CBSE Class 12 physics

Important Questions

Chapter 2

Solutions

3 Marks Questions

1. Find the molality and molarity of a 15% solution of H_2SO_4 when its density is 1.10 g/cm^3 & molar mass = 98 amu.

Ans. Volume = mass/density

$$= 100\ g / 1.10\ g/cm^3 = 90.9\ cm^3$$

Molarity = $\dfrac{\text{no. of moles of } H_2SO_4}{\text{volume of solution}} \times 1000$

$= \dfrac{(15/98)}{90.9} \times 1000 = 1.68\ \text{m}$.

Molality = $\dfrac{\text{no. of moles of solute}}{\text{mass of solvent in kg}}$

$\dfrac{(15/98)}{85g} \times 1000$ = 1.8 M.

2. Calculate the mole fraction of ethanol and water in a sample of rectified spirit which contains 46% ethanol by mass?

Ans. Mass of ethanol = 46g

Mass of water = 100 – 46 = 54g

Mole fraction of ethanol, $X_A = \dfrac{X_A}{X_A + X_B}$

= $\dfrac{\frac{46}{46}}{\frac{46}{46}+\frac{54}{18}} = \dfrac{1}{1+3} = \dfrac{1}{4} = 0.25.$

Mole fraction of water = 1-0.25 = 0.75

3. Calculate the % composition in terms of mass of a solution obtained by mixing 300g of a 25% & 400 g of a 40% solution by mass?

Ans. mass of solute in 400g of 40% = $\dfrac{40}{100}\times 400 = 160\text{g}$

Total mass of solute = 160+75 = 235g

Total mass of solution = 400+300 = 700g

Mass% of solute = $\dfrac{\text{mass of solute}}{\text{Total mass of solution}}\times 100$

= $\dfrac{235}{700}\times 100 = 33.57\%$

Mass % of solvent = 100 – 33.57 = 66.43%

4. One litre of sea water weight 1030g and contains about $6\times 10^{-3}\,g$ of dissolved O_2. Calculate the concentration of dissolved oxygen in ppm?

Ans. mass of $O_2 = 6\times 10^{-3}\,g$

ppm of O_2 in 1030 g sea water = $\dfrac{\text{mass of } o_2}{\text{mass of sea water}}\times 10^6 = \dfrac{6\times 10^{-3}}{1030}\times 10^6 = 5.8\text{ ppm}.$

5. The density of 85% phosphoric acid is $1.70\ g/cm^3$. What is the volume of a solution that contains 17g of phosphoric acid?

Ans. 85g phosphoric acid is present in 100g of solution.

17g of phosphoric acid is present in $\frac{100}{85} \times 17 = 20\text{g of soution}$

Volume of 17g of 85% acid = $\frac{mass}{density}$

= $\frac{20g}{1.70 g/cm^3} = 11.8\ \text{cm}^3$

6. Define the term azeotrope?

Ans. A solution at certain concentration when continues to boil at constant temperature without change in its composition in solution & in vapour phase is called an azeotrope.

