

LAKSHYA JEE

LAKSHYA KO HAR HAAL ME PAANA HAI



SOLUTION

By
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TODAY'S GOALS

- Immiscible liquids
- Colligative properties
- Relative lowering of vapour pressure

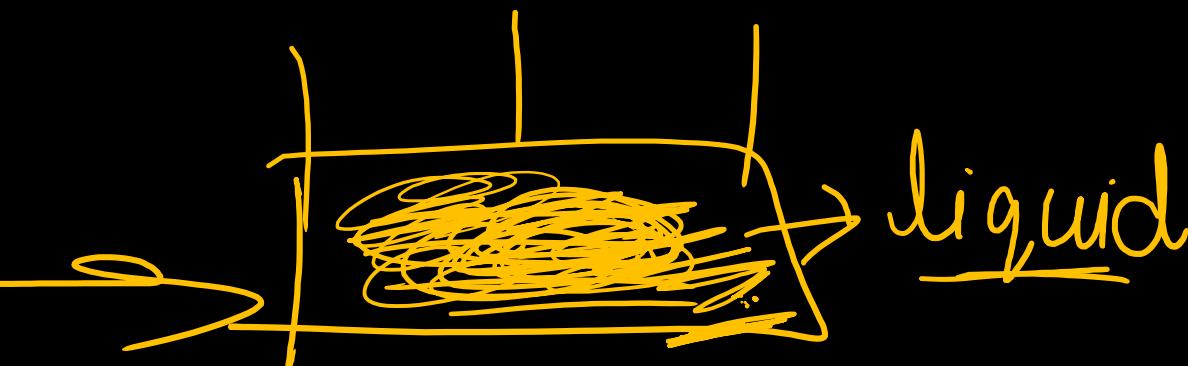


Immiscible liquids :-

↓
2 volatile immiscible liquids
are present in one container



$$P_S = P_A + P_B$$



$$P_A = P_A^o x_A, \quad P_B = P_B^o x_B$$

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

$$x_A = 1 \checkmark \quad \rightarrow \quad x_B = 1 \checkmark$$



As both liquids will act as different solution



$$P_S = P_A + P_B$$

$$\frac{Y_A}{Y_B} = \frac{P_A \chi_A}{P_B \chi_B} = \frac{n_A'}{n_B'}$$

$$Y_A = \frac{P_A \chi_A}{P_S}$$

$$Y_B = \frac{P_B \chi_B}{P_S}$$



$$\frac{Y_A}{Y_B} = \frac{P_A^o}{P_B^o} = \frac{n_A'}{n_B'}$$

n_A' = no. of moles of A in vapour phase

n_B' = no. of moles of B in vapour phase





$$P_S = P_A^o + P_B^o$$

$$732 = P_A^o +$$



A mixture of immiscible liquids of an organic liquid and water boils at 90°C and 732 torr pressure. The distillate contains 73% by weight of the organic liquid. Calculate the molar mass of the organic liquid (vapour pressure of water at 90°C is 526 torr)

- (a) 168.2 g mol^{-1}
- (b) 228.8 g mol^{-1}
- (c) 124.2 g mol^{-1}
- (d) 62.7 g mol^{-1}

Ans Org. liq. $\rightarrow A$, Water $\rightarrow B$

$$P_S = 732 \text{ torr}$$

$$P_B = 526 \text{ torr}$$

$$\omega_A = 73\% \checkmark$$

$$\omega_B = 27\% \checkmark$$

$$M_A = ? \checkmark$$

$$M_B = 18 \text{ g} \checkmark$$



$$P_S = P_A^o + P_B^o \quad \checkmark$$

$$732 = P_A^o + 526$$

$$P_A^o = 732 - 526 = 206 \text{ mm of Hg}$$

$$\frac{Y_A}{Y_B} = \frac{P_A^o}{P_B^o} = \frac{\omega_A \times M_B}{M_A \times \omega_B}$$



$$\frac{206}{526} = \frac{73 \times 18}{M_A \times 27}$$

$$M_A = \frac{\sqrt{73 \times 18} \times \sqrt{526}}{\underline{206} \times \underline{27}}$$

