
PRAYAS
JEE 2026
PHYSICAL CHEMISTRY
SOLUTIONS
Lecture – 05
FAISAL RAZAQ
Physics Wallah

Topics to be covered

A Vapour Pressure of Solution

24 Jan, 2023 (Shift-II)

(1)

The Total pressure observed by mixing two liquid A and B is 350 mm Hg when their mole fractions are 0.7 and 0.3 respectively.
The total pressure becomes 410 mm Hg if the mole fractions are changed to 0.2 and 0.8 respectively for A and B. The vapour pressure of pure A is mm Hg. (Nearest Integer) Consider the liquid and solution behave ideally.

$$350 = P_A^0(0.7) + P_B^0(0.3)$$

$$410 = P_A^0(0.2) + P_B^0(0.8)$$

$$P_A^0 = ? \; ; \; P_B^0 = ?$$

28 June, 2022 (Shift-II) (3)

The vapour pressure of two volatile liquids A and B at 25°C are 50 Torr and 100 Torr, respectively. If the liquid mixture contains 0.3 mole fraction of A, then the mole fraction of liquid B in the vapour phase is $\frac{x}{17}$. The value of x is 14.

x_A, P_A°, P_B°

$$\frac{Y_A}{1-Y_A} = \frac{P_A^\circ}{P_B^\circ}\left(\frac{X_A}{1-X_A}\right)$$

$$\frac{Y_A}{1-Y_A} = \frac{50}{100}\left(\frac{0.3}{0.7}\right)$$

$$\frac{Y_A}{1-Y_A} = \frac{3}{14}$$

$$Y_A = \frac{3}{17} \; ; \; Y_B = 1 - \frac{3}{17} = \frac{14}{17}$$

Question 5

A vessel labelled 1 contains 3 mol of A and 1 mol of liquid B forming an ideal solution. The solution is allowed to reach equilibrium with its vapours. The vapours are then quickly taken out and condensed in vessel labelled 2. Here again the solution is allowed to reach an equilibrium with its vapours. The vapours are again quickly taken out and condensed in vessel labelled 3. This process is continued several times.

If $P_A^0 = 700$ mmHg

$P_B^0 = 350$ mmHg

$x_A = \frac{3}{4}$

$$\frac{Y_{A,n}}{1-Y_{A,n}} = \left(\frac{P_A^0}{P_B^0}\right)^n \left(\frac{x_{A,1}}{1-x_{A,1}}\right)$$

i) composition of vapour in vessel 1.

ii) composition of vapour in vessel 2

iii) composition of vapour in vessel 100.

i) $\frac{Y_{A,1}}{1-Y_{A,1}} = \left(\frac{700}{350}\right)\left(\frac{3/4}{1-3/4}\right) = 6$

$Y_{A,1} = \frac{6}{7}$; $Y_{B,1} = \frac{1}{7}$

ii) $\frac{Y_{A,2}}{1-Y_{A,2}} = \left(\frac{700}{350}\right)^2\left(\frac{3/4}{1-3/4}\right) = 12$

$Y_{A,2} = \frac{12}{13}$

iii) $\frac{Y_{A,100}}{1-Y_{A,100}} = \left(\frac{700}{350}\right)(3)$

$= 2^{100} \cdot 3 \simeq \infty$

$1 - Y_{A,100} \simeq 0$

$$\boxed{Y_{A,100} \simeq 1}$$

NCERT

(6) Vapour pressure of water at 293 K is 17.535 mm Hg. Calculate the vapour pressure of water soln at 293 K when 25 gm of glucose is dissolved in 450 gm of water.

$$P_s = P^0 X_{solvent}$$

$$= 17.535 \left(\frac{450/18}{450/18 + 25/180} \right) \text{mm Hg}$$

NCERT

(7) 100 gm of liquid A (molar mass 140 g/mol) was dissolved in 1000 gm of liquid B (molar mass 180 g/mol). The vapour pressure of pure liquid B was found to be 500 torr. Calculate the vapour pressure of pure liquid A and its vapour pressure in the solution if the total vapour pressure of solution is 475 torr.