7. Obtain a relationship between relative lowering of vapour pressure and mole fraction of solute?

Ans. According to Raoult's Law –

$$P_1 = x_1 p_1^0$$

$$\Delta P = P_1^0 - P = P_1^0 - P_1^0 X_1$$

$$= \Delta P_1 = P_1^0 (1 - X_1)$$

$$\Delta P_1 = P_1^0 X_2 \left(X_1 + X_2 = 1 \right)$$

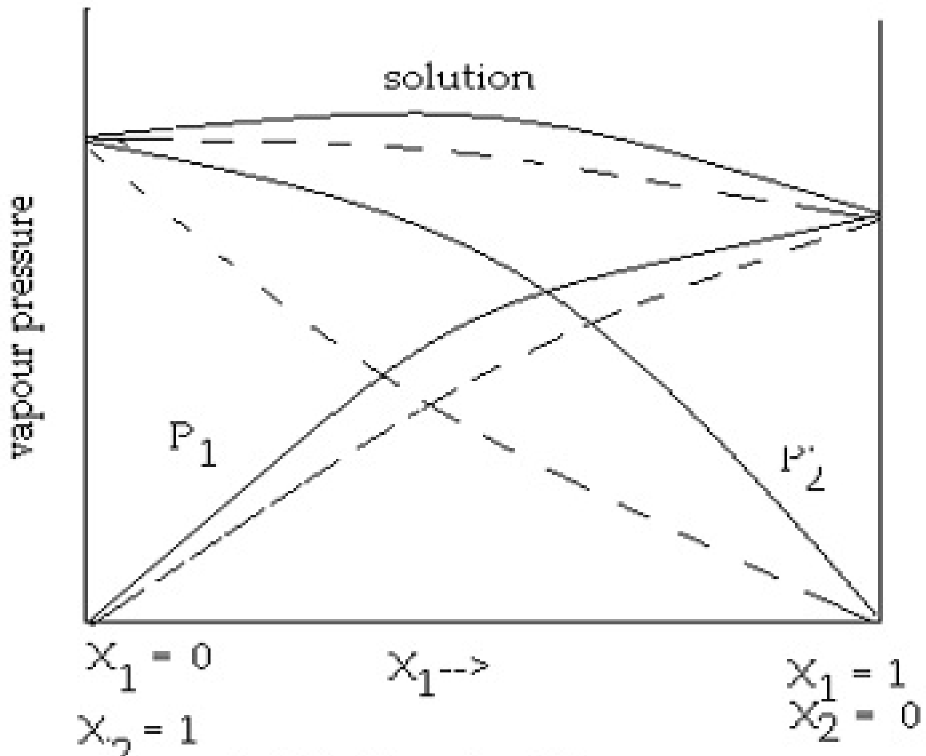
$$\frac{\Delta P_1}{P_1^0} = \text{X}_2$$

$= \frac{P_1^0 - P_1}{P_1^0} = X_2$

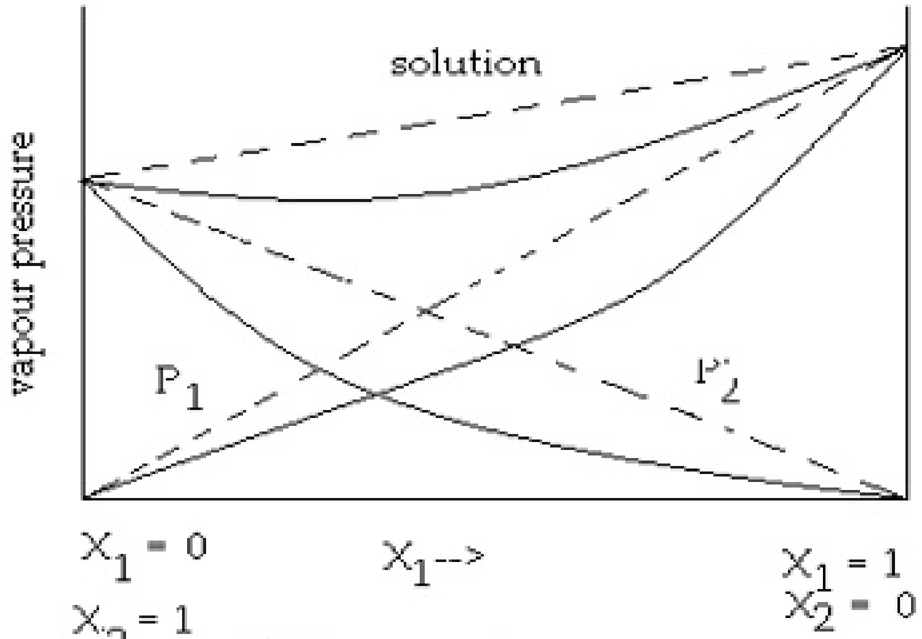
Relative lowering of vapour pressure.

8. Draw the graphs of both deviations from ideal behaviours?

Ans.



(a) Positive deviation.