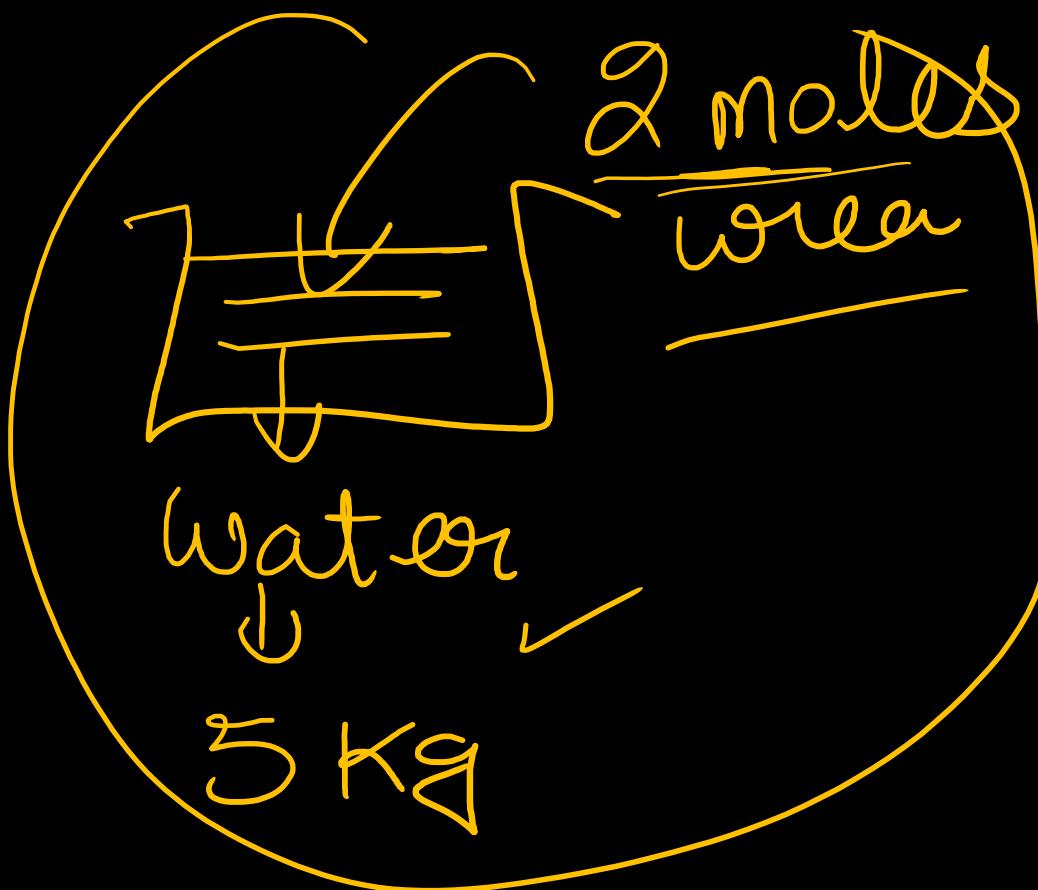
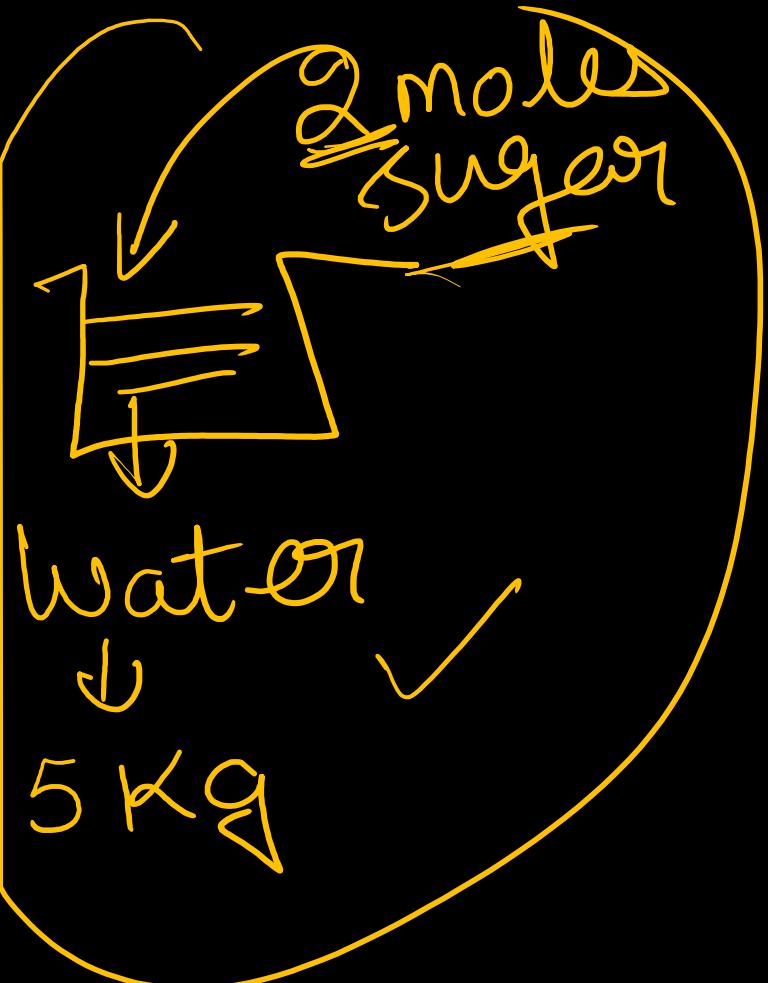
$$M_A \approx 124.2 \text{ g/mol}$$