$n_A = 100/140$

$n_B = 1000/180$

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

$475 = P_A^{\circ}(X_A) + 500(1 - X_A)$

$P_A^{\circ} = ?$

Question (11)

The vapour pressure of two pure liquids, A and B, which form an ideal solution are 300 and 800 torr respectively, at temperature T. A liquid solution of A and B for which the mole fraction of A is 0.60 is contained in a cylinder closed by a piston on which the pressure can be varied. The solution is slowly vaporized at temperature T by decreasing the applied pressure, starting with a pressure of about 1atm. Calculate

A. The pressure at which the first bubble of vapour is formed

B. The composition of the vapour in this bubble

C. The composition of the last droplet, and

D. The pressure when only this last droplet of liquid remains.

i)
$$P_T = P_A^\circ x_A + P_B^\circ x_B$$
$$= 300(0.6) + 800(0.4)$$
$$= 500 \text{ torr}$$

ii)
$$\frac{Y_A}{1-Y_A} = \frac{P_A^\circ}{P_B^\circ}\left(\frac{x_A}{1-x_A}\right)$$
$$= \frac{300}{800}\left(\frac{0.6}{0.4}\right) = \frac{9}{16}$$
$$Y_A = \frac{9}{25} = 0.36$$

iii)
$$\frac{Y_A}{1-Y_A} = \frac{P_A^\circ}{P_B^\circ}\left(\frac{x_A}{1-x_A}\right)$$
$$\frac{0.6}{0.4} = \frac{300}{800}\left(\frac{x_A}{1-x_A}\right)$$
$$\frac{3}{2} = \frac{3}{8}\cdot\left(\frac{x_A}{1-x_A}\right)$$
$$\frac{x_A}{1-x_A} = 4$$
$$x_A = \frac{4}{5} = 0.8 \;;\; x_B = 0.2$$

iv)
$$P_T = P_A^\circ x_A + P_B^\circ x_B = 300(0.8) + 800(0.2)$$
$$= 400 \text{ torr}$$

Ans : i) 500 torr

ii) 0.36, 0.64

iii) 0.8, 0.2

iv) 400 torr

Question (Advanced level)

(17) Two liquids A and B form ideal solution. At 300 K the vapour pressure of a solution containing 1 mol of A and 3 mol of B is 550 mm of Hg. At the same temperature one more mol of B is added to this solution, the vapour pressure of solution increases by 10 mm of Hg. Determine the vapour pressure of A and B in their pure state.

$$550 = P_A^\circ\left(\frac{1}{4}\right) + P_B^\circ\left(\frac{3}{4}\right) \quad \text{---} (1)$$

$$560 = P_A^\circ\left(\frac{1}{5}\right) + P_B^\circ\left(\frac{4}{5}\right) \quad \text{---} (2)$$

