SOLID STATE

KEY CONCEPTS

As we know that matter exists in different physical states under different conditions of temperature and pressure. For example solid state, liquid gases plasma and BEC etc. Now we will study about different aspects of solid state.

Introduction:

1. The state of matter whose M.P is above room temp is solid state. Solids have definite shape and volume, having high density and constituent particles are held strongly.
2. Based on arrangement of particles types of solid : 1: Crystalline

   2:Amorphous
3. Crystalline solids have regular arrangement of constituent particles throughout, melting point is sharp, Anisotropic in nature and give clear cut cleavage.
4. Amorphous solids have no regular arrangement, no sharp M.P, isotropic in nature they do not exhibit cleavage property.
5. Amorphous silica is used in photovoltaic cells.(Applications of amorphous solid)
6. Space lattice is the regular 3D, arrangement of constituent particles in the crystalline solid. It shows how the constituents particles(atoms, molecules etc.) are arranged.
7. Smallest repeating unit in a space lattice is called unit cell.
8. There are 4 types of unit cells, 7 crystal systems and 14 bravais lattices.
9. Types of unit cell — No. of atoms per unit cell

i. Simple cubic unit cell	8*1/8=1
ii. FCC (Face centered cubic)	8*1/8+6*1/2=4
iii. BCC (Body centered cubic)	8*1/8+1*1=2

10. Hexagonal close packing and cubic close packing have equal efficiency i.e 74%
11. Packing efficiency =volume occupied by spheres (Particles)/volume of unit cell *100
12. For simple cubic unit cell the p.f.=$1*4/3 *\pi r^3/8*r^3 *100$ =52.4
13. The packing efficiency in **fcc** =$4*4/3 *\pi r^3/16*2^{1/2} r^3 *100$ =74

14. The packing efficiency in **bcc** =2*4/3 *πr^3/64*$3^{3/2}$ r^3 *100 =68
15. The packing efficiency in **hcp =74**
16. Packing efficiency in bcc arrangement in 68% and simple cubic unit cell is 52.4%
17. Unoccupied spaces in solids are called interstitial voids or interstitial sites.
18. Two important interstitial voids are (I). Tetrahedral void and (II). Octahedral void.
19. Radius ratio is the ratio of radius of void to the radius of sphere.
    a. For tetrahedral void radius ratio=0.225

       For octahedral void radius ratio=0.414
20. No. of tetrahedral void=2*N (N=No. of particles)
21. No. of octahedral void=N
22. Formula of a compound depends upon arrangement of constituent of particles.
23. Density of unit cell

    $D=Z*M/a^3*NA$

D=density, M=Molar mass, a=side of unit cell, NA=$6.022*10^{23}$

24. The relationship between edge length and radius of atom and interatomic or interionic distance for different types of unit is different as given below
    a. Simple cubic unit cell a=2R
    b. F C C a=4R/$\sqrt{2}$
    c. B C C a=4R/$\sqrt{3}$
25. Interatomic distance=2R
26. Interionic distance=Rc+Ra (Rc=Radius of cation, Ra=Radius of anion)
27. Imperfection is the ir-regularty in the arrangement of constituent particles.
28. Point defect or Atomic defect-> it is the deviation from ideal arrangement of constituent atom. Point defects are two types (a) Vacancy defect (b) Interstitial defect
29. Vacancy defect lowers the density and

30. Interstitial defect increases the density of crystal.

31. Point defects in the ionic crystal may be classified as:

a. Stoichiometric defect (Ratio of cation and anion is same).

b. Non Stoichiometric defect (disturb the ratio).

c. Impurity defects (due to presence of some impurity ions at the lattice sites)

32. Schottky defect lowers the density of crystal it arises due to missing of equal no. of cations of anions from lattice sites e.g. Nacl.

33. Frenkel defectis the combination of vacancy and interstitial defects. Cations leave their actual lattice sites and come to occupy the interstitial space density remains the same eg. Agcl.

34. Non stoichiometric defect

    a. Metal excess defect due to anion vacancy.

    b. Metal excess due to presence of interstitial cation.

    c. Metal deficiency due to absence of cation.

    SHORT ANSWER QUESTION (2)

Q1. What do you mean by paramagnetic substance?