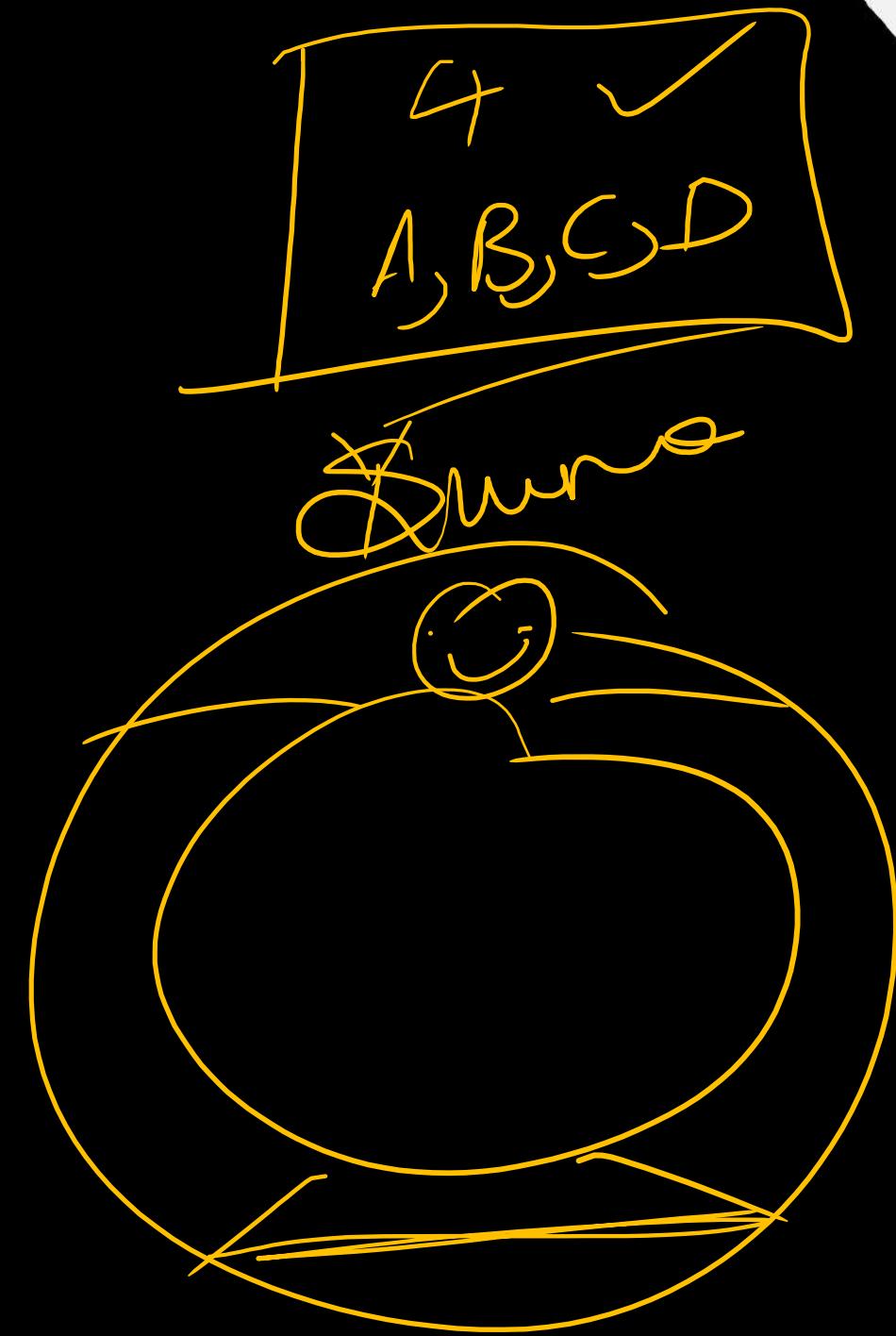


Colligative Properties :-

Properties of solution which depend upon no. of particles of solute & does not depend upon nature of solute.







Colligative Properties → 4

- ① Relative lowering of V.P.
- ② Elevation in Boiling point.
- ③ Depression in freezing point
- ④ Osmotic pressure.



Molar mass of solute

will give excellent results.

if (a) solute is non-volatile

(b) solution is dilute

(c) solute neither dissociate
nor associate in solution.

