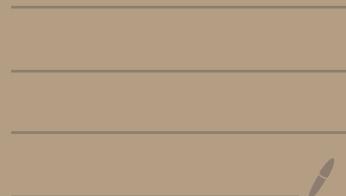


JEE MAINS : LIQUID SOLUTION

LEADER



1. The degree of dissociation ( $\alpha$ ) of a weak electrolyte,  $A_xB_y$  is related to van't Hoff factor (i) by the expression :- [AIEEE-2011]

$$(1) \alpha = \frac{x+y-1}{i-1} \quad (2) \alpha = \frac{x+y+1}{i-1} \quad (3) \alpha = \frac{i-1}{(x+y-1)} \quad (4) \alpha = \frac{i-1}{x+y+1}$$

1. एक दुर्बल विद्युत् अपघट्य  $A_xB_y$  की वियोजन मात्रा ( $\alpha$ ) वान्ट हॉफ फैक्टर (i) से किस व्यंजक द्वारा सम्बन्धित है :- [AIEEE-2011]

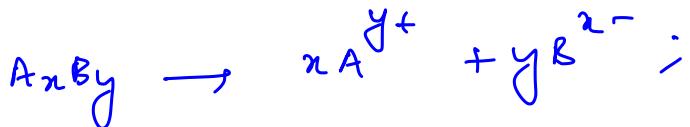
$$(1) \alpha = \frac{x+y-1}{i-1} \quad (2) \alpha = \frac{x+y+1}{i-1} \quad (3) \alpha = \frac{i-1}{(x+y-1)} \quad (4) \alpha = \frac{i-1}{x+y+1}$$

**Ans.** (3)

van't Hoff factor (i) =  $1 + (m - 1)\alpha$ ; where

$m$  = total moles of product per mole  
of reactant

$\alpha$  = degree of dissociation



$$m = (x+y)$$

$$\Rightarrow i = 1 + (x+y-1)\alpha \Rightarrow \alpha = \left( \frac{i-1}{x+y-1} \right)$$

2.  $K_f$  for water is  $1.86 \text{ K kg mol}^{-1}$ . If your automobile radiator holds  $1.0 \text{ kg}$  of water, how many grams of ethylene glycol ( $\text{C}_2\text{H}_6\text{O}_2$ ) must you add to get the freezing point of the solution lowered to  $-2.8^\circ\text{C}$ ? [AIEEE-2012]
- (1) 27 g      (2) 72 g      (3) 93 g      (4) 39 g
2. जल के लिए  $K_f$  का मान  $1.86 \text{ K kg mol}^{-1}$  है। यदि आप के आटोमोबाइल रेडियेटर में  $1.0 \text{ kg}$  पानी भरा हो तो विलयन के हिपांक को  $-2.8^\circ\text{C}$  तक निम्न करने के लिए एथिलीन ग्लायकॉल ( $\text{C}_2\text{H}_6\text{O}_2$ ) के कितने ग्राम आप को मिलाने होंगे? [AIEEE-2012]
- (1) 27 g      (2) 72 g      (3) 93 g      (4) 39 g

Ans. (3)

*Ans. to depression in freezing point*

$$\text{depression in freezing point} = \Delta T_f \\ = T_f - T_f'$$

$T_f$  = freezing point of pure solvent

$T_f'$  = " " " solution

$k_f$  = cryoscopic constant or  
molal depression constant

$m$  = molality of solute

$i$  = van't Hoff factor

$\Rightarrow$  mass of ethylene glycol to be added = ? gm

$$\Rightarrow \Delta T_f = 2.8 \text{ K} = 1.86 \frac{\text{K} \cdot \text{kg}}{\text{mol}} \times \frac{\frac{\text{ag}}{62 \text{ g/mol}}}{1 \text{ kg}} \times i$$

$$\Rightarrow x \approx 93.33 \text{ gm}$$

3. 0.85 g ZnCl<sub>2</sub> का विलयन 125.0 g जल में हिमांक -0.23°C है, तो लवण के वियोजन की दर होगी

[JEE (MAIN)-2012 ONLINE]

(जल के लिये  $k_f = 1.86 \text{ K kg mol}^{-1}$ , परमाणु द्रव्यमान ; Zn = 65.3 तथा Cl = 35.5)

- (1) 1.36%      (2) 2.47%      (3) 73.5%      (4) 7.35%

Ans. (3)

Ans. to depression in freezing point

depression in freezing point =  $\Delta T_f$

$$= T_f - T_f'$$

$T_f$  = freezing point of pure solvent

$T_f'$  = " " " solution

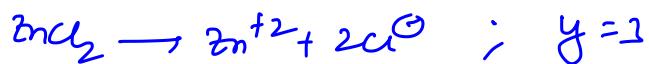
$k_f$  = cryoscopic constant or  
molal depression constant

m = molality of solute

i = van't Hoff factor

$$\Rightarrow \Delta T_f = 0.23 \text{ K} = 1.86 \frac{\text{K} \cdot \text{kg}}{\text{mol}} \times \frac{\frac{0.85 \text{ g}}{136.3 \text{ g/mol}} \times i}{0.125 \text{ kg}}$$

$$\Rightarrow i = 2.47$$



$$\Rightarrow i = 1 + (3-1)2 \Rightarrow k = \frac{1.47}{2} = 0.739$$

4. Liquids A and B form an ideal solution. At 30°C, the total vapour pressure of a solution containing 1 mol of A and 2 moles of B is 250 mm Hg. The total vapour pressure becomes 300 mm Hg when 1 more mol of A is added to the first solution. The vapour pressures of pure A and B at the same temperature are

[JEE (MAIN)-2012 ONLINE]