(b) Negative deviation

9. A weak electrolyte AB in 5% dissociated in aqueous solution? What is the freezing point of a 0.10 molar aqueous solution of AB? K_f = 1.86 deg/molal?

Ans. Degree of dissociation $\times$ of AB = $\frac{5}{100} = 0.05$.

AB $\rightarrow A^+ + B^-$

M 0 0

No. of moles dissolved

No. of moles after dissociations m(1-α) mα mα

0.1 (1 – 0.05) 0.1×0.05 0.1×0.0

Total moles = [0.1(1- 0.05)] + $(0.1 \times 0.05) + (.1 \times 0.05)$

= 0.095 + 0.005 + 0.005 = 0.105m

$\Delta T_f = K_f$ .m

$= 1.86 \times 0.105$

= 0.1953 deg.

$T_f = 0^0 C - 0.1953 = 0.1953^0 C$

10. Henry's law constant for the molality of methane in benzene at 298 K is $4.27 \times 105\,\text{mm Hg}$. Calculate the solubility of methane in benzene at 298 K under 760 mm Hg.

Ans. Here,

p = 760 mm Hg

$k_H = 4.27 \times 105\,\text{mm Hg}$

According to Henry's law,

$p = k_H x$

$x = \frac{p}{k_H}$

$= \frac{760\,\text{mm Hg}}{4.27 \times 10^5\,\text{mm Hg}}$

= 177.99×10^{-5}

= 178×10^{-5} (approximately)

Hence, the mole fraction of methane in benzene is 178×10^{-5}.

11. Nalorphene $C_{19}H_{21}NO_3$, similar to morphine, is used to combat withdrawal symptoms in narcotic users. Dose of nalorphene generally given is 1.5 mg. Calculate the mass of

1.5×10^{-3} m aqueous solution required for the above dose.

Ans. The molar mass of nalorphene $C_{19}H_{21}NO_3$ is given as:

$19\times12+21\times1+1\times14+3\times16=311\,g\,mol^{-1}$

In $1.5\times10^{-3}\,m$ aqueous solution of nalorphene,

1 kg (1000 g) of water contains 1.5×10^{-3} mol = $1.5\times10^{-3}\times311\,g$

= 0.4665 g

Therefore, total mass of the solution = (1000 + 0.4665) g

= 1000.4665 g

This implies that the mass of the solution containing 0.4665 g of nalorphene is 1000.4665 g.

Therefore, mass of the solution containing 1.5 mg of nalorphene is:

$$\frac{1000.4665\times1.5\times10^{-3}}{0.4665}\,g$$

= 3.22 g

Hence, the mass of aqueous solution required is 3.22 g.

12. Calculate the amount of benzoic acid (C_6H_5COOH) required for preparing 250 mL of 0.15 M solution in methanol.

Ans. 0.15 M solution of benzoic acid in methanol means,

1000 mL of solution contains 0.15 mol of benzoic acid

Therefore, 250 mL of solution contains = $\frac{0.15\times250}{1000}$ mol of benzoic acid

= 0.0375 mol of benzoic acid

Molar mass of benzoic acid $\left(C_6H_5COOH\right) = 7\times12+6\times1+2\times16$

= 122 g mol^{-1}

Hence, required benzoic acid = $0.0375\ mol \times 122\ g\ mol^{-1}$

= 4.575 g

13. If the solubility product of CuS is 6×10^{-16}, calculate the maximum molarity of CuS in aqueous solution.

Ans. Solubility product of CuS, $K_sp = 6\times10^{-16}$

Let *s* be the solubility of CuS in $mol\ L^{-1}$.

$$\underset{}{CuS} \leftrightarrow \underset{s}{Cu^{2+}} + \underset{s}{S^{2+}}$$

Now, $K_sp = \left[Cu^{2+}\right]\left[S^{2-}\right]$

= $s \times s$
$= s^2$

Then, we have, $K_sp = s^2 = 6\times10^{-16}$

$$s = \sqrt{6\times10^{-16}}$$

= 2.45 × 10 - 8 $mol\ L^{-1}$

Hence, the maximum molarity of CuS in an aqueous solution is $2.45\times10^{-8} mol\ L^{-1}$.