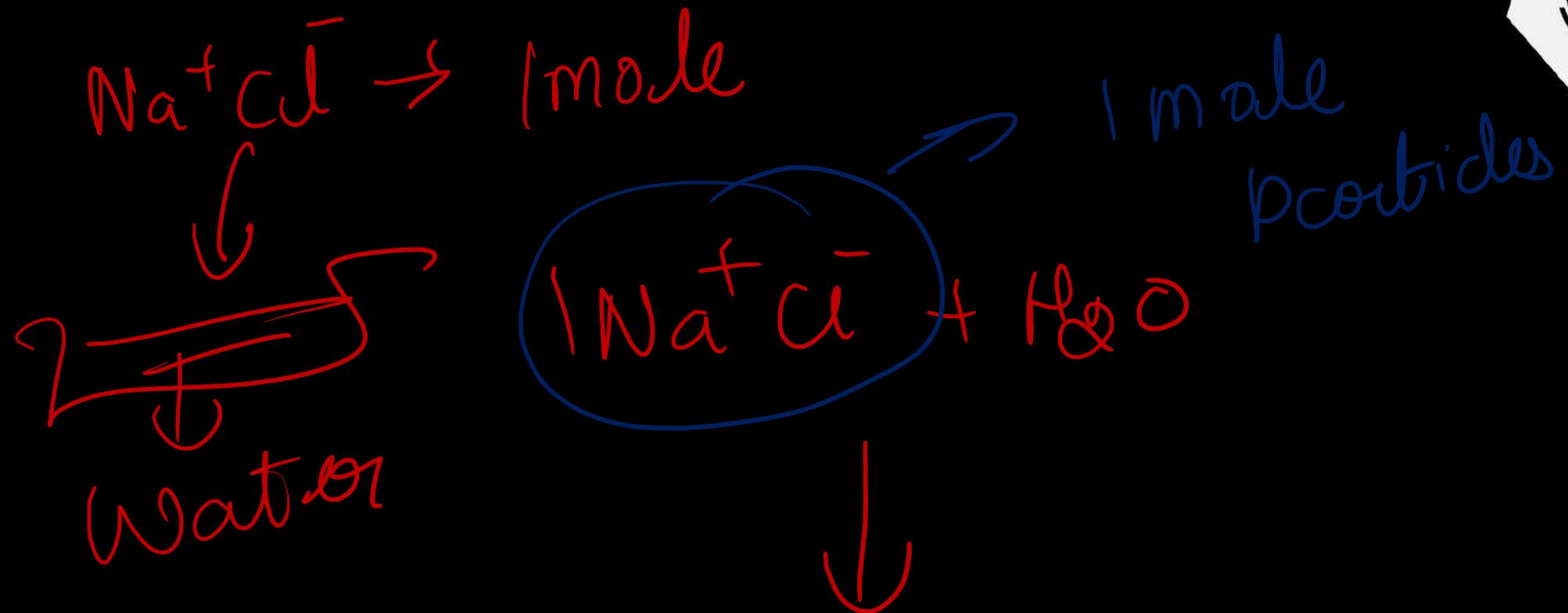


3000 Rs. → Total

1 + 14

2700 Rs.
300 Rs.





Relative lowering of V.P. :-



↓
(CRLVP)