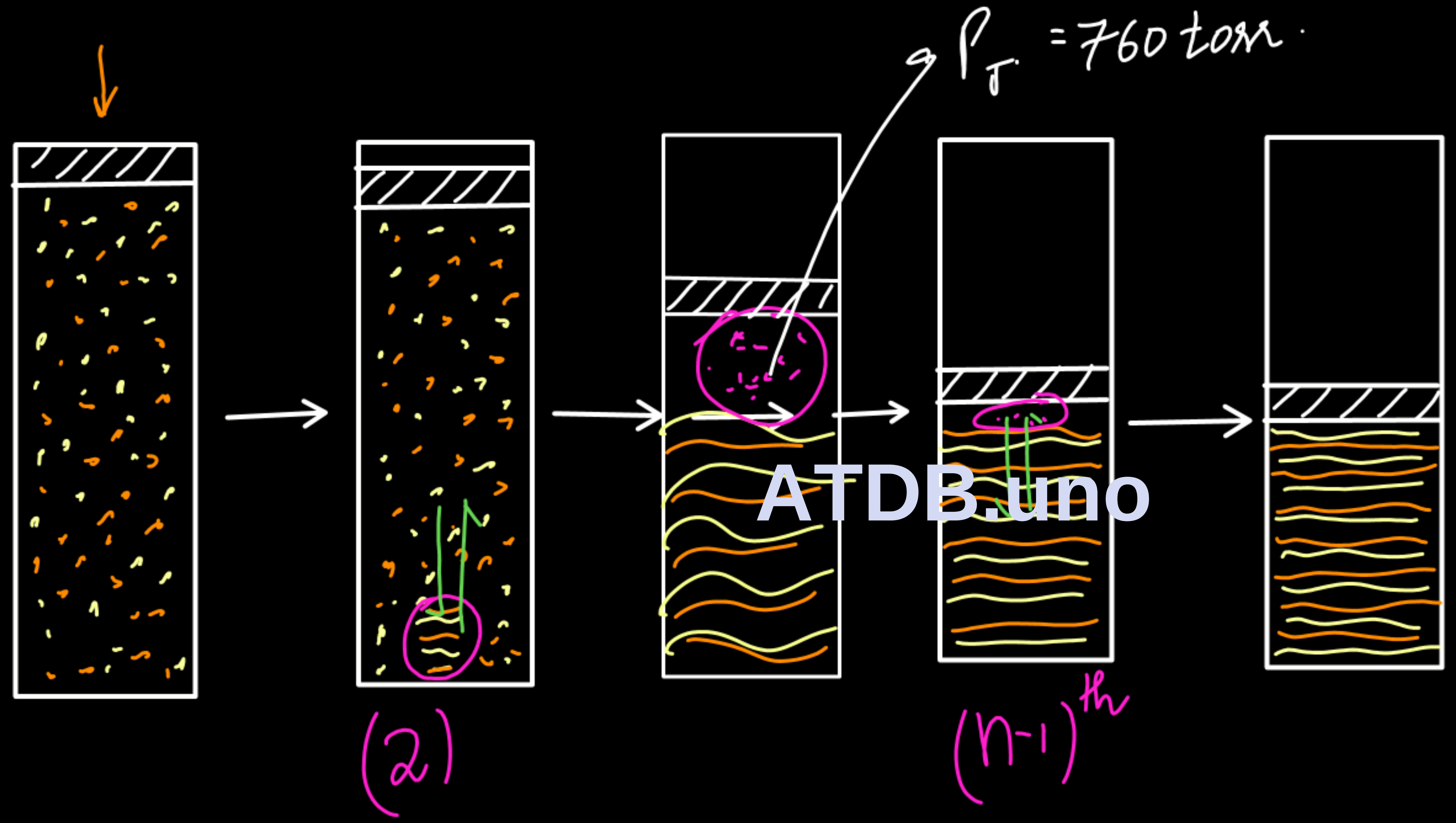
Ans- $P_A^\circ = 400$ mm Hg

$P_B^\circ = 600$ mm Hg

Case of Condensation

Boiling occurs when V.P = atmospheric Pressure

= 760 torr
or
= 1 atm
or
= 760 mmHg



Question

The vapour pressure of two pure liquids, A and B that form an ideal solution are 300 and 800 torr respectively, at temperature T. A mixture of the vapours of A and B for which the mole fraction of A is 0.25 is slowly compressed at temperature T. Calculate

i) The composition of the first drop of the condensate 0.47 ✓

ii) The total pressure when this drop is formed 565 ✓

iii) The composition of the solution whose normal boiling point is T 0.08

iv) The pressure when only the last bubble of vapour remains, and 675 ✓

v) The composition of the last bubble. 0.11 ✓

i) $\dfrac{Y_A}{1-Y_A} = \dfrac{P_A^\circ}{P_B^\circ}\left(\dfrac{X_A}{1-X_A}\right)$