14. A solution is obtained by mixing 300 g of 25% solution and 400 g of 40% solution by mass. Calculate the mass percentage of the resulting solution.

Ans. Total amount of solute present in the mixture is given by,

$$300\times\frac{25}{100}+400\times\frac{40}{100}$$

= 75 + 160

= 235 g

Total amount of solution = 300 + 400 = 700 g

Therefore, mass percentage (w/w) of the solute in the resulting solution, $=\frac{235}{700}\times100\%$

= 33.57%

And, mass percentage (w/w) of the solvent in the resulting solution,

= (100 - 33.57)%

= 66.43%

15. Calculate the mass of ascorbic acid (Vitamin C, $C_6H_8O_6$) to be dissolved in 75 g of acetic acid to lower its melting point by $1.5\,^{\circ}C \cdot Kf = 3.9\,K\,kg\,mol^{-1}$.

Ans. Mass of acetic acid, $w_1 = 75\ g$

Molar mass of ascorbic acid $(C_6H_8O_6), M_2 = 6\times12+8\times1+6\times16$

= $176\ g\ mol^{-1}$

Lowering of melting point, $\Delta Tf = 1.5\ K$

We know that:

$$\Delta T_f = \frac{K_f\times w_2\times1000}{M_2\times w_1}$$

$$w_2 = \frac{\Delta T_f\times M_2\times w_1}{K_f\times1000}$$

$$= \frac{1.5 \times 176 \times 75}{3.9 \times 1000}$$

= 5.08 g (approx)

Hence, 5.08 g of ascorbic acid is needed to be dissolved.

16. Calculate the osmotic pressure in pascals exerted by a solution prepared by dissolving 1.0 g of polymer of molar mass 185,000 in 450 mL of water at $37°C$.

Ans. It is given that:

Volume of water, *V*= 450 mL = 0.45 L

Temperature, *T* = (37 + 273)K = 310 K

Number of moles of the polymer, $n = \frac{1}{185000} \text{mol}$

We know that:

Osmotic pressure, $\pi = \frac{n}{V} RT$

$$= \frac{1}{185000} \text{mol} \times \frac{1}{0.45} \times 8.314 \times 10^3 \text{Pa L K}^{-1} \text{mol}^{-1} \times 310\text{K}$$

= 30.98 Pa

= 31 Pa (approximately)

17. Define the term solution. How many types of solutions are formed? Write briefly about each type with an example.

Ans. Homogeneous mixtures of two or more than two components are known as solutions.

There are three types of solutions.

(i) Gaseous solution:

The solution in which the solvent is a gas is called a gaseous solution. In these solutions, the solute may be liquid, solid, or gas. For example, a mixture of oxygen and nitrogen gas is a gaseous solution.

(ii) Liquid solution:

The solution in which the solvent is a liquid is known as a liquid solution. The solute in these solutions may be gas, liquid, or solid.

For example, a solution of ethanol in water is a liquid solution.

(iii) Solid solution:

The solution in which the solvent is a solid is known as a solid solution. The solute may be gas, liquid or solid. For example, a solution of copper in gold is a solid solution.

18. Calculate the mass of urea (NH_2CONH_2) required in making 2.5 kg of 0.25 molal aqueous solution.

Ans. Molar mass of urea $NH_2CONH_2 = 2(1\times14+2\times1)+1\times12+1\times16$ = 60 $g\ mol^{-1}$

0.25 molar aqueous solution of urea means:

1000 g of water contains 0.25 mol = $(0.25\times60)\,g$ of urea

= 15 g of urea

That is,

(1000 + 15) g of solution contains 15 g of urea

Therefore, 2.5 kg (2500 g) of solution contains = $\frac{15\times2500}{1000+15}g$

= 36.95 g

= 37 g of urea (approximately)

Hence, mass of urea required = 37 g