- (1) 450, 150 mm Hg (2) 250, 300 mm Hg (3) 125, 150 mm Hg (4) 150, 450 mm Hg  
4. 30°C पर, द्रव A तथा B एक आदर्श विलयन बनाते हैं। एक विलयन, जिसमें 1 मोल A तथा 2 मोल B के हैं, का कुल वाष्पदाब 250 mm Hg है। यदि 1 मोल A का इस विलयन में मिलाया जाय तो कुल वाष्प दाब 300 mm Hg हो जाता है।

एक ही ताप पर शुद्ध A तथा शुद्ध B के वाष्प दाब होंगे :-

[JEE (MAIN)-2012 ONLINE]

- (1) 450, 150 mm Hg (2) 250, 300 mm Hg  
(3) 125, 150 mm Hg (4) 150, 450 mm Hg  
4. (1)

Acc. to Raoult's law;

$$P_s = p_A^\circ \chi_A + p_B^\circ \chi_B; \text{ where}$$

$\chi_A$ ;  $\chi_B$  = mole fractions of A & B in the liquid phase, respectively

$p_A^\circ$ ;  $p_B^\circ$  = vapour pressures of pure A & pure B, respectively

$P_s$  = vapour pressure of the binary solution of A & B

$$\text{Given; } P_s = 250 \text{ mm Hg}; \chi_A = \frac{1}{3}; \chi_B = \frac{2}{3}$$

$$P_s = 300 \text{ mm Hg}; \chi_A = \frac{1}{2}; \chi_B = \frac{1}{2}$$

$$\Rightarrow 250 = \frac{1}{3} p_A^\circ + \frac{2}{3} p_B^\circ \quad \text{--- (1)}$$

$$300 = \frac{1}{2} p_A^\circ + \frac{1}{2} p_B^\circ \quad \text{--- (2)}$$

} solve (1) & (2) to  
get  $p_A^\circ$  &  $p_B^\circ$

5. The freezing point of a 1.00 m aqueous solution of HF is found to be  $-1.91^{\circ}\text{C}$ . The freezing point constant of water,  $K_f$ , is  $1.86 \text{ K kg mol}^{-1}$ . The percentage dissociation of HF at this concentration is

[JEE (MAIN)-2012 ONLINE]

- (1) 2.7%                          (2) 30%                          (3) 10%                          (4) 5.2%

5. HF के 1.00 m जलीय विलयन का हिमांक  $-1.91^{\circ}\text{C}$  पाया गया। जल का हिमांक स्थिरांक  $K_f$ ,  $1.86 \text{ K kg mol}^{-1}$  है। इस साद्रता पर, HF के वियोजन की प्रतिशतता है :-

[JEE (MAIN)-2012 ONLINE]

- (1) 2.7%                                  (2) 30%                                  (3) 10%                                  (4) 5.2%

Ans. (1)

*Ans. to depression in freezing point,*

$$\text{depression in freezing point} = \Delta T_f$$

$$= T_f - T_f'$$

$T_f$  = freezing point of pure solvent

$T_f'$  = in a solution

$k_f$  = cryoscopic constant or  
molal depression constant

$m$  = molality of solute

$i$  = van't Hoff factor

$\text{HF} \rightleftharpoons \text{H}^+ + \text{F}^- ; i = 2$ ; if degree of dissociation is  $x$

$$\Rightarrow i = 1 + (2-1)x = (1+x)$$

$$\Rightarrow \Delta T_f = 1.91 \text{ K} = \left( 1.86 \frac{\text{K kg}}{\text{mol}} \right) \times \left( 1 \frac{\text{mol}}{\text{kg}} \right) \times (1+x)$$

$$\Rightarrow x = 0.027$$

6. How many grams of methyl alcohol should be added to 10 litre tank of water to prevent its freezing at 268 K ?

[JEE (MAIN)-2013 ONLINE]

( $K_f$  for water is  $1.86 \text{ K kg mol}^{-1}$ , Normal freezing point of water =  $273.15\text{K}$ )

- (1) 899.04 g      (2) 886.02 g      (3) 868.06 g      (4) 880.07 g

6. यदि एल्कोहॉल की कितनी मात्रा 10 लीटर पानी के टैंक में मिलाने पर विलयन का हिमांक 268 K प्राप्त होगा ?

[JEE (MAIN)-2013 ONLINE]

( $K_f$  for water is  $1.86 \text{ K kg mol}^{-1}$ , Normal freezing point of water =  $273.15\text{K}$ )

- (1) 899.04 g      (2) 886.02 g      (3) 868.06 g      (4) 880.07 g

Ans. (2)

*Ans. to depression in freezing point*

depression in freezing point =  $\Delta T_f$

$$= T_f - T_f'$$

$T_f$  = freezing point of pure solvent

$T_f'$  = " " " solution

$k_f$  = cryoscopic constant or  
molal depression constant

$m$  = molality of solute

$i$  = van't Hoff factor

$$\Rightarrow \Delta T_f = (273.15 - 268) \text{ K} = 1.86 \frac{\text{K} \cdot \text{kg}}{\text{mol}} \times \frac{\frac{x}{32 \text{ g/mol}}}{10 \text{ kg}} \times 1$$

where  $x = \text{wt-}\% \text{ } \text{CH}_3\text{OH}$  added = 886.02 gm

7. Vapour pressure of pure benzene is 119 torr and that of toluene is 37.0 torr at the same temperature. Mole fraction of toluene in vapour phase which is in equilibrium with a solution of benzene and toluene having a mole fraction of toluene 0.50, will be : [JEE (MAIN)-2013 ONLINE]

(1) 0.137                    (2) 0.205                    (3) 0.237                    (4) 0.435

7. समान ताप पर शुद्ध बेंजीन तथा टॉलुइन का वाष्प दाब क्रमशः 119 torr तथा 37.0 torr है। बेंजीन तथा टॉलुइन के विलयन के साम्य में टॉलुइन का वाष्प प्रावस्था में मोल प्रभाज होगा। यदि टॉलुइन का मोल प्रभाज 0.50 है :