Ans: - Attracted by pragnetic field and these substances are made of atoms or ions with unpaired electrons.

Q2. Which substance exhibit schottky and Frenkel both defects.

Ans: - AgBr

Q3. Name a salt which is added to Agcl so as to produce cation vacancies.

Ans:-Cdcl2

Q4. Why Frenkel defects not found in pure Alkali metal halide.

Ans: - Due to larger size of Alkali metal ion.

Q5. What is the use of amorphous silica?

Ans. Used in Photovoltaic cell.

Q6. Analysis shows that a metal oxide has the empirical formula $Mo.98^{0}1.00$. Calculate the percentage of M^{2+} and M^{3+} ions in the crystal.

Ans: - Let the M^{2+} ion in the crystal be x and $M3^{+}$ =0.98-x

Since total change on the compound must be zero

2x+3(0.098-x)-z=0

X=0.88

%of M^{2+} 0.88/0.96*100=91.67

% of $M3^{+}$ =100-91.91.67=8.33

Q7. What is the co-ordination no. of cation in Antifluorite structure?

Ans: - 4

Q8. What is the Co.No. of cation and anion in Caesium Chloride.

Ans: 8 and 8

Q9. What is F centre?

Ans:- It is the anion vacancy which contains unpaired electron in non-stoichiometric compound containing excess of metal ion.

Q10. What makes Alkali metal halides sometimes coloured, which are otherwise colourless?

Very Short Answers(1 marks) :

1. How does amorphous silica differ from quartz?

In amorphous silica, SiO_4 tetrahedral are randomly joined to each other whereas in quartz they are linked in a regular manner.

2. Which point defect lowers the density of a crystal?

Schottky defect.

3. Why glass is called supper cooled liquids?

It has tendency to flow like liquid.

4. Some of the very old glass objects appear slightly milky instead of being transparent why?

Due to crystallization.

5. What is anisotropy?

Physical properties show different values when measured along different in crystalline solids.

6. What is the coordination number of atoms?

a) in fcc structure b) in bcc structure

a) 12 b) 8

7. How many lattice points are there in one cell of -

a) fcc b) bcc c) simple cubic

a) 14 b) 9 c) 8

8. What are the co-ordination numbers of octahedral voids and tetrahedral voids?

6 and 4 respectively.

9. Why common salt is sometimes yellow instead of being of being pure white?

Due to the presence of electrons in some lattice sites in place of anions these sites act as F-centers. These electrons when excited impart color to the crystal.

10. A compound is formed by two elements X and Y. The element Y forms ccp and atoms of X occupy octahedral voids. What is formula of the compound?

No. of Y atoms be N No. of octahedral voids N

No. of X atoms be =N Formula XY

HOTS Very Short Answers:

1. **Define F centers.**
2. **What type of stoichiometric defect is shown by**
    a. **Zns**
    b. **AgBr**
3. **What are the differences between frenkel and schottky defect?**
4. **Define the following terms with suitable examples**
    - **Ferromagnetism**
    - **Paramagnetism**
    - **Ferrimagnetism**
    - **12-16 and 13-15 group compound**
5. **In terms of band theory what is the difference**
    - **Between conductor and an insulator**
    - **Between a conductor and a semi-conductor**

Short Answers (2 Marks):HOTS

1. **Explain how electrical neutrality is maintained in compounds showing Frenkel and Schottky defect.**

   In compound showing Frenkel defect, ions just get displaced within the lattice. While in compounds showing Schottky defect, equal number of anions and Cations are removed from the lattice. Thus, electrical neutrality is maintained in both cases.

2. **Calculate the number of atoms in a cubic unit cell having one atom on each corner and two atoms on each body diagonal.**
   8 corner *1/8 atom per unit cell = 1atom

   There are four body diagonals in a cubic unit cell and each has two body centre atoms.

   So **4*2=8 atoms** therefore total number of atoms per unit cell =1+8=9

3. **Gold crystallizes in an FCC unit cell. What is the length of a side of the cell(r=0.144mm)**
   r=0.144nm

   a=2*√2r

   =2*1.414*0.144nm

   =0.407nm

4. **Classify each of the following as either a p-type or n-type semi-conductor.**
   a) Ge doped with In

   b) B doped with Si

(a) Ge is group 14 elements and In is group 13 element. Therefore, an electron deficit hole is created. Thus semi-conductor is p-type.