Raoult's law for non-volatile

Solute \rightarrow

$$P_S = P_A^0 x_A + P_B^0 x_B$$

$$P_B^0 = 0 \text{ (non-volatile solute)}$$

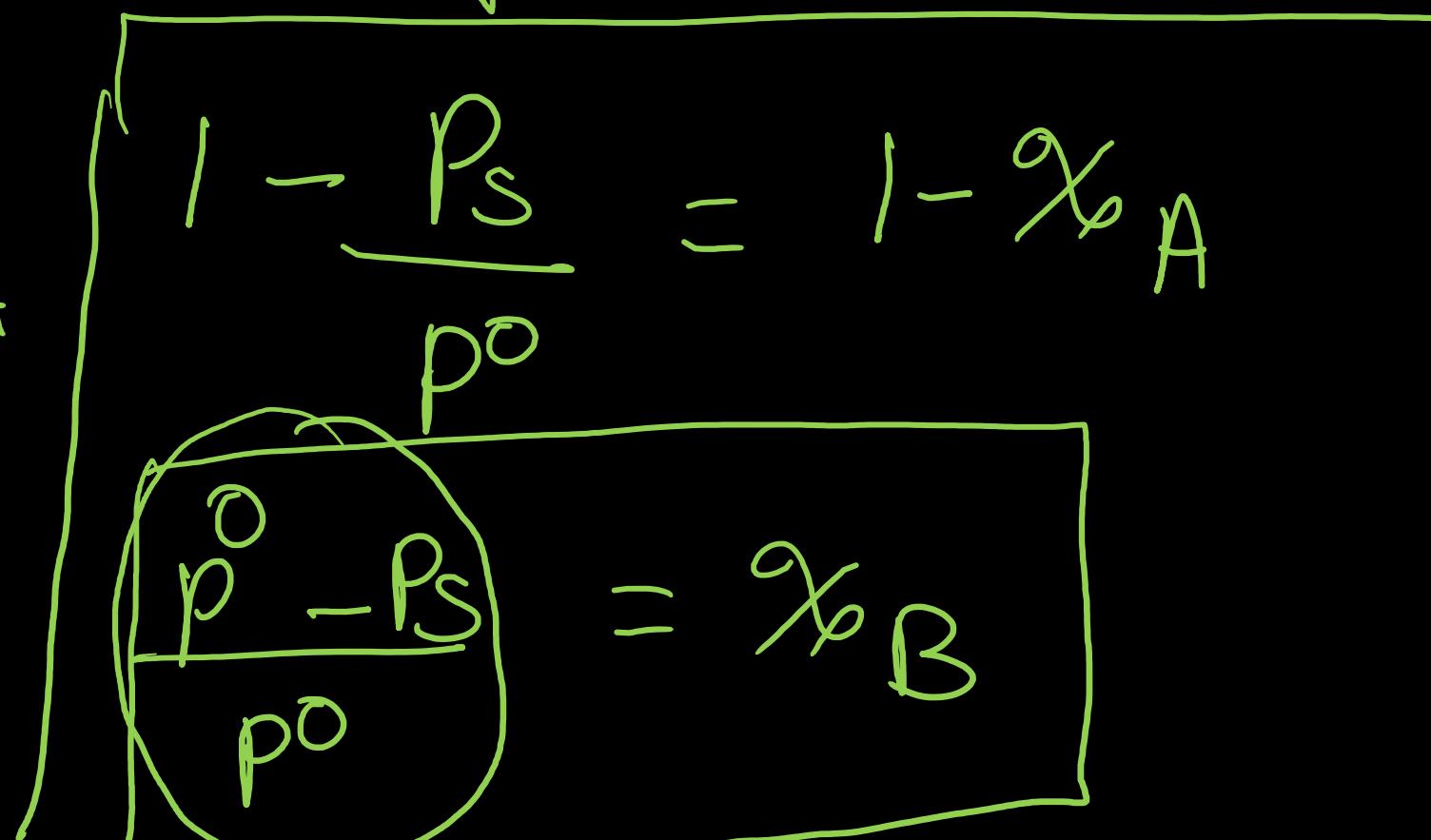


$$P_S = P_A^\circ \chi_A \quad C_P^\circ = P^\circ = V.P. \text{ of}$$

solvent in pure
forms

$$P_S = \underline{P^\circ} \chi_A$$

$$\frac{P_S}{P^\circ} = \chi_A$$



$P^o \checkmark = V.P. \text{ of volatile solvent}$

$P_s \checkmark = V.P. \text{ of solution}$

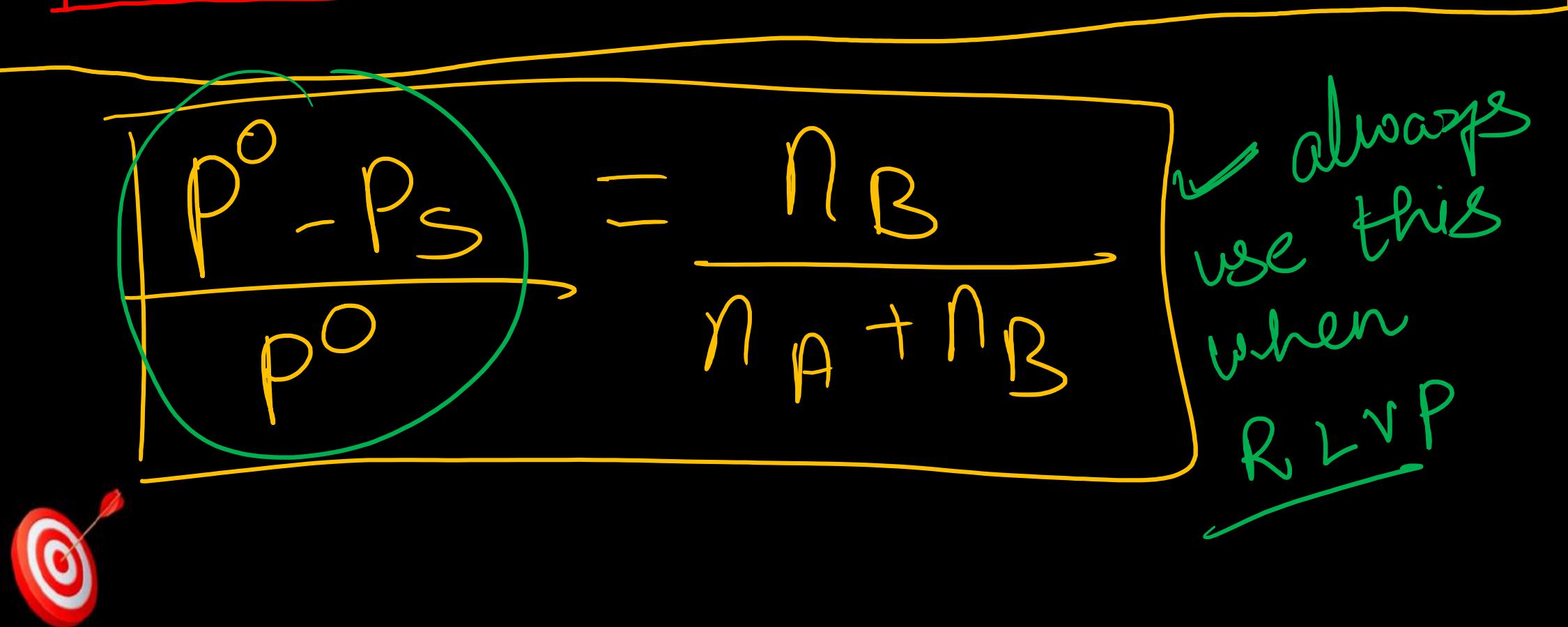
$P^o - P_s = \text{lowering of } V.P.$

$\frac{P^o - P_s}{P^o} = \text{Relative lowering of } V.P.$



χ_B = mole fraction of solute

$$\chi_B = \frac{n_B}{n_A + n_B}$$



if solution is dilute

or solute $\leq 5\%$

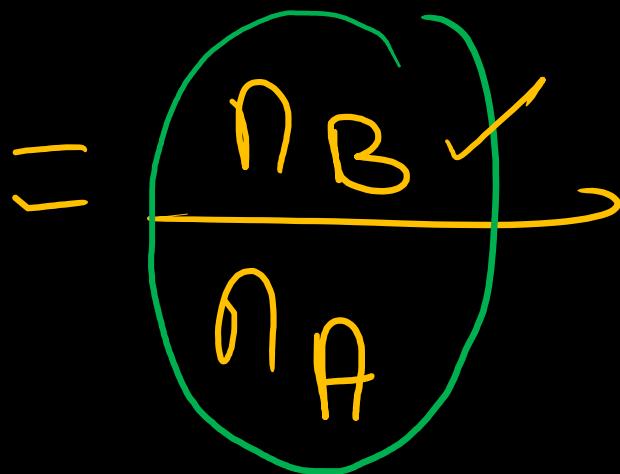


$$n_A + n_B \approx n_A$$



$$P - P_s$$

$$P^o$$



\rightarrow C.B.S.E.