[JEE (MAIN)-2013 ONLINE]

(1) 0.137                    (2) 0.205                    (3) 0.237                    (4) 0.435

Ans. (3)

Acc. to Raoult's law;

$$P_s = p_A^\circ \chi_A + p_B^\circ \chi_B; \text{ where}$$

$\chi_A; \chi_B$  = mole fractions of A & B in the liquid phase, respectively

$p_A^\circ; p_B^\circ$  = vapour pressures of pure A & pure B, respectively

$P_s$  = vapour pressure of the binary solution of A & B

Acc. to Dalton's & Raoult's law;

$$P_A = p_A^\circ \chi_A = P_s y_A; \text{ where}$$

$y_A$  = mole fraction of A in the vapours above the solution

$$P_s = p_{\text{Benzene}}^\circ \chi_{\text{Benzene}} + p_{\text{Toluene}}^\circ \chi_{\text{Toluene}}$$

$$= (119 \text{ torr}) \left(\frac{1}{2}\right) + (37 \text{ torr}) \left(\frac{1}{2}\right) = 78 \text{ torr}$$

$$= 1 \quad \gamma_{\text{volume}} = \frac{p_{\text{volume}}}{p_s} \xrightarrow{\text{X Toluene}}$$

$$= 2 \quad \frac{37 \text{ torr} \times \frac{1}{2}}{78 \text{ torr}} = 0.237$$

8. A molecule M associates in a given solvent according to the equation  $M \rightleftharpoons (M)_n$ . For a certain concentration of M, the van't Hoff factor was found to be 0.9 and the fraction of associated molecules was 0.2. The value of n is : [JEE (MAIN)-2013 ONLINE]

(1) 2                                 (2) 4                                 (3) 5                                 (4) 3

8. दिये हुए विलायक में एक अणु M दी गई अभिक्रिया  $M \rightleftharpoons (M)_n$  की तरह जुड़ता है। एक निश्चित सान्दर्भ M के लिये वास्तविक गुणांक 0.9 है तथा जुड़े हुए अणु का मोल प्रभाज 0.2 है। n का मान बताइये :

[JEE (MAIN)-2013 ONLINE]

(1) 2                                     (2) 4                                     (3) 5                                     (4) 3

**Ans. (1)**

$$\text{van't Hoff factor } i = 1 + (m-1)\alpha ; \text{ where}$$

m = total moles of product per mole  
of reactant

$\alpha$  = degree of dissociation

$$\Rightarrow nM \rightleftharpoons M_n \Rightarrow m = \frac{1}{n} ; i = 0.9 ; \alpha = 0.2$$

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

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

$$\therefore n = 2$$

-

9. 12g of a nonvolatile solute dissolved in 108g of water produces the relative lowering of vapour pressure of 0.1. The molecular mass of the solute is : [JEE (MAIN)-2013 ONLINE]

(1) 60 (2) 80 (3) 40 (4) 20

9. 12 ग्राम अवाष्पशील विलेय को 108 ग्राम जल में घोलने पर, वाष्प दाब में अवनमन 0.1 होता है। विलेय का अणुभार क्या होगा ? [JEE (MAIN)-2013 ONLINE]

(1) 60 (2) 80 (3) 40 (4) 20

Ans. (4)

Acc. to relative lowering of vapour pressure

$$\frac{\Delta p}{p^o} = \frac{p^o - p_s}{p^o} = \frac{n_{\text{solute}}}{n_{\text{solute}} + n_{\text{solvent}}} ;$$

$p^o$  = vapour pressure of pure solvent

$p_s$  : " " " solution

$$\therefore 0.1 = \frac{\frac{12 \text{ gm}}{M}}{\frac{12 \text{ gm} + \frac{108 \text{ g}}{18 \text{ g/mol}}}{M}}.$$

$\therefore \frac{\Delta p}{p^o} \leq 0.1 ; \therefore$  we can approximate

$$\frac{\Delta p}{p^o} \approx \frac{n_{\text{solute}}}{n_{\text{solvent}}}.$$

$$\therefore \frac{\left( \frac{12 \text{ gm}}{M} \right)}{\frac{6 \text{ mol}}{10}} \approx \frac{1}{10} \Rightarrow M = 20$$

10. The molarity of a solution obtained by mixing 750 mL of 0.5(M)HCl with 250 mL of 2(M)HCl will be:- [JEE (MAIN)-2013]
- (1) 0.875 M      (2) 1.00 M      (3) 1.75 M      (4) 0.975 M
10. 750 mL , 0.5(M)HCl के साथ 250 mL , 2(M)HCl को मिश्रित करने पर प्राप्त होने वाले विलयन की मोलरता है [JEE (MAIN)-2013]
- (1) 0.875 M      (2) 1.00 M      (3) 1.75 M      (4) 0.975 M

**Ans. (1)**

$$M_{\text{final}} = \frac{M_1 V_1 + M_2 V_2}{V_1 + V_2}; \text{ where}$$

$M_{\text{final}}$  = molarity of final solution

$M_1$ ;  $M_2$  : molanities of two solutions

$V_1$ ;  $V_2$  : volume " " "

$$\Rightarrow M_{\text{final}} = \frac{0.5 \times 750 + 2 \times 250}{1000}$$

$$= 0.875 \text{ M}$$

11. The observed osmotic pressure for a 0.10 M solution of  $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2$  at 25°C is 10.8 atm. The expected and experimental (observed) values of Van't Hoff factor ( $i$ ) will be respectively :  
 $(R = 0.082 \text{ L atm k}^{-1} \text{ mol}^{-1})$

[JEE (MAIN)-2014 ONLINE]