(b) Since b group 13 element and Si is group 14 elements, there will be a free electron, thus it is n-type semi-conductor.

5. **In terms of band theory what is the difference between a conductor, an insulator and a semi-conductor?**

The energy gap between the valence band and conduction band in an insulator is very large while in a conductor, the energy gap is very small or there is overlapping between valence band and conduction band.

6. **$CaCl_2$ will introduce Scotty defect if added to AgCl crystal. Explain**

Two Ag+ ions will be replaced by one Ca^{2+} ions to maintain electrical neutrality. Thus a hole is created at the lattice site for every Ca^{2+} ion introduced.

7. **The electrical conductivity of a metal decreases with rise in temperature while that of a semi-conductor increases. Explain.**

In metals with increase of temperature, the kernels start vibrating and thus offer resistance to the flow of electrons. Hence conductivity decreases. In case of semi-conductors, with increase of temperature, more electrons can shift from valence band to conduction band. Hence conductivity increases.

8. **What type of substances would make better permanent magnets, ferromagnetic or ferromagnetic, why?**

Ferromagnetic substances make better permanent magnets. This is because the metal ions of a ferromagnetic substance are grouped into small regions called domains. Each domain acts as tiny magnet and get oriented in the direction of magnetic field in which it is placed. This persists even in the absence of magnetic field.

9. **In a crystalline solid, the atoms A and B are arranged as follows:-**
   a. **Atoms A are arranged in ccp array.**
   b. **Atoms B occupy all the octahedral voids and half of the tetrahedral voids. What is the formula of the compound?**

Let no. of atoms of A be N

No. of octahedral voids = N

No. of tetrahedral voids= 2N

i) There will be one atom of b in the octahedral void
ii) There will be one atom of B in the tetrahedral void (1/2*2N)
Therefore, total 2 atoms of b for each atom of A

Therefore formula of the compound =AB_2

10. In compound atoms of element Y forms ccp lattice and those of element X occupy 2/3rd of tetrahedral voids. What is the formula of the compound?

No. of Y atoms per unit cell in ccp lattice=4

No. of tetrahedral voids= 2*4=8

No. of tetrahedral voids occupied by X= 2/3*8=16/3

Therefore formula of the compound =$X_{16/3}\,Y_4$

=$X_{16}\,Y_{12}$

=$X_4\,Y_3$

HOTS Short Answer:

1. **How many lattice points are there in one unit cell of the following lattices?**
   - **FCC**
   - **BCC**
   - **SCC**

2. **A cubic solid is made of two elements X and Y. Atom Y are at the corners of the cube and X at the body centers. What is the formula of the compound?**
3. **Silver forms ccp lattice and X –ray studies of its crystal show that the edge length of its unit cell is 408.6 pm. Calculate the density of silver (Atomic wt= 107.9u).**
4. **A cubic solid is made up of two elements P and Q. Atoms of the Q are present at the corners of the cube and atoms of P at the body centre. What is the formula of the compound? What are the co-ordination number of P and Q.**
5. **What happens when:-**
   - **CsCl crystal is heated**
   - **Pressure is applied on NaCl crystal.**

Short Answers (3 marks):

1. **The density of chromium is 7.2g cm^{-3}. If the unit cell is a cubic with length of 289pm, determine the type of unit cell (Atomic mass of Cr=52 u and N_A = 6.022*10^{23} atoms $mol^{-1)}$.**

d= $\frac{Z * M}{}$

$a^3 * N_A$

Z=? , a= 289 pm =28910^{-10} cm, M=52g mol^{-1}, d=7.2g cm^{-3}

$$Z = \frac{d * a^3 * N}{M} = \frac{7.2(g\ cm^{-3}) * [289 * 10^{-10}\ cm]^3 * 6.022 * 10^{23}(atom\ mol^{-1})}{52\ g\ mol^{-1}}$$

