Chemistry Worksheet on Chapter 2 Solutions with Answers -Set 2

Q-1: In the mixture obtained by mixing 25.0 mL of 1.2×10^{-3} M $MnCl_2$ and 35.0 mL of 6.0×10^{-4} M KCl solution, calculate the concentration(M) of Mn^{2+}, K^+, and Cl^- ions.

Answer: For the $MnCl_2$ solution, the initial volume was 25 mL. After addition of 35 mL KCl solution, the solution is diluted by to 60 mL, so the concentration of Mn^{2+} ion will become = $(1.2\times10^{-3}\times25)/60 = 5\times10^{-4}$ M

In case of KCl solution, the concentration of K^+ is $(6\times10^{-4}\times35)/60 = 3.5\times10^{-4}$ M
$MnCl_2$ on ionisation will give $2Cl^-$ ions and KCl will give one Cl^- ion per molecule so the concentration of $Cl^- = 2\times5\times10^{-4} + 3.5\times10^{-4}$
$= 1.35\times10^{-3}$ M

Q-2: The freezing point constant for water is 1.86 K(mol/kg)$^{-1}$. The freezing point when 0.01 mol of glucose is added to 1 kg of water is

a) 1.86 K
b) -1.86 K
c) 0.0186 K
d) -0.0186 K

Answer: d) -0.0186 K

Explanation: We know that depression in freezing point, $\Delta T_f = i K_f m$

Glucose is a non electrolyte, so i=1

Given: K_f = 1.86 K(mol/kg)$^{-1}$
Molality, m= Moles of solute/Mass of solvent(in Kg)
= 0.01/1
= 0.01 m
$\Delta T_f = 1\times 1.86 \times 0.01 = 0.0186$ K

$\Delta T_f = T_f - T_s$
Where T_f is the freezing point of pure water
T_s is the freezing point of solution

T_s= 0-0.0186 = -0.0186 K

Q-3: How liquid-liquid solutions are classified according to Rault's law?

Answer: According to Raoult's law, liquid-liquid solutions can be classified as ideal or non-ideal. Ideal solutions are those that obey Raoult's law over the entire concentration range. When a solution does not obey Raoult's law over the entire concentration range, it is referred to as a non-ideal solution.

Q-4: Identify the type of deviation shown by following solutions from Raoult's law?

a) CS_2+CH_3COCH_3
b) Phenol + Aniline
c) $CHCl_3$+ CH_3COCH_3

Answer:
a) Positive Deviation
b) Negative deviation
c) Negative deviation

Q-5: Which of the following is correct for degree of dissociation,***α*** for a electrolyte A_xB_y?

a) $\alpha = \frac{i-1}{x+y-1}$

b) $\alpha = \frac{1-i}{1-x-y}$

c) i= (1-***α***)+x***α*** + y***α***
d) None of the above

Answer: a), b) and c)
Explanation: $A_xB_y \rightarrow xA^{y+} + yB^{x-}$

We know that the general expression for the degree of dissociation and the van't Hoff factor, i is

i= 1+(n-1)***α*** …….1
Where n is the number of ions it dissociates into
From the reaction, we can see that n= x+y
Hence, i= 1+(x+y-1)***α*** or (1-***α***)+x***α*** + y***α***

Likewise, rearranging the expression in 1 can result in $\alpha = \frac{i-1}{x+y-1}$ and $\alpha = \frac{1-i}{1-x-y}$

Q-6: a) Define the term dissolution.
b) How does the solubility of solid in liquid vary with temperature if the dissolution process is endothermic?

Answer:
a) When a solid solute is added to a solvent, some of it dissolves and its concentration in solution rises. This is referred to as dissolution.
b) Temperature changes have a significant impact on a solid's solubility in a liquid. If the dissolution process is endothermic ($\Delta_{sol}H > 0$), the solubility should increase as the temperature rises, according to Le Chatelier's principle.

Q-7: At the same temperature, a 0.004 M solution of Na_2SO_4 is isotonic with a 0.010 M solution of glucose. Na_2SO_4's apparent degree of dissociation is
a) 25%
b) 50%
c) 75%
d) 85%

Answer: c) 75%

Explanation: The expression for osmotic pressure is π= iCRT. For isotonic solutions, osmotic pressure is the same.

π(glucose)= π(Na_2SO_4)
1×0.010×RT= i×0.004×RT
i= 2.5
The relation for the degree of dissociation and the van't Hoff factor, i is
i= 1+(n-1)α
For Na_2SO_4, n= 3($2Na^+$ and SO_4^{2-})
Substituting the values, i= 2.5 and n=3, we get
α= 0.75
%α= 75%

Q-8: 35% by mass of HCl solution has density 1.46g/mL. Find the molarity.

Answer: Mass % of HCl in solution = 35%
Therefore, 100g of solution= 35 g of HCl
Given, density of solution=1.46 g/mL
Therefore, volume of solution = (100/1.46) mL

Molarity = Number of moles of solute/Volume of solution(L)

$$Molarity = \frac{35}{36.5} \times \frac{1000}{\frac{100}{1.46}} = 14M$$

Q-9: Two eggs' outer shells are removed. One egg is immersed in pure water, while the other is immersed in a saturated NaCl solution. What will be observed and why will it be observed?