- (1) 3 and 5.42      (2) 5 and 3.42      (3) 4 and 4.00      (4) 5 and 4.42

11. 25°C पर  $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2$  के 0.10 M विलयन का आसमाटिक (परासरण) दब 10.8 atm देखा गया। बांट हाफ गुणांक के आशा अनुसार और प्रायोगिक (मापित) मान क्रमानुसार होंगे :

$(R = 0.082 \text{ L atm k}^{-1} \text{ mol}^{-1})$  [JEE (MAIN)-2014 ONLINE]

- (1) 3 और 5.42      (2) 5 और 3.42  
 (3) 4 और 4.00      (4) 5 और 4.42

Ans. (4)

According to osmotic pressure equation;

$$\pi = CRT \times i; \text{ where}$$

$\pi$  = osmotic pressure of the solution

$c$  = molarity of the solution

$R = 0.082 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}$

$T$  = Temperature of the solution

$i$  = van't Hoff factor

$$\Rightarrow 10.8 \text{ atm} = \left( 0.1 \frac{\text{mol}}{\text{L}} \right) \left( 0.082 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}} \right) (298 \text{ K}) \times i$$

$$\Rightarrow i = 4.42 ; i_{\text{theo}} = 5$$

12. For an ideal Solution of two components A and B, which of the following is true ?

(1)  $\Delta H_{\text{mixing}} < 0$  (zero)

[JEE(MAIN)-2014 ONLINE]

(2) A – A, B – B and A – B interactions are identical

(3) A – B interaction is stronger than A – A and B – B interactions

(4)  $\Delta H_{\text{mixing}} > 0$  (zero)

12. दो घटकों A और B के आदर्श विलयन के लिये निम्नों में से कौन सही होगा ?

(1)  $\Delta H_{\text{mixing}} < 0$  (शून्य)

[JEE(MAIN)-2014 ONLINE]

(2) A – A, B – B और A – B सभी परस्पर प्रभाव एक समान हैं।

(3) A – A और B – B के परस्पर प्रभाव से A – B का परस्पर प्रभाव अधिक प्रबल होगा।

(4)  $\Delta H_{\text{mixing}} > 0$  (शून्य)

Ans. (2)

Theory based question ;

→  $\Delta H_{\text{mixing}} = 0$  for ideal  $\Rightarrow$  ;

$\Delta H_{\text{mixing}} < 0$  for solutions showing negative deviation from Raoult's law

→ A-A & B-B interactions are similar to A-B interactions in ideal solutions

13. Consider separate solution of 0.500 M  $C_2H_5OH$ (aq), 0.100 M  $Mg_3(PO_4)_2$ (aq), 0.250 M KBr(aq) and 0.125 M  $Na_3PO_4$ (aq) at 25°C. Which statement is true about these solutions, assuming all salts to be strong electrolytes ? [JEE (MAIN)-2014]

- (1) 0.125 M  $Na_3PO_4$ (aq) has the highest osmotic pressure.
- (2) 0.500 M  $C_2H_5OH$ (aq) has the highest osmotic pressure.
- (3) They all have the same osmotic pressure.
- (4) 0.100 M  $Mg_3(PO_4)_2$ (aq) has the highest osmotic pressure.

13. 25°C पर 0.500 M  $C_2H_5OH$ (aq), 0.100 M  $Mg_3(PO_4)_2$ (aq), 0.250 M KBr(aq) तथा 0.125 M  $Na_3PO_4$ (aq) के दिये गये अलग-अलग विलयनों पर विचार कीजिए। निम्न में से कौनसे कथन इन विलयनों के बारे में सत्य है, मानें कि लवण प्रबल वैद्युत अपघट्य है ? [JEE-MAIN-2014]

- (1) 0.125 M  $Na_3PO_4$ (aq) का परासरण दाब सर्वाधिक है
- (2) 0.500 M  $C_2H_5OH$ (aq) का परासरण दाब सर्वाधिक है
- (3) इन सभी विलयनों के परासरण दाब समान है।
- (4) 0.100 M  $Mg_3(PO_4)_2$ (aq) का परासरण दाब सर्वाधिक है

13. Ans.(3)

According to osmotic pressure equation,

$$\pi = CRT \times i; \text{ where}$$

$\pi$  = osmotic pressure of the solution

$c$  = molarity of the solution

$R = 0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}$

$T$  = temperature of the solution

$i$  = van't Hoff factor

The solution for which the value of  $(c \times i)$  is maximum will show maximum osmotic pressure

$$(a) (c \times i) = (0.5 \times 1) = 0.5$$



$$(c \times i) = (0.1 \times 5^-) = 0.5^-$$

(c) 0.25M KBr :



$$(c \times i) = 0.25 \times 2 = 0.5^-$$

(d) 0.125M Na<sub>3</sub>PO<sub>4</sub> ;



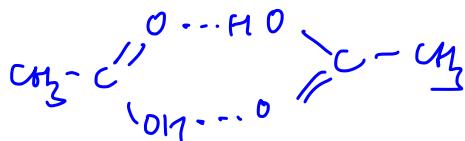
$$= 1 (c \times i) = (0.125 \times 4) = 0.5^-$$

∴ all solutions will have similar osmotic pressures.