2. **An element crystallizes in FCC structure; 200 g of this element has $4.12*10^{24}$ atoms. If the density of A is 7.2g cm^{-3}, calculate the edge length of unit cell.**
3. **Niobium crystallizes in bcc structure. If its density is 8.55 cm^{-3}, calculate atomic radius of [At. Mass of Niobium = 92.9u, N_A = $6.022*10^{23}$ atoms mol^{-1}].**
4. **If radius of octahedral void is r and radius of atom in close packing is R, derive the relationship between r and R.**
5. **Non stoichiometric cuprous oxide can be prepared in the laboratory. In this oxide, copper to oxygen ratio is slightly less than 2:1 can u account for the fact that the substance is a p=type semiconductor?**
6. **The unit cell of an element of atomic mass 50u has edge length 290pm. Calculate its density the element has bcc structure (N_A $6.02*10^{23}$ atoms mol^{-1}).**
7. **Calculate the density of silver which crystallizes in face centered cubic form. The distance between nearest metal atoms is 287pm (Ag= 107.87g mol^{-1}, N_A= $6.022*10^{23}$).**

8. **What is the distance between Na^+ and Cl-ions in NaCl crystal if its density 2.165g cm^{-3}. NaCl crystallizes in FCC lattice.**

9. **Analysis shows that Nickel oxide has $Ni_{0.98}O_{1.00}$ what fractions of nickel exist as Ni^{2+} ions and Ni^{3+} ions?**

10. **Find the type of lattice for cube having edge length of 400pm, atomic wt. = 60 and density =6.25g/cc.**

HOTS Short Answer:

1. **Aluminium crystallizes in cubic closed pack structure. Its metallic radius is 125 pm**
   - **What is the length of the side of the unit cell?**
   - **How many unit cell are there in 100 cm^3 of Aluminium.**

2. **Classify the following as either p-type or n-type semiconductors.**
   Ge doped with In

   B doped with Si

3. **Zinc oxide is white but it turns yellow on heating. Explain.**

Long Answer(5 Marks):

1. **It is face centered cubic lattice A metal has cubic lattice. Edge length of lattice cell is $2A^0$. The density of metal is 2.4g $cm^{-3.}$ How many units cell are present in 200g of metal.**

2. **A metal crystallizes as face centered cubic lattice with edge length of 450pm. Molar mass of metal is 50g mol^{-1}. The density of mental is?**

3. **A compound forms hexagonal close packed structure. What is the total number of voids in 0.5 mol of it? How many of these are tetrahedral voids?**

4. **Copper Crystallizes into FCC lattice with edge length $3.61*10^{-8}$ cm. Show that calculated density is in agreement with measured value of 8.92g/cc.**

5. **Niobium crystallizes in bcc structure with density 8.55g/cc, Calculate atomic radius using atomic mass i.e. 93u.**

HOTS Long Answer:

1. The compound CuCl has Fu structure like ZnS, its density is 3.4g cm^{-3}. What is the length of the edge of unit cell?

Hint: d=Z X M /a3 X NA

a^3=4X99 / 3.4 X 6.022 X $10^{2.3}$

a^3=193.4 X 10-24 cm^3

a=5.78 X 10^{-8}cm

2. If NaCl is dropped with 10^{-3} mol% $SrCl_2$. What is the concentration of cation valancies?

3. If the radius of the octahedral void is r and the radius of the atom in the close packing is R. derive relationship between r and R.

4. **The edge length of the unit cell of mental having molecular weight 75g/mol is A^0 which crystallizes into cubic lattice. If the density is 2g/cm^3 then find the radius of metal atom (N_A = $6.022*10^{23}$)**
5. **The density of K Br. Is 2.75 gm cm^{-3}. the length of edge of the unit cell is 654 pm. Predict the type of cubic lattice to which unit cell of KBr belongs.**
   NA=$6.023*10^{23}$; at mass of K=39: Br. = 80
   Ans. Calculate value of z= 4 so it has fcc lattice

6. **CsCl has bcc arrangement and its unit cell edge lenth is 400 pm . calculate the interionic distance of CsCl. Ans. 34604 pm**
7. **The radius of an Iron atom is 1.42 A^0 . It has rock salt structure. Calculate density of unit cell. Ans. 5.74 g cm^{-3}**
8. **What is the distance between na^+ and Cl^- in a NaCl crystal if its density is 2.165 gcm^{-3} NaCl crystalline in the fcc lattice. Ans.281PM**
9. **Copper crystalline with fcc unit cell. If the radius of copper atom is 127.8 pm. Calculate the density of copper metal. At. Mass of Cu=63.55u NA= $6.02*10^{23}$ Ans.a=2√2 .r , a3=$4.723*10^{-23}$, d=8.95 5.74 g cm^{-3}**

Solution

KEY CONCEPTS

Solution is the homogeneous mixture of two or more substances in which the components are uniformly distributed into each other. The substances which make the solution are called components. Most of the solutions are binary i.e., consists of two components out of which one is solute and other is solvent. Ternary solution consists of three components

Solute - The component of solution which is present in smaller quantity.