Answer: When an egg is placed in water, it swells due to osmosis of pure water into the egg. The egg, on the other hand, will shrink due to osmosis of water out of the egg when placed in a saturated solution of 'NaCl.'

Q-10: Find the osmotic pressure (in atm) of a mixture in which 2g of a protein having molar mass 6 Kg is present in 2 mL solution at 27°C.(Round off to the nearest integer)

Answer: Osmotic pressure (**π**) = iCRT

$$\Pi = 1 \times \frac{\frac{2}{6000}}{\frac{2}{1000}} \times 0.0821 \times 300 = 4atm$$

Q-11: Why is the boiling point of a solution higher than that of a pure liquid?

Answer: Due to lowering in vapour pressure, the boiling point of a solution is higher than that of a pure liquid.

Q-12: The molecular weight of benzoic acid in benzene as determined by depression in freezing point corresponds to
a) trimerization of benzoic acid
b) dimerization of benzoic acid
c) ionisation of benzoic acid
d) None of the above

Answer: b) dimerization of benzoic acid

Q-13: Which of the statements below is true?
a) The boiling point of a solution decreases as the amount of solute increases.
b) Adding more solvent lowers the freezing point of the solution.
c) Adding more solute raises the freezing point of the solution.
d) As the solute concentration increases, the freezing point of the solution decreases.

Answer: d)

Q-14: Why is it recommended to mix ethylene glycol into the water in a car radiator in a hill station?
Answer: Because ethylene glycol lowers the freezing point of water, it does not freeze in a hill station.

Q-15: The boiling point of a solution containing 1.8 g of glucose in 100 g of solvent rises by 0.1°C. Determine the liquid's molal elevation constant.

Answer:

$$\Delta T_b = K_b \times m = K_b \times \frac{Weight\ of\ glucose}{Molecular\ weight\ of\ glucose} \times \frac{1000}{Weight\ of\ solvent}$$

$$0.1 = K_b \times \frac{1.8}{180} \times \frac{1000}{100}$$

K_b= 1 °C/m

Q-16: In one litre of water, one mole of urea, glucose, and sodium chloride were dissolved. Solutions of which will generate equal osmotic pressure,

a) Glucose and sodium chloride
b) Urea and glucose
c) Sodium chloride and Urea
d) Water and Sodium chloride

Answer: b) Urea and glucose

Explanation: We understand that osmotic pressure,**π**=iCRT. In water, urea and glucose remain molecular, with the same "i" value of one. Equimolar solutions have the same osmotic pressure.

Because "i" for NaCl is equal to two, its osmotic pressure will differ from that of glucose and urea.

Q-17: Which of the following represents a solid solution?
a) Camphor in nitrogen gas
b) Solution of hydrogen in palladium
c) Glucose dissolved in water
d) None of the above

Answer: b) Solution of hydrogen in palladium
Explanation: A solid solution is one with a solid solvent. Example: hydrogen(gas) solution in palladium (solid). In this case, hydrogen gas is the solute and palladium is the solid solvent.

Camphor in nitrogen gas is an example of gaseous solutions. Glucose dissolved in water is an example of liquid solutions.

Q-18: What is the mass of a nonvolatile solute (molar mass=45g/mol) that should be dissolved in 90g of water to reduce its vapour pressure by 75%?

Answer: The expression for relative lowering in vapour pressure is given below:

$$\frac{P^o - P}{P^o} = \frac{n_2}{n_1 + n_2}$$

Where, n_2 is the moles of solute

n_1 is the moles of solvent(water)

$$\frac{100 - 75}{100} = \frac{n_2}{n_1 + n_2}$$

Taking the reciprocal of above equation,

$$\frac{100}{25} = \frac{n_1}{n_2} + 1$$

$$\frac{n_1}{n_2} = 3 \qquad \text{.....1)}$$

n_1= 90/18

n_2= w_2/45

On substituting values in 1) , we get mass of non volatile solute w_2 = 75 g

Q-19: In medicine and pharmacy, which concentration unit is most commonly used?

Answer: The mass by volume percentage unit is commonly used in medicine and pharmacy. It is the amount of solute dissolved in 100 millilitres of solution.

Q-20: When scuba divers approach the surface, the pressure gradually decreases, causing the release of dissolved gases and the formation of bubbles of N_2 gas in the blood, which block the capillaries and cause bends. The air is diluted with helium to avoid bends and the toxic effects of high concentrations of N_2 gas.

Answer the following questions after reading the preceding passage:

(a) How does the use of helium alleviate the harmful condition of bends?

(b) Which of the laws is used to calculate the concentration of gases in solution?

(c) Which gas has less value of K_H , O_2 or He, and why ?

d) Mention the value associated with providing divers air diluted with helium.

Answer:

a) Helium is less soluble in the bloodstream and thus does not accumulate as much, posing a lower risk to divers and being used for deep dives.

b) Henry's Law

c) We already know that the gas's solubility is inversely proportional to Henry's law constant. Helium(He) is less soluble than O_2 in the bloodstream. Therefore, Helium will have more value of K_H than O_2.

d) Critical thinking and decision making