14. Determination of the molar mass of acetic acid in benzene using freezing point depression is affected by : [JEE (MAIN)-2015 ONLINE]  
 (1) association      (2) dissociation      (3) complex formation      (4) partial ionization
14. हिमांक अवनमन का प्रयोग करते हुए बैंजीन में एसिटिक अम्ल के मोलर द्रव्यमान का निर्धारण प्रभावित होता है। [JEE (MAIN)-2015 ONLINE]
- (1) संगुणन द्वारा      (2) वियोजन द्वारा      (3) संकुल निर्माण द्वारा      (4) आंशिक आयनन द्वारा

Ans. (1)

Acetic acid undergoes dimerisation in benzene :-



15. A solution at 20°C is composed of 1.5 mol of benzene and 3.5 mol of toluene. If the vapour pressure of pure benzene and pure toluene at this temperature are 74.7 torr and 22.3 torr, respectively, then the total vapour pressure of the solution and the benzene mole fraction in equilibrium with it will be, respectively :

[JEE (MAIN)-2015 ONLINE]

- (1) 38.0 torr and 0.589                                  (2) 30.5 torr and 0.389  
(3) 35.8 torr and 0.280                                  (4) 35.0 torr and 0.480

15. 20°C पर एक विलयन में 1.5 मोल बेन्जीन और 3.5 मोल टोलुइन हैं। अगर इस ताप पर शुद्ध बेन्जीन और शुद्ध टोलुइन के वाष्प दाब क्रमशः 74.7 torr और 22.3 torr, हैं, तब विलयन का कुल वाष्प दाब और बेन्जीन का मोल अंश इसके साम्य में क्रमशः हैं :

[JEE (MAIN)-2015 ONLINE]

- (1) 38.0 torr और 0.589                                  (2) 30.5 torr और 0.389  
(3) 35.8 torr और 0.280                                  (4) 35.0 torr और 0.480

Ans. (1)

Acc. to Raoult's law;

$$P_s = P_A^\circ \chi_A + P_B^\circ \chi_B; \text{ where}$$

$\chi_A, \chi_B$  = mole fractions of A & B in the liquid phase, respectively

$P_A^\circ, P_B^\circ$  = vapour pressures of pure A & pure B, respectively

$P_s$  = vapour pressure of the binary solution of A & B

Acc. to Dalton's & Raoult's law;

$$P_A = P_A^\circ \chi_A = P_s y_A; \text{ where}$$

$y_A$  = mole fraction of A in the vapours above the solution

$$P_s = P_{\text{Benzene}}^\circ \chi_{\text{Benzene}} + P_{\text{Toluene}}^\circ \chi_{\text{Toluene}}$$

$$= \left( 74.7 \text{ torr} \times \frac{1.5}{5} \right) + \left( 22.3 \text{ torr} \times \frac{3.5}{5} \right)$$
$$= 38.02 \text{ torr}$$

$$\Rightarrow y_{\text{Benzene}} = \frac{P_{\text{Benzene}}^{\circ} \times X_{\text{Benzene}}}{P_T}$$

$$= \frac{74.7 \text{ torr} \times \frac{1.5}{5}}{38.02 \text{ torr}} = 0.587$$

16. The vapour pressure of acetone at 20°C is 185 torr. When 1.2 g of non-volatile substance was dissolved in 100 g of acetone at 20°C, its vapour pressure was 183 torr. The molar mass ( $\text{g mol}^{-1}$ ) of the substance is : [JEE (MAIN)-2015]

(1) 128 (2) 488 (3) 32 (4) 64

16. 20°C पर ऐसिटोन की वाष्प दब 185 torr है। जब 20°C पर 1.2 g अवाष्पशील पदार्थ को 100 g ऐसिटोन में घोला गया, तब वाष्प दब 183 torr हो गया। इस पदार्थ का मोलर द्रव्यमान ( $\text{g mol}^{-1}$  में) है : [JEE (MAIN)-2015]

(1) 128 (2) 488 (3) 32 (4) 64

16. Ans. (4)

*Ans. to relative lowering of vapour pressure*

$$\frac{\Delta p}{p^\circ} = \frac{p^\circ - p_s}{p^\circ} = \frac{n_{\text{solute}}}{n_{\text{solute}} + n_{\text{solvent}}} ;$$

$p^\circ$  = vapour pressure of pure solvent

$p_s$  : " " " solution

Given;  $p^\circ = 185 \text{ torr}$  ;  $p_s = 183 \text{ torr}$

$$\Rightarrow \left( \frac{185 - 183}{185} \right) \stackrel{?}{=} \frac{\left( \frac{1.2}{M} \right)}{\left( \frac{100}{58} + \frac{1.2}{M} \right)} ;$$

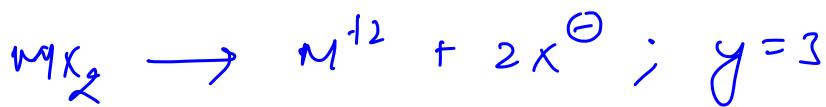
$M$  = molar mass of solute = 64 gm/mol

17. An aqueous solution of a salt  $\text{MX}_2$  at certain temperature has a van't Hoff factor of 2. The degree of dissociation for this solution of the salt is : [JEE (MAIN--2016-ONLINE)]  
 (1) 0.50      (2) 0.80      (3) 0.67      (4) 0.33
17. किसी विशेष ताप पर एक लवण  $\text{MX}_2$  के जलीय विलयन का वाट हॉफ गुणांक 2 है लवण के इस विलयन के लिये वियोजन की मात्रा होगी: [JEE (MAIN--2016-ONLINE)]  
 (1) 0.50      (2) 0.80      (3) 0.67      (4) 0.33
17. Ans. (1)

$\text{van't Hoff factor } (i) = 1 + (m-1)\alpha$ ; where

$m$  = total moles of product per mole  
 of reactant

$\alpha$  = degree of dissociation



$$\therefore i = 2 = 1 + (3-1)\alpha \Rightarrow \alpha = 0.5$$

18. The solubility of  $N_2$  in water at 300 K and 500 torr partial pressure is  $0.01 \text{ g L}^{-1}$ . The solubility (in  $\text{g L}^{-1}$ ) at 750 torr partial pressure is : [JEE (MAIN--2016-ONLINE)]