if solution

is dilute

or solute

$\leq 5\%$

$$m = \frac{n_B \times 1000}{w_A}$$

$$m = \frac{n_B \times 1000}{\frac{w_A}{M_A} \times M_A} = \frac{n_B \times 1000}{n_A \times M_A}$$



$$m = \frac{n_B \times 1000}{n_A \times M_A} \quad \left[\frac{n_B}{n_A} = \frac{m \times M_A}{1000} \right]$$

✓

$$\frac{P^o - P_s}{P^o} = \frac{m \times M_A}{1000}$$

→ if solⁿ
 is dilute
 or solute
 ≤ 5%



$$\frac{P^o - P_s}{P^o} = \frac{n_B}{n_A + n_B}$$

$$\frac{P^o}{P^o - P_s} = \frac{n_A + n_B}{\cancel{n_B}}$$

$$\frac{P^o}{P^o - P_s} = \frac{n_A}{n_B}$$



$$\frac{1}{T} + \frac{P^o}{P - P_s} = \frac{n_A}{n_B}$$

$$\frac{P + P_s + P}{P^o - P_s} = \frac{n_A}{n_B}$$

$$\frac{P_s}{P^o - P_s} = \frac{n_A}{n_B}$$



$$\frac{P^o - P_s}{P_s} = \frac{n_B}{n_A}$$

Comp.

$$\frac{P^o - P_s}{P_s} = \frac{m \times M_A}{1000}$$

Gwp



The vapour pressure of benzene at 30°C is 121.8 mm of Hg. By adding 15 g of non-volatile solute in 250 g of benzene, its vapour pressure is decreased to 120.2 mm of Hg. The molecular weight of solute is [AIIMS 1997]

- (a) 156.6 g mol⁻¹
- (b) 267.4 g mol⁻¹
- (c) 356.3 g mol⁻¹
- (d) 467.4 g mol⁻¹

~~Avg~~ $P^o = 121.8 \text{ mm of Hg}$, $P_s = 120.2 \text{ mm of Hg}$

Solute \rightarrow B $\rightarrow w_B = 15 \text{ g}$ of Hg

Benzene \rightarrow A $\rightarrow w_A = 250 \text{ g}$

$w_B = ?$ | C₆H₆ (Benzene)

$M_A = 6 \times 12 + 1 \times 6 = 78$



$$\frac{P^o - P_s}{P_s} = \frac{\omega_B \times M_A}{M_B \times \omega_A}$$

$$\frac{121.8 - 120.2}{120.2} = \frac{15 \times 78}{M_B \times 250}$$



$$M_B = \frac{15 \times 78 \times 120.2}{1.6 \times 250} g$$

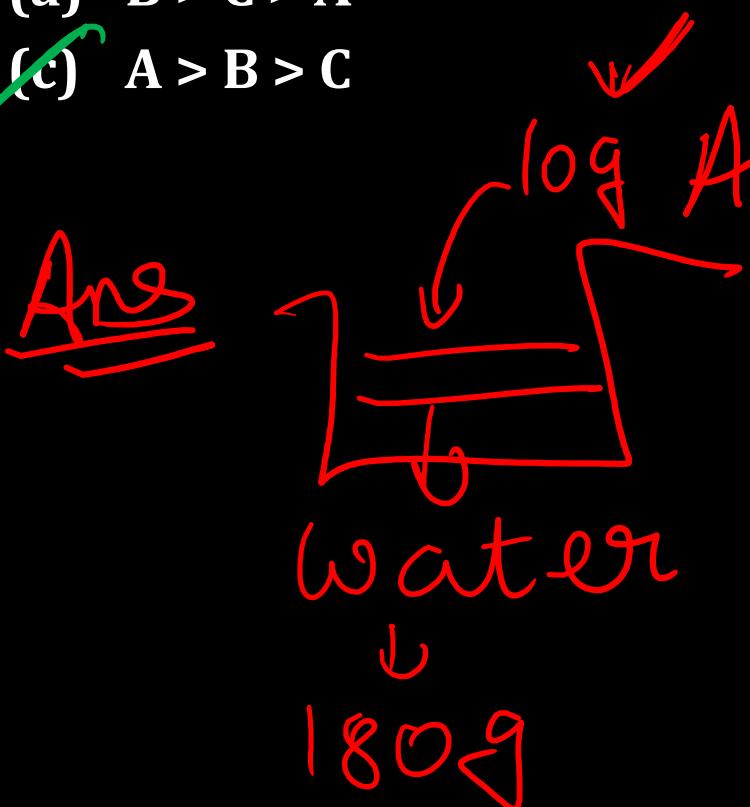
A set of solutions is prepared using 180 g of water as a solvent and 10 g of different non-volatile solutes A, B and C. The relative lowering of vapour pressure in the presence of these solutes are in the order

[Given, molar mass of A = 100 g mol⁻¹; B = 200 g mol⁻¹; C = 10,000 g mol⁻¹]

[JEE MAIN 2020, 6 September Shift-II]

