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CHEMISTRY

TARGET : JEE Advanced – 2021

CAPS – 13

Liquid Solution

Answer Key

1.	(D)	2.	(B)	3.	(D)	4.	(C)	**5.**	(D)
6.	(C)	**7.**	(A)	8.	(BD)	**9.**	(ABC)	10.	(B)
11.	(C)	12.	(2)	13.	(2)	14.	(160)		
15.	(0.04 mol)	**16.**	(23.25min)	**17.**	(5 times)	**18.**	(M = 53.8)		
19.	($H_{20}P$, 45560 amu)			**20.**	(18.27%)	**21.**	(1669.9)		
22.	(m_L = 112.7)								

23. (i) Tetraamminedichloroplatinum(IV) chloride,
(ii) Volume of NH_3(aq.) needed = 2 mL,
(iii) Diamminesilver(I) Chloride

Solution

1. **(D)** 2. **(B)**

3. 40 mL O_3 dissolve in 100 g water at 300 K and 1 atm

40 × 4 mL O_3 dissolve in 400 g water at 300 K and 1 atm

$\because$ $m \propto P$ so (40 × 4) × 4 mL O_3 dissolve in 400 g water at 300 K and 4 atm

$$^{n}O_3 \text{ dissolve} = \frac{4 \times 640 \times 10^{-3}}{0.0821 \times 300} = 0.1$$

or mass of O_3 = 4.8 g

4. Let n_B mole of B present in 1 mole of mixture that has been vaporized. Thus, $y_B = \frac{n_B}{1}$

Mole fraction of B in the remaining liquid phase will be $x_B = \frac{1-n_B}{1}$

$$x_B = \frac{P - P_T^{\circ}}{P_B^{\circ} - P_T^{\circ}} \qquad \text{........(1)}$$

[P = P°$_T$ + (P°$_B$ – P°$_T$) x_B]

and $$y_B = \frac{P_B}{P} \Rightarrow \frac{P_B^{\circ} x_B}{P} \qquad \text{........(2)}$$

After substitution of values of x_B and y_B in (1) and (2)

we get $$1 - n_B = \frac{P - P_T^{\circ}}{P_B^{\circ} - P_T^{\circ}} \qquad \text{........(3)}$$

and $$n_B = \frac{(1-n_B)P_B^{\circ}}{P} \qquad \text{........(4)}$$

or $$n_B = \frac{P_B^{\circ}}{P + P_B}$$

so $$1 - \frac{P_B^{\circ}}{P + P_B} = \frac{P - P_T^{\circ}}{P_B^{\circ} - P_T^{\circ}}$$

$\Rightarrow$ $P = \sqrt{P_B^{\circ} . P_T^{\circ}} = \sqrt{100 \times 900}$

$\Rightarrow$ 300 torr

5. KI (aq) + $AgNO_3$ (aq) $\longrightarrow$ AgI(s) $\downarrow$ + KNO_3 (aq)

	KI +	$AgNO_3$	$\rightarrow$	KNO_3 +	AgI$\downarrow$
Initial:	0.3 mole	0.2mole		–	–
Final:	0.1 mole	–		0.2	0.2

Total moles of solute ions = (0.1 + 0.2) × 2 ($\because$ i = 2)

$$[\text{Solute}] = \frac{0.6}{4}\text{M}$$

$$\Delta T_f = K_f.\frac{0.6}{4}$$

$$= 1.86 \times \frac{0.6}{4} = 0.279\text{K}$$

6. Given that,

$$L_f = 1436.3\,\text{cal/mol} = \frac{1436.3}{18}\text{cal/g}$$

$$T_f = 273\text{K}$$

$$K_f = \frac{RT^2}{1000l_f} = \frac{2\times273\times273}{1000\times\frac{1436.3}{18}} = 1.87$$

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

$$= \quad 1000\times1.87\times\frac{0.2}{0.8\times18} = 25.97^\circ\text{C}$$

$\therefore$ T_f = 0 − 25.97 = −25.97°C

7. In vaporization of a pure solvent at a constant temperature, ΔS will be maximum.

8. **(BD)**

9. P = MRT

$$P = \frac{n}{V}\times RT$$

$$P = \frac{w}{V\times m}\times RT$$

$$\frac{P}{d} = \frac{RT}{m}$$

10. P = $P^o_Ax_A + P^o_Bx_B$

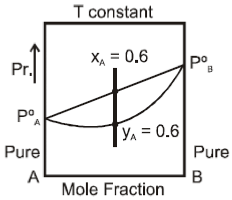
$\Rightarrow$ 500 × 0.6 + 800 × 0.4

$\Rightarrow$ 620 torr

$$y_A = \frac{P_A}{P} \Rightarrow \frac{300}{620}$$

$\Rightarrow$ 0.48 ; y_B = 0.52

11. $P^o_A = 500$; $P^o_B = 800$ totr



When most ofthe liquid has vaporized $x_A = 0.6$ (given) would be $y_A = 0.6$

$$y_A = \frac{P^\circ_A x_A}{P^\circ_A x_A + P^\circ_B(1-x_A)} \quad \Rightarrow \quad 0.6 = \frac{500.x_A}{500x_A + 800(1-x_A)}$$

$x_A = 0.70$; $x_B = 0.30$

12. **(2)** 13. **(2)** 14. **(160)**

15. The expression for the molality of $Hg(NO_3)_2$ solution is $m = \frac{\Delta T_f}{K_f} = \left(\frac{0.0558}{1.86} = 0.03\,m\right)$.