(1) 0.02                  (2) 0.005                  (3) 0.015                  (4) 0.0075

18. 300 K तथा 500 torr के आंशिक दाब पर जल में  $N_2$  की विलेयता  $0.01 \text{ g L}^{-1}$  है तो 750 torr के आंशिक दाब पर विलेयता ( $\text{L}^{-1}$  में) होगी। [JEE (MAIN--2016-ONLINE)]

(1) 0.02                  (2) 0.005                  (3) 0.015                  (4) 0.0075

18. Ans. (3)

Acc. to Henry's law;

$$P_i = k_h \cdot x_i ; \text{ where;}$$

$x_i$  = partial pressure of gas above the liquid

$x_i$  = mole fraction of gas in the liquid

$k_h$  = Henry's constant

$$500 \text{ torr} = k_h \times \left( \frac{\frac{0.01 \text{ g}}{1 \text{ g/mol}}}{\left( \frac{1000 \text{ g}}{18 \text{ g/mol}} \right)} \right)$$

$$750 \text{ torr} = k_h \times \left( \frac{\frac{x}{M}}{\frac{1000 \text{ g}}{18 \text{ g/mol}}} \right)$$

$$\Rightarrow \left( \frac{750}{500} \right) = \left( \frac{0.01}{x} \right)$$

$x$  = amount of  $N_2$  soluble at 750 torr =  $0.015 \text{ g}$

19. 18 g glucose ( $C_6H_{12}O_6$ ) is added to 178.2g at 100°C water. The vapour pressure of water (in torr) for this aqueous solution is :

[JEE (MAIN)-2016]

- |  |         |          |           |
|--|---------|----------|-----------|
| (1) 759.0  | (2) 7.6 | (3) 76.0 | (4) 752.4 |
| 19. 18 g ग्लूकोस ( $C_6H_{12}O_6$ ) को 178.2g पानी में 100°C पर मिलाया जाता है। इस जलीय विलयन के लिए जल का वाष्प दाब (torr में) होगा |         |          |           |
| (1) 759.0  | (2) 7.6 | (3) 76.0 | (4) 752.4 |

19. Ans. (4)

Acc. to Raoult's law;

$$P_s = \bar{P}_A \cdot X_A; \text{ where}$$

$P_s$  = vapour pressure of solution

$\bar{P}_A$  = vapour pressure of pure solvent

$X_A$  = mole fraction of A in the solution

Given;  $n_{\text{solute}} = \frac{18 \text{ g}}{180 \text{ g/mol}} = 0.1 \text{ mol}$

$$n_{\text{solvent}} = \frac{178.2 \text{ g}}{18 \text{ g/mol}} = 9.9 \text{ mol}$$

$$\begin{aligned} \Rightarrow P_s &= (760 \text{ torr}) \times \left( \frac{9.9 \text{ mol}}{10 \text{ mol}} \right) \\ &= 752.4 \text{ torr} \end{aligned}$$

20. The freezing point of benzene decreases by  $0.45^{\circ}\text{C}$  when 0.2 g of acetic acid is added to 20 g of benzene. If acetic acid associates to form a dimer in benzene, percentage association of acetic acid in benzene will be :- [JEE (MAIN)-2017]  
 $(K_f$  for benzene =  $5.12 \text{ K kg mol}^{-1}$ )  
(1) 64.6% (2) 80.4% (3) 74.6% (4) 94.6%
20. जब एसिटिक एसिड का 0.2 g बैंजीन के 20g में मिलाया जाता है, तो बैंजीन का हिमांक  $0.45^{\circ}\text{C}$  से कम हो जाता है। यदि एसिटिक एसिड बैंजीन में संगुणित होकर डाइमर (द्वितीय) बनाता है, तो एसिटिक एसिड का प्रतिशतता संगुणन होगा :- [JEE (MAIN)-2017]  
(बैंजीन के लिए  $K_f = 5.12 \text{ K kg mol}^{-1}$ )  
(1) 64.6% (2) 80.4% (3) 74.6% (4) 94.6%
20. Ans.(4)

*Ans. to depression in freezing point*

$$\text{depression in freezing point} = \Delta T_f \\ = T_f - T_f'$$

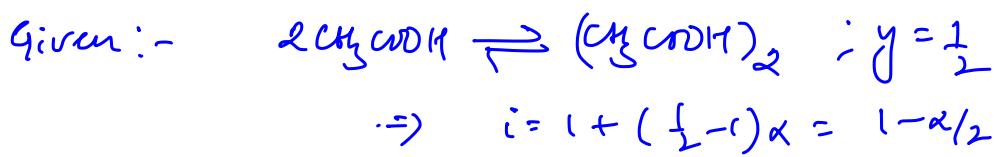
$T_f$  = freezing point of pure solvent

$T_f'$  = " " " solution

$k_f$  = cryoscopic constant or  
molal depression constant

$m$  = molality of solute

$i$  = van't Hoff factor



$$\Rightarrow \Delta T_b = 0.45 K = 5.12 \frac{K \cdot kg}{mol} \times \underbrace{\left( \frac{0.2 g}{60 g} \right)}_{0.02 kg} \times \left( 1 - \frac{x}{2} \right)$$

$$\therefore x = 0.945$$

21. 5 g of  $\text{Na}_2\text{SO}_4$  was dissolved in x g of  $\text{H}_2\text{O}$ . The change in freezing point was found to be  $3.82^\circ\text{C}$ . If  $\text{Na}_2\text{SO}_4$  is 81.5% ionised, the value of x [JEE (MAIN--2017-ONLINE)]

( $K_f$  for water =  $1.86^\circ\text{C kg mol}^{-1}$ ) is approximately.

