DAILY PRACTICE PROBLEMS

CHEMISTRY SOLUTIONS

DPP/CC13

1. **(b)** $P_{total} = P_A^\circ X_A + P_B^\circ X_B$

$$550 = P_A^\circ \times \frac{1}{4} + P_B^\circ \times \frac{3}{4}$$

$P_A^\circ + 3P_B^\circ = 550 \times 4$ ...(i)

In second case

$$P_{total} = P_A^\circ \times \frac{1}{5} + P_B^\circ \times \frac{4}{5}$$

$P_A^\circ + 4P_B^\circ = 560 \times 5$ ...(ii)

Subtract (i) from (ii)

$\therefore P_B^\circ = 560 \times 5 - 550 \times 4 = 600$

$\because P_A^\circ = 400$

2. **(c)** Let vapour pressure of $A = P_A^o$

Vapour pressure of $B = P_B^o$

In first solution,

Mole fraction of $A(x_A) = \frac{1}{1+2} = \frac{1}{3}$

Mole fraction of $B(x_B) = \frac{2}{1+2} = \frac{2}{3}$

According to Raoult's law,

Total vapour pressure

$= 250 = P_A^o x_A + P_B^o x_B$

$250 = \frac{1}{3}P_A^o + \frac{2}{3}P_B^o$ ...(i)

In second solution

Mole fraction of $A(x_A) = \frac{2}{2+2} = \frac{2}{4} = \frac{1}{2}$

Mole fraction of $B(x_B) = \frac{2}{4} = \frac{1}{2}$

$\therefore$ Total vapour pressure

$= 300 = P_A^o x_A + P_B^o x_B$

$300 = \frac{1}{2}P_A^o + \frac{1}{2}P_B^o$ ...(ii)

Multiplying equation (i) by $\frac{1}{2}$ and equation (ii) by $\frac{1}{3}$

$\frac{1}{6}P_A^o + \frac{2}{6}P_B^o = 125$

$\frac{1}{6}P_A^o + \frac{1}{6}P_B^o = 100$

$\frac{1}{6}P_B^o = 25$

$P_B^o = 25 \times 6 = 150$ mm Hg

On substituting value of P_B^o in equation (ii) we get

$300 = P_A^o \times \frac{1}{2} + 150 \times \frac{1}{2}$

$P_A^o = 450$ mm Hg

3. **(c)** van't Hoff factor (i) and the degree of association are related as below :

$$i = 1 - \alpha\left(1 - \frac{1}{n}\right)$$

$$0.9 = 1 - 0.2\left(1 - \frac{1}{n}\right)$$

On solving,

$$\left(1 - \frac{1}{n}\right) = \frac{1}{2}$$

$$\frac{1}{n} = 1 - \frac{1}{2} = \frac{1}{2}$$

$\therefore n = 2$

4. **(a)** $\text{Molarity} = \frac{\% \times 10 \times d}{\text{GMM}} = \frac{22 \times 10 \times 1.253}{342} = 0.805\text{M}.$

$\text{Normality} = \frac{\% \times 10 \times d}{\text{GEM}} = \frac{22 \times 10 \times 1.253}{342/6} = 4.83\text{N}$

$\text{Molality} = \frac{22 \times 1000}{342(100 - 22)} = 0.825\text{m}$

5. **(a)** $K_H = 100$ kbar $= 10^5$ bar, $P = 1$ bar

$P = K_H \times x_A$

$$x_A = \frac{P}{K_H} = \frac{1}{100 \times 10^3} = 10^{-5}$$

Moles of water $= \frac{1000}{18} = 55.5$

Weight of water = 1000 g ($\because$ 1000 mL = 1000 g)

Mole fraction $= 10^{-5} = \frac{x}{55.5 + x}$

As 55.5 >>> x, thus neglecting x from denominator

$10^{-5} = \frac{x}{55.5} \Rightarrow x = 55.5 \times 10^{-5}$ moles

or 0.555 millimoles.

