o\ \chi_A + P_B^o\ \chi_B$$

$$= 100 \times \frac{2}{2+3} + 80 \times \frac{3}{2+3}$$

$$= 100 \times \frac{2}{5} + 80 \times \frac{3}{5}$$

$$= 40 + 48$$

$$P_{total} = 88 \text{ mmHg}$$

But the given value of P_{total} is 90 mmHg, thus there is a positive deviation from Raoult's law, boiling point has been lowered and force of attraction between A and B is smaller than that between A and A or between B and B.

88. (1)

$$\text{ppm} = \frac{w_{solute}}{w_{solution}} \times 10^6$$

$$= \frac{0.2}{500} \times 10^6$$

$$= 0.0004 \times 10^6$$

$$= 4 \times 10^{-4} \times 10^6$$

$$= 4 \times 10^2 \text{ ppm}$$

89. (2)

$$\text{Mass \% of solute} = \frac{w_{solute}}{w_{solution}} \times 100$$

$$= \frac{2\ g}{2g + 18\ g} \times 100$$

$$= \frac{2\ g}{20\ g} \times 100$$

$$= 10\ \%$$

90. (1)

A solution of acetone (CH_3COCH_3) in ethanol (C_2H_5OH) is a non-ideal solution and shows positive deviation from Raoult's law

91. (1)

1 molal aqueous solution means 1 mole of solute is dissolved in 1000 g of water.

Thus,

$$\chi_{solute} = \frac{n_{solute}}{n_{solute} + n_{solvent}}$$

$$= \frac{1}{1 + \frac{1000}{18}}$$

$$= \frac{1}{1 + 55.55}$$

$$= \frac{1}{56.55}$$

$$= 0.0177$$

$$= 0.018$$

92. (4)

Statement I: 10 ml of a liquid A is mixed with 20 ml of liquid B, total volume of the solution is 30 ml. (True)

Statement II: Liquid A and liquid B will form an ideal solution. (True)

For an ideal solution $\Delta V_{mix} = 0$

Hence, statement I and II both are true and statement II is the correct explanation of statement II

93. (2)

$$\text{Vapour pressure} \propto T$$

94. (3)

Sum of mole fraction of all components in a mixture is 1. (Correct)

Mole fraction is a temperature independent mode of concentration.

95. (1)

In case of immiscible and volatile liquids;

$$P_{total} = P_A^o + P_B^o$$

$$= 100 \text{ torr} + 200 \text{ torr}$$

$$= 300 \text{ torr}$$

96. (1)

van't Hoff factor greater than 1 means observed value is greater than calculated value which is so when the solute dissociates.

97. (1)

$$\Delta T_f = \frac{1000 \times K_f \times w}{M \times W}$$

$$\therefore \quad w = \frac{\Delta T_f \times M \times W}{1000 \times K_f}$$

$$= \frac{2.8 \times 62 \times 1000}{1000 \times 1.86} = 93.33 g$$

98. (4)

According to Raoult's law the relative lowering of vapour pressure of a dilute solution is equal to the mole fraction of the solute present in the solution, i.e.,

$$\frac{P_A^o - p_s}{P_A^o} = \frac{in_B}{(i \times n_B) - n_A}$$

99. (2)

$$Na_2SO_4 \rightleftharpoons 2Na^+ + SO_4^{2-}$$

van't Hoff factor i =[1 + (y – 1) α]

where y is the number of ions from one mole solute, (in this case y = 3), and α is the degree of dissociation.

$$i = (1 + 2\alpha)$$

100. (1)

Osmosis is explained in terms of vapour pressure theory, i.e., movement of solvent particles from higher vapour pressure to lower vapour pressure. Note that a solution of high osmotic pressure is concentrated in comparison to other having low osmotic pressure.