(Molar mass of S =  $32 \text{ g mol}^{-1}$  and that of Na =  $23 \text{ g mol}^{-1}$ )

- (1) 45 g (2) 65 g (3) 15 g (4) 25 g

21. x ग्राम पानी में 5 ग्राम सोडियम सल्फेट घोला गया। गलतांक में परिवर्तन  $3.82^\circ\text{C}$  पाया गया। यदि  $\text{Na}_2\text{SO}_4$  81.5% आवृत्ति होता है तो x का लगभग मान है [JEE (MAIN--2017-ONLINE)]

(जल के लिए  $K_f = 1.86^\circ\text{C kg mol}^{-1}$ )

(मोलर द्रव्यमान S =  $32 \text{ g mol}^{-1}$  तथा Na =  $23 \text{ g mol}^{-1}$ )

- (1) 45 g (2) 65 g (3) 15 g (4) 25 g

21. Ans.(1)

Ans. to depression in freezing point

depression in freezing point =  $\Delta T_f$

$$= T_f - T_f'$$

$T_f$  = freezing point of pure solvent

$T_f'$  = " " " solution

$k_f$  = cryoscopic constant or  
molal depression constant

m = molality of  $\text{Na}_2\text{SO}_4$

i = Van't Hoff factor



$$\Rightarrow i = 1+2 \times 0.815 = 2.63$$

$$\Rightarrow \Delta T_f = 3.82 \text{ K} = \left( 1.86 \frac{\text{K} \cdot \text{kg}}{\text{mol}} \right) \times \left( \frac{5\text{g}}{142\text{g}} \frac{\text{mol}}{\text{kg}} \right) \times 2.63$$

$$\Rightarrow x = 45 \text{ g/m}$$

22. A solution is prepared by mixing 8.5 g of  $\text{CH}_2\text{Cl}_2$  and 11.95 g of  $\text{CHCl}_3$ . If vapour pressure of  $\text{CH}_2\text{Cl}_2$  and  $\text{CHCl}_3$  at 298 K are 415 and 200 mmHg respectively, the mole fraction of  $\text{CHCl}_3$  in vapour form is: (Molar mass of Cl = 35.5 g mol<sup>-1</sup>) [JEE (MAIN--2017-ONLINE)]
- (1) 0.486      (2) 0.325      (3) 0.162      (4) 0.675
22. 8.5 g  $\text{CH}_2\text{Cl}_2$  तथा 11.95 g  $\text{CHCl}_3$  को मिलाकर एक विलयन तैयार किया जाता है। यदि 298 K पर  $\text{CH}_2\text{Cl}_2$  तथा  $\text{CHCl}_3$  के वाष्प दाब क्रमशः 415 तथा 200 mmHg हो तो वाष्प रूप में उपस्थित  $\text{CHCl}_3$  का मोल अंश है (Cl का मोलर द्रव्यमान = 35.5 g mol<sup>-1</sup>) [JEE (MAIN--2017-ONLINE)]
- (1) 0.486      (2) 0.325      (3) 0.162      (4) 0.675

22. Ans.(2)

Acc-to Raoult's law;

$$P_s = P_A^\circ \chi_A + P_B^\circ \chi_B; \text{ where}$$

$\chi_A, \chi_B$  = mole fractions of A & B in the liquid phase, respectively

$P_A^\circ, P_B^\circ$  = vapour pressures of pure A & pure B, respectively

$P_s$  = vapour pressure of the binary solution of A & B

Acc-to Dalton's & Raoult's law;

$$P_A = P_A^\circ \chi_A = P_s y_A; \text{ where}$$

$y_A$  = mole fraction of A in the vapours above the solution

Given:-  $\chi_{\text{CHCl}_3} = \frac{\frac{11.95 \text{ g}}{119.5 \text{ g/mol}}}{\frac{11.95 \text{ g}}{119.5 \text{ g/mol}} + \frac{8.5 \text{ g}}{85 \text{ g/mol}}} = \frac{1}{2}$

$$\Rightarrow \chi_{C_2Cl_2} = 1 - \chi_{CH_3I_3} = \frac{1}{2}$$

$$\Rightarrow p_s = \left( \frac{1}{2} \right) (415 \text{ mm}) + \left( \frac{1}{2} \right) (200 \text{ mm}) = 307.5 \text{ mm}$$

$$\Rightarrow y_{CH_3I_3} = \frac{p_{CH_3I_3}^o \times \chi_{CH_3I_3}}{p_s}$$

$$= \frac{200 \text{ mm} \times \frac{1}{2}}{307.5 \text{ mm}} = 0.325$$

23. For 1 molal aqueous solution of the following compounds, which one will show the highest freezing point ?

[JEE (MAIN)-2018]

- (1)  $[\text{Co}(\text{H}_2\text{O})_5\text{Cl}]\text{Cl}_2 \cdot \text{H}_2\text{O}$       (2)  $[\text{Co}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl} \cdot 2\text{H}_2\text{O}$   
 (3)  $[\text{Co}(\text{H}_2\text{O})_3\text{Cl}_3] \cdot 3\text{H}_2\text{O}$       (4)  $[\text{Co}(\text{H}_2\text{O})_6]\text{Cl}_3$

23. निम्न यौगिकों के 1 मोलल जलीय विलयन लेने पर किसका हिमांक उच्चतम होगा ?