6. **(c)** For dilute solution, $\frac{\Delta P}{P^\circ} \Rightarrow \frac{n_{solute}}{n_{solvent}}$

For solution in A, $\frac{\Delta P_A}{P^\circ_A} = \frac{W/M}{W_A/M_A} = \frac{W}{M}\times\frac{M_A}{W_A}$ ....(i)

For solution in B, $\frac{\Delta P_B}{P^\circ_A} = \frac{W}{M}\times\frac{M_B}{W_B}$ ....(ii)

From (i) and (ii), $\frac{\Delta P_A/P^\circ_A}{\Delta P_B/P^\circ_B} = 2 = \frac{M_A W_B}{M_B W_A} = \frac{M_A}{M_B}$

$(W_A = W_B)$

7. **(a, b, c)** when $n_A = n_B$, we have $x_A = \frac{n_A}{n_A + n_B} = \frac{1}{2}$

and $x_B = \frac{n_B}{n_A + n_B} = \frac{1}{2}$

Using the given relation, we have

$P_S = (110\times\frac{1}{2} + 125\times\frac{1}{2})$ mm of Hg

$= 117.5$ mm of Hg

In case of pure A or pure B the mole fraction of other component will be zero, then

For pure A; $x_A = 1, x_B = 0$

$\therefore P_A = (110\times 1 + 125\times 0)$ mm of Hg

$= (110 + 0)$ mm of Hg

$= 110$ mm of Hg

Similarly, $\overset{o}{P_B} = 125$ mm of Hg $[x_B = 1, x_A = 0]$

From the above calculations it is clear that

when $n_A = n_B : P_s < \overset{o}{P_B}$ $[P_S = 117.5$ mm and

$\overset{o}{P_B} = 125$ mm$]$

$n_A = n_B : P_S > \overset{o}{P_A}$ $[P_S = 117.5$ mm

and $\overset{o}{P_A} = 110$mm$]$

Also $\overset{o}{P_A} = 110$ mm of Hg and $\overset{o}{P_B} = 125$ mm of Hg

Statement (d) is incorrect.

8. **(a, b, c)**

Since the solute X behaves as univalent electrolyte in solution, so for this solute, $i = 2$

Since the solute Y dimerises in solution, so for this solute $i = \frac{1}{2}$

We know that

b.p. $\propto i$, $\therefore$ b.p. of X will be greater than that of Y

Osmotic pressure $\propto i$, $\therefore$ O.P. of $X >$ O.P. of Y

Freezing point $\propto \frac{1}{i}$; $\therefore$ f.p. of $X <$ f.p. of Y

and relative lowering of V.P. i.e. $\frac{\Delta P}{P^\circ} \propto i$

$\therefore \left(\frac{\Delta P}{P^\circ}\right)_X > \left(\frac{\Delta P}{P^\circ}\right)_Y$

Thus statement (d) is incorrect. All other statements are correct.

9. **(b, c)** Vapour pressure of solution containing non-volatile solute is always smaller than that of solvent. Points a and b represent the boiling points of solvent and solution respectively (temperatures at which their V.P. = 1 atm each). Hence gap $ab = K_b m$ = elevation of boiling point.

10. **(b)** $P_{\text{Total}} = X_A \overset{o}{p_A} + X_B \overset{o}{p_B} = X_A \overset{o}{p_A} + (1 - X_A)\overset{o}{p_B}$

$= \overset{o}{p_B} + (\overset{o}{p_A} - \overset{o}{p_B})X_A$

11. **(2)** Let x g be the mass of element in 51.0 g of saturated solution.

Mass of benzene in 51.0 g of saturated solution $= 51.0 - x$ g

Total mass of benzene containing x g of solute = 50 + 51 − x = $(101 - x)$ g

$$\Delta T_f = \frac{1000 K_f W_B}{M_B W_A} = \frac{1000\times 5.5\times x}{4\times 25\times(101 - x)} = 0.55\ (given)$$

$\Rightarrow x = 1.0$g

Hence, solubility $= \frac{W_B\times 100}{W_A} = \frac{1}{(51-1)}\times 100 = 2.0$ g