But 1000 g contains $= \frac{3.24}{324} = 0.01$ moles of $Hg(NO_3)_2$.

The observed molality is thrice of the calculated value.

Thus, each molecule of $Hg(NO_3)_2$ dissociates to give three ions.

$Hg(NO_3)_2 \rightarrow Hg^{2+} + 2NO_3^{2-}$

The molality of $HgCl_2$ solution is $\frac{0.0744}{1.86} = 0.04\,m$.

The number of moles of $HgCl_2$ = $\frac{10.84}{271} = 0.04\,mol$.

The observed value is equal to the calculated value. Hence, the molecules of $HgCl_2$ do not undergo dissociation.

16. Density of methanol is 0.8 g/mL

2.5 L of methanol corresponds to a mass of 0.8 × 2500 = 2000 g

The molar mass of methanol is 32 g/mol

The number of moles of methanol = $\frac{2000}{32} = 62.5$ moles.

Volume of water is 10 L

Density of water is 1 kg/L

Mass of water will be 10 kg

Molality of methanol will be $\frac{62.5}{10} = 6.25\,m$

The depression in the freezing point $\Delta T_f = K_f \times m$

$\Delta T_f = 1.86 \times 6.25 = 11.625$ºC

The rate of decrease of temperature = 0.5ºC/min

The time for which there will be no danger to the radiator of the car = $\frac{11.625}{0.5} = 23.25$ min

17. We have the equation π = iCRT

As urea is non-electrolyte, i = 1

$\pi_{urea} = iC_{urea}RT_1$ .... (1)

$\pi_{solution} = iC_{solution}RT_2$ .... (2)

Dividing Equation 1 and 2,

$$\frac{\pi_{urea}}{\pi_{solution}} = \frac{C_{urea}T_1}{C_{solution}T_2}$$

$$\frac{500 \times 298}{105.3 \times 283} = \frac{C_{urea}}{C_{solution}}$$

We get,

$5C_{solution} = C_{urea}$

This means the solution was diluted 5 times with respect to the urea concentration.

18. Wt. of Solute (Urea) = 40 g = W_2

Wt. of Solvent (Water) = 300 g = W_1

Mol. wt. of Solvent = 18 g/mol = M_1

Now, we know that, Relative lowering of Vapour Pressure = $\frac{\text{Loss in weight of Solvent or Water bulbs}}{\text{Gain in weight of Sulphuric acid tube}}$

$$\frac{\Delta P}{P^0} = \frac{0.087}{2.036} = 0.0427$$

Now, Using Raoult's Law:

$$M_2 = \frac{W_2}{W_1} \times M_1 \times \frac{p^0}{\Delta p} = \frac{40}{300} \times 18 \times \frac{1}{0.0427} = 53.7\,g/mol$$

19. $\Delta T_b = i \times K_f \times m$

$$5.93 \times 10^{-3} = \frac{(x+1) \times 0.52 \times 0.25 \times 1000}{M \times 10}$$

$$\frac{(x+1)}{M} = 4.56 \times 10^{-4} \quad \text{....(i)}$$

$$\frac{M}{100} = 23x \quad \text{....(ii)}$$

From equation (i) and (ii)

X = 20.49 $\cong$ 20

Formula of protein = $H_{20}P$

M = (2300 × 20 – 20 × 23) + 20 = 45560 amu

20. $\frac{0.5}{M} = 3.75 \times 10^{-3}$

M = 133.33

$$0.165 = (1 + \alpha) \times 1.86 \times 1.5 \times \frac{1000}{133.33 \times 150}$$

α = 0.1827 = 18.27%

21. ΔH =1659.9 Cal.at 80 K, ΔH = R [313.7 × 2.303 + 1.40655T]

$$\frac{d\ln P}{dT} = \frac{\Delta H}{RT^2} \quad ....(i)$$

$$\log P = 3.54595 - \frac{313.7}{T} + 1.40655 \log T$$

$$\ln P = 3.54595 \times 2.303 - \frac{313.7}{T} \times 2.303 + 1.40655 \ln T$$

$$\frac{d\ln P}{dT} = \frac{313.7 \times 2.303}{T^2} + \frac{1.40655}{T} \quad .....(ii)$$

Comparing equation (i) & (ii)

ΔH = R[313.7 × 2.303 + 1.40655T]

at T = 80 K

ΔH =1669.9cal.

22. The relation is:

$$\frac{W_1}{W_2} = \frac{M_1 \times P_1^0}{M_2 \times P_2^0}$$

$$M_1 = \frac{2.5 \times 18 \times 526}{1 \times (736 - 526)} = 112.7 \text{ g/mol}$$

23. **($[Pt(NH_3)_4Cl_2]Cl_2 \rightarrow [Pt(NH_3)_4Cl_2]^{2+} + 2Cl^-$)**

$\Delta T_f = i \times K_f \times m$

0.0054 = i × 1.80 × 0.001

The van' Hoff factor, i = 3

This suggests that 1 molecule of $\left[Pt(NH_3)_4Cl_4\right]$ dissociates in solution to produce 3 ions.

Hence, the correct formula of the complex is $\left[Pt(NH_3)_4Cl_3\right]Cl_2$

$[Pt(NH_3)_4Cl_3]Cl_2 \rightarrow [Pt(NH_3)_4Cl_3]^{2+} + 2Cl^-$