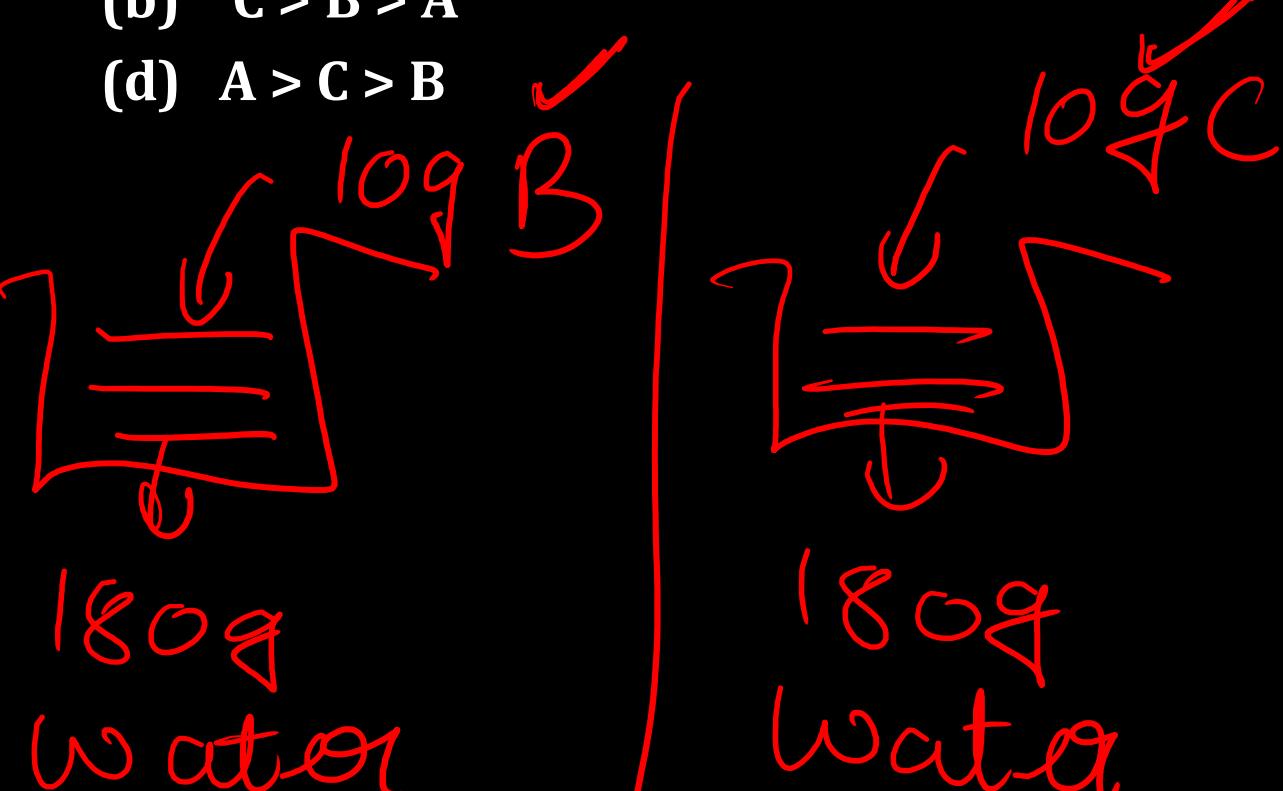
(a) B > C > A

(c) A > B > C



(b) C > B > A

(d) A > C > B



$$\frac{P^o - P_S}{P^o}$$

=

$$\frac{n_A}{n_A + n_{H_2O}}$$

→ Ist soln

$$\frac{P^o - P_S}{P^o}$$

=

$$\frac{n_B}{n_B + n_{H_2O}}$$

II Ind soln

$$\frac{P^o - P_S}{P^o}$$

=

$$\frac{n_C}{n_C + n_{H_2O}}$$

III 3rd soln

$$n_A = \frac{10}{100} = \frac{1}{10}$$

$$n_B = \frac{10}{200} = \frac{1}{20}$$

$$n_C = \frac{10}{10000} = \frac{1}{1000}$$

n_A is highest
 \therefore RLRP
 of A is highest



At room temperature, a dilute solution of urea is prepared by dissolving 0.60 g of urea in 360 g of water. If the vapour pressure of pure water at this temperature is 35 mm Hg, lowering of vapour pressure will be (molar mass of urea = 60 g mol⁻¹)

[JEE Main 2019, 10 April Shift-I]

- (a) 0.027 mmHg
- (b) 0.031 mmHg
- (c)* 0.017 mmHg

(d) 0.028 mmHg

Ans Urea \rightarrow Solute \rightarrow B

$$w_B = 0.6 \text{ g} \checkmark$$

$$M_B = 60 \text{ g} \checkmark$$

$$P^{\circ} = 35 \text{ mm of Hg} \checkmark$$

$$w_A = 360 \text{ g} \checkmark$$

$$M_A = 18 \text{ g} \checkmark$$

$$P^{\circ} - P_s = ?$$



$$\frac{P_o - P_s}{P_o} = \frac{W_B \times M_A}{M_B \times w_A}$$

$$\frac{P_o - P_s}{35} = \frac{0.6 \times 18}{600 \times 360} \quad 20$$

$$P_o - P_s = \frac{35}{2000} = \frac{7}{400}$$



The vapour pressure of CCl_4 at 25°C is 143 mm Hg. If 0.5 gm of a non-volatile solute (mol. Weight = 65) is dissolved in 100 g CCl_4 , the vapour pressure of the solution will be