12. **(2)** $\Delta T = iK_f m$

$(273 - 269.28) = i\times 1.86\times 1$

$3.72 = i\times 1.86$

$i = 2$

$\alpha = \frac{i-1}{n-1}; (\alpha = 100\% = 1)$

$1 = \frac{2-1}{n-1} \Rightarrow n = 2$

13. **(2)** Let $\pi_1 = 200$ mm; $T_1 = 283$

$\pi_2 = 105.3$; $T_2 = 298$

Now, $\pi = \frac{n}{V}RT$

At $T_1, 200 = \frac{n}{V_1}R\times 283$

At $T_2, 105.3 = \frac{n}{V_2}\times R\times 298$

Dividing Eq. (i) by Eq. (ii), we get

$\frac{200}{105.3} = \frac{V_2}{V_1}\times\frac{283}{298} \Rightarrow V_2 = 2V_1$

14. **(4)** $\pi = CRT = \frac{\left(\frac{W_2}{Mw_2}\right)RT}{V}$

Given $W_2 = 40$ g

$Mw_2 = 246$

$T = 27°C = 300\ K$

$V = 1\ L$

Substituting all the values, we get

$$\pi = \frac{40}{246} \times 0.082 \times 300 = 4 \text{ atm}$$

15. **(d)** Molality of water in ethanol $= \frac{0.1 \times 1000}{0.9 \times 46} = 2.41$

$\Delta T_f = K_f m = 2.0 \times 2.41 = 4.82\ K;$

Hence, freezing point $= 150.7 - 4.82 = 150.9\ K$

16. **(a)** Vapour pressure of solution $= X_A P_A^{\circ} + X_B P_B^{\circ}$

$= 0.9 \times 40 + 0.1 \times 32.8 = 39.3$ torr

17. **(b)** From the given data, we have

$w = 0.5 \times 10^{-3}$ kg [0.5 % solution]

$W = 100 \times 10^{-3}$ kg

[solvent in water, density = 1 g/km^3]

$\Delta T_f = 273 - 272.76 = 0.24$

$K_f = 1.86\ K\ \text{kg mol}^{-1}$

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

$$= \frac{1000 \times 1.86 \times 0.5 \times 10^{-3}}{0.24 \times 100 \times 10^{-3}} = 38.76$$

$\therefore$ The apparent molecular weight of KCl = 38.76

The molar mass of KCl = 39 + 35.5 = 74.5

$$\therefore i = \frac{\text{Normal molecular weight}}{\text{Apparent molecular weight}}$$

$$= \frac{74.5}{38.76} = 1.92 \approx 2$$

18. **(c)** In solution KCl dissociates as follows

$$KCl \rightleftharpoons K^+ + Cl^-$$

If α is degree of dissociation, then

$$KCl \rightleftharpoons K^+ + Cl^-$$

$(1 - \alpha) \quad \alpha \quad \alpha$

The number of effective particles is $1 - \alpha + \alpha + \alpha$

$= (1 + \alpha)$

$$\therefore i = \frac{1 + \alpha}{1}$$

or $\alpha = i - 1$

$= 1.92 - 1$ [$i = 1.92$]

$= 0.92$ or 92.0%

19. **A-s; B-p; C-q; D-r**

(A) All gases dissolve in water exothermically with decrease in randomness. Hence $\Delta H < 0$, $\Delta S < 0$.

(B) Since solubility of the given solid in water increases on raising temperature, dissolution is endothermic. Hence $\Delta H > 0$ and $\Delta S > 0$ (Increase in disorder on dissolution).

(C) In a saturated solution, there is no further dissolution of solid. Hence $\Delta H = 0$ and $\Delta m = 0$.

(D) On adding solid to super saturated solution, excess of solid dissolved separates out with the evolution of heat. Hence $\Delta H < 0$ and $\Delta m < 0$.

20. **A-r, s; B-p, q; C-r, s; D-p, q**

(A) $K_f = \frac{R T_f^{\circ 2}}{1000 L_f} = \frac{R T_f^{\circ 2} M}{1000\ \Delta H_f}$;

T_f°(water) $= 273K$, $M = 18$

(B) $K_b = \frac{R T_b^{\circ 2}}{1000 L_v} = \frac{R T_b^{\circ 2} M}{1000\ \Delta H_f}$

T_b° (water) $= 373\ K$, $M = 18$

(C) $\Delta T_f = K_f \times m = K_f \times \frac{9 \times 1000}{180 \times 50} = K_f$

(D) $\Delta T_b = K_b \times m = K_b \times \frac{3 \times 1000}{60 \times 50} = K_b$