Solvent – The component of solution present in larger quantity or whose physical state is same as the physical state of resulting solution.

Types of solutions: Based on physical state of components solutions can be divided into 9 types.

Solubility - The amount of solute which can be dissolved in 100grm of solvent at particular temp. to make saturated solution.

Solid solutions are of 2 types -

1. Substitutional solid solution e.g. Brass (Components have almost similar size)

2. Interstitial solid solution e.g. steel (smaller component occupies the interstitial voids)

Expression of concentration of solution

1. **Mass percentage**= amount of solute present in 100grm solution.

Percentage = $\frac{mass\ of\ solute W_B}{mass\ of\ solution(W_A+W_B)} \times 100$

For liquid solutions percentage by volume is expressed as = $\frac{Volume\ of\ solute(V_B)}{volume\ of\ solution(V_A+V_B)} \times 100$

2**. Mole fraction** it is the ratio of no. of one component to the total no. of moles of all components. It is expressed as 'x'. For two component system made of A and B ,$X_A = n_A + n_B$, $X_B = n_A + n_B$, Sum of all the components is 1 ; $X_A + X_B = 1$

3. **Molarity (M)** = $\frac{no.of\ moles\ of\ solute}{volume\ of\ solution(L)}$

It decreases with increase in temperature as volume of solution increases with temperature.

4. **Molality (m)** = $\frac{No.of\ moles\ of\ solute}{Mass\ of\ solvent(in\ kg)}$

No effect of change of temperature on molality as it is mass to mass ratio.

5**. Normality (N)** = $\frac{no.of\ gram\ equivalent\ of\ solute}{volume\ of\ solution(L)}$

It changes with changes temperature.

6. **Parts per million (ppm)** concentration of very dilute solution is expressed in ppm.

Ppm = $\frac{W_B}{W_B + W_A} \times 10^6$

Vapor pressure – It is defined as the pressure exerted by the vapour of liquid over the liquid over the liquid in equilibrium with liquid at particular temperature vapour pressure of liquid depends upon nature of liquid and temperature.

Roult's Law –

1. For the solution containing non-volatile solute the vapor pressure of the solution is directly proportional to the mole fraction of solvent at particular temperature
   $P_A \propto X_A$
   $P_A = P^0_A.X_A$
2. For the solution consisting of two miscible and volatile liquids the partial vapor pressure of each component is directly proportional to its own mole fraction in the solution at particular temperature.
   $P_A = P^0_A. X_A$, $P_B = P^0_B .X_B$
   And total vapor pressure is equal to sum of partial pressure. $P_{total} = P_A + P_B$

Ideal solution – The solution which obeys Roult's law under all conditions of temperature and concentration and during the preparation of which there is no change in enthalpy and volume on mixing the component.

Conditions –

$P_A = P^0_A X_A$, $P_B = P^0_B.X_B$

$\Delta H_{Mix} = 0$, $\Delta V_{mix} = 0$

This is only possible if A-B interaction is same as A-A and B-B interaction nearly ideal solution are –

1. Benzene and Toluene
2. Chlorobenzene and Bromobenzene

Very dilute solutions exhibit ideal behavior to greater extent.