(a) 199.34 mm Hg ✓

(c) ~~141.43~~ mm Hg

(b) ~~143.99~~ mm Hg ✓

(d) 94.39 mm Hg

Ans $P^o = 143 \text{ mm of Hg}$, $P_s = ?$

$w_B = 0.5 \text{ g}$, $M_B = 65 \text{ g}$ ✓

$w_A = 100 \text{ g}$, $M_A (\text{CCl}_4) = 154 \text{ g}$

$$\frac{P^o - P_s}{P^o} = \frac{w_B \times M_A}{M_B \times w_A}$$



$$\frac{143 - Ps}{143} = \frac{0.5 \times 154}{65 \times 100}$$

$$143 - Ps = \frac{77 \times 143}{6500}$$

$$6500 \times 143 - 6500 Ps = 77 \times 143$$

$$\frac{6500 \times 143 - 77 \times 143}{6500} = Ps = 141.43$$

mm of Hg



How much urea (molar mass = 60 g m ol⁻¹) should be dissolved in 50 g of water so that its vapour pressure at room temperature is reduced by 25%. Calculate molality of the solution obtained.

Ans Urea \rightarrow solute \rightarrow B \Rightarrow $w_B = ?$

$$M_B = 60 \text{ g} \quad , \quad w_A = 50 \text{ g} \quad , \quad M_A = \underline{18 \text{ g}}$$

het $P^{\circ} = 100 \text{ mm of Hg}$

$P_S = 75 \text{ mm of Hg}$



$$\frac{P^o - P_S}{P_S} = \frac{m \times M_A}{1000}$$

$$\frac{100 - 75}{75} = \frac{m \times 18}{1000}$$

$$\frac{\cancel{25} \times 1000}{\cancel{75} \times 18} = m$$

$$m = \frac{1000}{54} m$$



Vapour pressure of an aqueous solution of glucose is 750 mm of Hg at 373 K. Calculate the molality and mole fraction of solution (solute)

Ans

Glucose Water $T = 373K$

$$P_S = 750 \text{ mm of Hg} \quad M_A = 18 \text{ g}$$

$$\frac{P^o - P_S}{P^o} = \frac{m}{1000} \times \frac{M_A}{1}$$



$P^o = V.P.$ of water at 373K

$P^o = 760 \text{ mm of Hg}$

$$\frac{P - P_s}{P^o} = \frac{m \times M_A}{1000}$$

$$\frac{760 - 750}{760} = \frac{m \times 18}{1000}$$



$$\frac{P - P_s}{P_0} = \chi_B$$

$$\frac{760 - 750}{760} = \chi_B = \frac{10}{760}$$

$$\chi_B = \frac{1}{76}$$



The vapour pressure of water is 92 mm at 323 K. 18.1 g of urea are dissolved in 100 g of water. The vapour pressure is reduced by 5 mm. Calculate the molar mass of urea.

~~Ans~~ $P^o = 92 \text{ mm of Hg}$, $M_B = ?$

Urea \rightarrow solute $\rightarrow B$

$$w_B = 18.1 \text{ g} \quad w_A = 100 \text{ g}$$

$$\sqrt{P^o - P_S} = 5 \text{ mm of Hg} \quad M_A = 18 \text{ g}$$

$$92 - P_S = 5 \Rightarrow P_S = 87 \text{ mm of Hg}$$



$$M_B = ?$$

$$\frac{P_o - P_s}{P_s} = \frac{\omega_B \times M_A}{M_B \times \omega_A}$$

$$\frac{5}{87} = \frac{18.1 \times 18}{M_B \times 100}$$



$$M_B = \frac{18.1 \times 18 \times 87}{500} g$$



At 298 K, the vapour pressure of water is 23.75 mm Hg. Calculate the vapour pressure at the same temperature over 5% aqueous solution of urea $[CO(NH_2)_2]$.

Aus

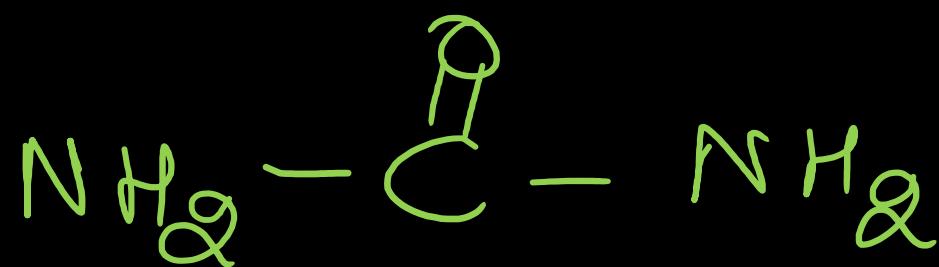
$$P^o = 23.75 \text{ mm of Hg}$$

$$P_S = ?$$

$$w_B = 5\%$$

$$w_A = 95\%$$

$$M_A = 18\text{g}$$



$$M_B = 60\text{g}$$



$$\frac{P_o - P_s}{P_o} = \frac{\omega_B \times M_A}{M_B \times \omega_f}$$

$$\boxed{\frac{23.75 - P_s}{23.75} = \frac{5 \times 18}{60 \times 95}}$$

$$P_s = ?$$



The ratio between lowering of vapour pressure of solution and mole fraction of solute is equal to

- (a) relative lowering of vapour pressure
- (b) vapour pressure of pure solvent
- (c) vapour pressure of solution
- (d) molar mass of solvent

Ans

$$\frac{P^o - P_s}{\chi_B} = ?$$

$$\frac{P^o - P_s}{P^o} = \chi_B$$





Thank You *Lakshyians*