[JEE (MAIN)-2018]

- (1)  $[\text{Co}(\text{H}_2\text{O})_5\text{Cl}]\text{Cl}_2 \cdot \text{H}_2\text{O}$       (2)  $[\text{Co}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl} \cdot 2\text{H}_2\text{O}$   
 (3)  $[\text{Co}(\text{H}_2\text{O})_3\text{Cl}_3] \cdot 3\text{H}_2\text{O}$       (4)  $[\text{Co}(\text{H}_2\text{O})_6]\text{Cl}_3$

23. Ans.(3)

Ans. to depression in freezing point

$$\text{depression in freezing point} = \Delta T_f \\ = T_f - T_f'$$

$T_f$  = freezing point of pure solvent

$T_f'$  = n u u solution

$k_f$  = cryoscopic constant or  
molal depression constant

m = molality of soln;

i = van't Hoff factor

that solution for which the value of 'i'  
will be least will have the highest  
freezing point

24. Two 5 molal solutions are prepared by dissolving a non-electrolyte non-volatile solute separately in the solvents X and Y. The molecular weights of the solvents are  $M_X$  and  $M_Y$ , respectively where  $M_X = \frac{3}{4} M_Y$ . The relative lowering of vapour pressure of the solution in X is "m" times that of the solution in Y. Given that the number of moles of solute is very small in comparison to that of solvent, the value of "m" is -
- [JEE (MAIN-2018-ONLINE)]

- (1)  $\frac{3}{4}$       (2)  $\frac{4}{3}$       (3)  $\frac{1}{2}$       (4)  $\frac{1}{4}$

24. X तथा Y विलायकों में विद्युत अनपघट्य तथा अवाष्पशील विलेय को घोलकर अलग-अलग 5 मोलल विलयन तैयार किये जाते हैं। विलायकों के अणुभार क्रमशः  $M_X$  तथा  $M_Y$  हैं, जहाँ  $M_X = \frac{3}{4} M_Y$ . में बनाये हुए विलयन के वाष्पदाब का सापेक्ष अवनमन Y में बनाये हुए विलयन के सापेक्ष वाष्पदाब अवनमन का m गुना है। दिया गया है कि विलेयकी तुलना में विलेय के मोलों की संख्या बहुत कम है। "m" का मान होगा - [JEE (MAIN-2018-ONLINE)]

- (1)  $\frac{3}{4}$       (2)  $\frac{4}{3}$       (3)  $\frac{1}{2}$       (4)  $\frac{1}{4}$

**Ans.** (1)

Acc. to relative lowering of vapour pressure,

$$\frac{P^o - P_s}{P^o} : \frac{\Delta p}{P^o} = \frac{\gamma_{\text{solute}}}{\gamma_{\text{solute}} + \gamma_{\text{solvent}}} ; \text{ where}$$

$P^o$  = vapour pressure of pure solvent;

$P_s$  = " " " " solution;

$\frac{\Delta p}{P^o}$  = relative lowering of vapour pressure

Given:  $\left(\frac{\Delta p}{P^o}\right)_X = m \left(\frac{\Delta p}{P^o}\right)_Y$

$$\Rightarrow \left( \frac{n_{\text{solute}}}{n_{\text{solvent}} + n_{\text{solute}}} \right)_X = m \left( \frac{n_{\text{solute}}}{n_{\text{solvent}} + n_{\text{solute}}} \right)_Y$$

$\Rightarrow$  Given;  $n_{\text{solvent}} \gg n_{\text{solute}}$

$$\Rightarrow \left( \frac{n_{\text{solute}}}{n_{\text{solvent}}} \right)_X = m \left( \frac{n_{\text{solute}}}{n_{\text{solvent}}} \right)_Y$$

$$\Rightarrow \left( \frac{n_{\text{solute}} \times M_{\text{solvent}}}{\text{wt}_{\text{solvent}}} \right)_X = \left( \frac{n_{\text{solute}} \times M_{\text{solvent}}}{\text{wt}_{\text{solvent}}} \right)_Y$$

$\Rightarrow$  given that molalities are same;

$$\Rightarrow (M_{\text{solvent}})_X = m \times (M_{\text{solvent}})_Y$$

Given;  $M_X = \frac{3}{4} M_Y$ ;

$$\Rightarrow \frac{3}{4} \times M_Y = m \times M_Y \Rightarrow m = \frac{3}{4}$$

25. The mass of a non-volatile, non-electrolyte solute (molar mass = 50 g mol<sup>-1</sup>) needed to be dissolved in 114 g octane to reduce its vapour pressure by 75%, is :- [JEE (MAIN-2018-ONLINE)]  
 (1) 50 g                    (2) 37.5 g                    (3) 75 g                    (4) 150 g
25. एक अवाष्पशील तथा विद्युत-अनपघट्य विलेय की मात्रा (मोलर संहति = 50 g mol<sup>-1</sup>), जिसको 114 g ऑक्टेन के वाष्प दाब को 75% से कम करने के लिए, मिलाने की आवश्यकता पड़ती है, है :- [JEE (MAIN-2018-ONLINE)]  
 (1) 50 g                    (2) 37.5 g                    (3) 75 g                    (4) 150 g

Ans. (4)

Acc. to relative lowering of vapour pressure,

$$\frac{p^0 - p_s}{p^0} : \frac{\Delta p}{p^0} = \frac{n_{\text{solute}}}{n_{\text{solute}} + n_{\text{solvent}}} ; \text{ where}$$

$p^0$  = vapour pressure of pure solvent;

$p_s$  = " " " solution;

$\frac{\Delta p}{p^0}$  = relative lowering of vapour pressure

$$\text{Given:- } \frac{\Delta p}{p^0} = 0.75 ;$$

$$0.75 = \frac{n_{\text{solute}}}{n_{\text{solute}} + n_{\text{solvent}}} = \frac{\left(\frac{x}{50 \text{ gm/mol}}\right)}{\left(\frac{x}{50 \text{ gm/mol}}\right) + \left(\frac{114 \text{ g}}{114 \text{ gm/mol}}\right)}$$

$$\Rightarrow \frac{3}{4} = \frac{\left(\frac{x}{50}\right)}{\left(\frac{x}{50}\right) + 1} \Rightarrow \left(\frac{x}{50}\right) = 3 \Rightarrow x = 150 \text{ gm}$$