Non-ideal solution –

(a) $P_A \neq P^0_A.X_A$ (b) $P_B \neq P^0_B.X_B$
(b) $\Delta H_{mix} \neq 0$ (d) $\Delta V_{mix} \neq 0$

For non-ideal solution the A-B interaction is different from A-A and B-B interactions

i. For solution showing positive deviation
   $P_A > P^0_A$, $P_B > P^0_B. X_B$
   ΔH_{Mix} = positive, ΔV_{mix}=positive (A-B interaction is weaker than A-A and B-B)
   E.g. alcohol and water

ii. For the solution showing negative deviation

$P_A < P^0_A.X_A$, $P_B<P^0_B.X_B$

ΔH_{Mix}= negative, ΔV_{mix} = negative'

A-B interaction is stronger than A-A and B-B interactions

E.g. Chloroform, acetone, HCl and water

What is Azeotrope? – The mixture of liquids at particular composition which has constant boiling point which behaves like a pure liquid and cannot be separated by simple distillation. Azeotropes are of two types:

(a) minimum boiling Azeotrope (mixture which shows +ve deviations) ex. alcohol and water
(b) maximum boiling Azeotrope (which shows –ve deviations) ex. acetone and chloroform

Colligative Properties - Properties of ideal solution which depends upon no. of particles of solute but independent of the nature of particle are called colligative property

Relative lowering in vapour pressure:

$$(P^o_A - P_A)/ P^o_A = X_B$$

Determination of molar mass of solute

$$M_B =(W_A\times M_A\times P^o_A)/W_A\times(P^o_A - P_A)$$

Elevator in Boiling Point

$$\Delta T_B = Kb.\ m$$

Where $\Delta T_B = T'_B - T^o_B$

Kb = molal elevator constant

M = molality

$$M_B =(Kb\times1000\times W_B)/\Delta T_B\times W_A$$

Depression in Freezing Point:

$$\Delta T_f = k_f.\ m$$

Where $\Delta T_f - T'_f$; m = molality

K_f = molal depression constant

unit = $k.kgmol^{-1}$

Osmotic Pressure

The hydrostatic pressure which is developed on solution side due movement of solvent particles from lower concentration to higher concentration through semipermeable membrane denoted as **π** and it is expressed as

$$\Pi = \frac{n}{V} RT$$

$$\Pi = CRT$$

n = No. of moles; v = volume of solution (L)

R = 0.0821 $Latmmol^{-1}$; T = temperature in kelvin.

Isotonic solutions have same osmotic pressure and same concentration.

Hypertonic solutions have higher osmotic pressure and hypotonic solutions have lower osmotic pressure.

0.91% solutions have sodium chloride solution RBC swells up or burst.

Q1- What do you mean by Henry's Law? The Henry's Law constant for oxygen dissolved in water is 4.34×10^4 atm at 25^o C. If the partial pressure of oxygen in air is 0.2 atm, under atmospheric pressure conditions. Calculate the concentration in moles per Litre of dissolved oxygen in water in equilibrium with water air at 25^o C.

Ans: Partial pressure of the gas is directly proportional to its mole fraction in solution at particular temperature.

$P_A \alpha X_A$; K_H = Henry's Law of constant

$$P_A = K_H \times A$$

$$K_H = 4.34\times10^4 \text{ atm}$$

$$PO_2 = 0.2 \text{ atm}$$

$$Xo_2 = PO_2 / K_H \quad = 0.2 / 4.34\times10^4 = 4.6\times10^{-6}$$

If we assume 1L solution = 1L water

n water = 1000/18 = 55.5

$$XO_2 = nO_2 / (nO_2 + n H_2O) \sim = nO_2 / nH_2O$$

$nO_2 = 4.6 \text{ X } 10^{-6} \text{ X } 55.5 = 2.55 \text{ X } 10^{-4}$ mol

$M = 2.55 \text{ X } 10^{-4}$ M

Q.2. What is Vant Hoff factor?

Ans. It is the ratio of normal molecular mass to observed molecular mass . H is denoted as 'i'

i = normal m.m / observed m.m

= no. of particles after association or dissociation / no. of particles before

Q.3. What is the Vant Hoff factor in $K_4[Fe(CN)_6]$ and $BaCl_2$?

Ans 5 and 3

Q.4. Why the molecular mass becomes abnormal?

Ans. Due to association or dissociation of solute in given solvent .

Q.5. Define molarity, how it is related with normality ?

Ans. N = M x Basicity or acidity.

Q.6. How molarity is related with percentage and density of solution ?
Ans. M = P x d x10/M.M

Q.7. What role does the molecular interaction play in the solution of alcohol and water?

Ans. Positive deviation from ideal behavior .

Q.8. What is Vant Hoff factor , how is it related with

a. degree of dissociation b. degree of association

Ans. a. $\alpha = i - 1/n-1$ b. $\alpha = i - 1 / 1/n - 1$

Q.9. Why NaCl is used to clear snow from roads ?

Ans. It lowers f.p of water

Q10. why the boiling point of solution is higher than oure liquid

Ans. Due to lowering in v.p

HOTS

Q1. Out of 1M and 1m aqueous solution which is more concentrated

Ans. 1M as density of water is 1gm/Ml

Q2. Henry law constant for two gases are 21.5 and 49.5 atm ,which gas is more soluble .

Ans. KH is inversely proportional to solubility .

Q.3. Define azeotrope , give an example of maximum boiling azeotrope.

Q.4. Calculate the volume of 75% of H_2SO_4 by weight (d=1.8 gm/ml) required to prepare 1L of 0.2M solution

Hint: $M_1 = P \times d \times 10 / 98$

$M_1 V_1 = M_2 V_2$

14.5ml

Q.5. Why water cannot be completely separated from aqueous solution of ethyl alcohol?

Ans. Due to formation of Azeotrope at (95.4%)

SHORT ANSWERS (2 MARKS)

Q.1. How many grams of KCl should be added to 1kg of water to lower its freezing point to -8.0^{0}C (kf = 1.86 K kg /mol)

Ans. Since KCl dissociate in water completely L=2

$\Delta Tf = t\,kf \times m$; m =$\Delta Tf / tkf$

m= 8 / 2X1.86 = 2.15mol/kg.

Grams of KCl= 2.15 X 74.5 = 160.2 g/kg.

Q.2. With the help of diagram: show the elevator in boiling point colligative properties ?

Q.3. what do you mean by colligative properties, which colligative property is used to determine m.m of polymer and why?

Q.4. Define reverse osmosis, write its one use.

Ans. Desalination of water.

Q.5. Why does an azeotropic mixture distills without any change in composition.

Hint: It has same composition of components in liquid and vapour phase.

Q.6. Under what condition Vant Hoff's factor is

a. equal to 1 b. less than 1 c. more than 1

Q.7. If the density of some lake water is 1.25 gm /ml and contains 92gm of Na^+ ions per kg of water. Calculate the molality of Na^+ ion in the lake .

Ans. n = 92/23 = 4

m= 4/1 = 4m

Q.8. An aqueous solution of 2% non-volatile exerts a pressure of 1.004 Bar at the normal boiling point of the solvent . What is the molar mass of the solute .

Hint: $P^0_A - P_A / P^0_A = w_B \text{ X } m_A / m_B \text{ X } w_A$

1.013 – 1.004 / 1.013 = 2X 18 /m_B X 98

m_B = 41.35gm/mol

Q.9. Why is it advised to add ethylene glycol to water in a car radiator in hill station?

Hint: Anti- freeze.

Q.10. what do you mean by hypertonic solution, what happens when RBC is kept in 0.91% solution of sodium chloride?

Q 11. (a). define the following terms.

1. Mole fraction
2. Ideal solutions

(b)15 g of an unknown molecular material is dissolved in 450 g of water. The resulting solution frrezez at -0.34 ^{0}c . what is the molar mass of material? Kf for water= 1.86 K Kg mol^{-1} .

Ans. 182.35 glmol

Q 12.(a) explain the following :

1. Henry's law about dissolution of a gas in a liquid .
2. Boling point elevation constant for a solvent

(b)a solution of glycerol ($C_3h_8O_3$) in water was prepared by dissolving some glycerol in in 500 g of water. The solution has a boiling point of 100.42 ^{0}c . what mass of glycerol was dissolved to make this solution?

Kb for water = 0.512 k Kg mol^{-1}

(hint: $atb = \frac{b*wb*1000}{Mb*Wa}$

Ans. 37.73 gm

Q 13. 2 g of benzoic acid (c_6h_5cooh) dissolved in 25 g of benzene shows a depression in freezing point equal to 1.62 K . KF for benzene is 4.9 K Kg mol^{-1}. What is the percentage association of acid if it forms dimer in solution. Ans. 99.2%

Q14. Osmotic pressure of a 0.0103 molar solution of an electrolite is found to be 0.70 atm at 27^{0}c . calculate Vant Hoff factor.(R=0.082 L atom mol^{-1} K^{-1}) Ans. 2.76