$\dfrac{0.25}{0.75} = \dfrac{300}{800}\left(\dfrac{X_A}{1-X_A}\right)$

$\dfrac{8}{9} = \dfrac{X_A}{1-X_A}$

$X_A = \dfrac{8}{17}$

$X_B = \dfrac{9}{17}$

ii) $P_T = P_A^\circ X_A + P_B^\circ X_B$

$= 300\left(\dfrac{8}{17}\right) + 800\left(\dfrac{9}{17}\right)$

$= 565$ torr

iii) $P_T = 300(0.25) + 800(0.75)$

$= 675$ torr

iv) $\dfrac{Y_A}{1-Y_A} = \dfrac{300}{800}\left(\dfrac{0.25}{0.75}\right)$

$Y_A = \dfrac{1}{9}$, $Y_B = \dfrac{8}{9}$

iii) $P_T = P_A^\circ X_A + P_B^\circ X_B$

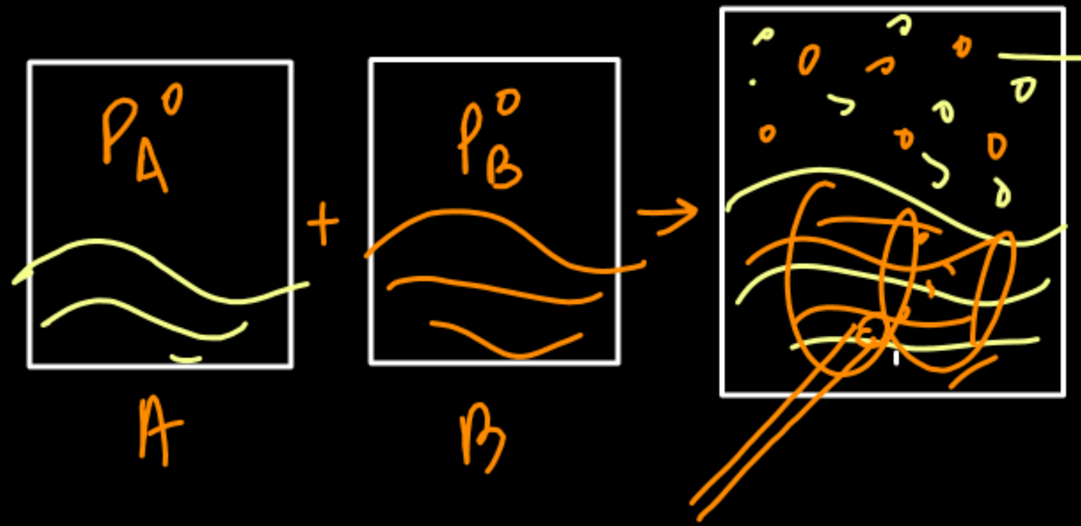
$760 = 300\,X_A + 800(1 - X_A)$

$760 = 300X_A + 800 - 800X_A$

$X_A = \frac{40}{500} = 0.08$

$X_B = 1 - 0.08 = 0.92$

Mixture of two volatile liquids both are immiscible



$$P_T = P_A^0 + P_B^0 \quad \left\{ \begin{array}{l} P_T > P_A^0 \\ P_T > P_B^0 \end{array} \right\}$$

Since these two liquids are immiscible then $X_A = 1$, $X_B = 1$.

$$Y_A = \frac{P_A^0}{P_T}$$

Y_A and Y_B are the mole fractions of A and B in vapour phase.

$$Y_B = \frac{P_B^0}{P_T}$$

$$Y_A / Y_B = P_A^0 / P_B^0$$

$$\frac{\dfrac{n_A}{n_A+n_B}}{\dfrac{n_B}{n_A+n_B}} = \frac{P_A^o}{P_B^o}$$

$$\boxed{\frac{n_A}{n_B} = \frac{P_A^o}{P_B^o}}$$

n_A = moles of A in vapour phase

n_B = moles of B in vapour phase

$$\frac{W_A/M_A}{W_B/M_B} = \frac{P_A^o}{P_B^o}$$

$$\boxed{W_A/W_B = \frac{P_A^o M_A}{P_B^o M_B}}$$

W_A = wt of A in vapour phase

W_B = wt of B in vapour phase.

i) $P_T = P_A^o + P_B^o$

ii) $Y_A/Y_B = P_A^o/P_B^o$

iii) $n_A/n_B = P_A^o/P_B^o$

Imp iv) $W_A/W_B = P_A^o M_A / P_B^o M_B$

300°C ← liq A = Jisko purify karna hai

100°C ← liq B = water Jo ki immiscible hai A ke sath.

Temperature	Vap. P of A	Vap. P. of B	Vap P of mix.
50°C	0.1 atm	0.5 atm	0.6 atm
70°C	0.2 atm	0.6 atm	0.8 atm
90°C	0.3 atm	0.62 atm	0.92 atm
95°C	0.31 atm	0.65 atm	0.96 atm
98°C	0.32 atm	0.68 atm	1.0 atm

Mix boils at 98°C

Question An unknown compound is immiscible with water. It is steam distilled at 98°C and $P_T = 737$ torr, $P^0_{H_2O} = 707$ torr at 98°C. This distillate was 75% by weight water. Calculate the molecular weight of the unknown.

HoWo

Imp

$P^0_A = 737 - 707 = 30$ torr

$P^0_{H_2O} = 707$ torr

$$\frac{W_{H_2O}}{W_A} = \frac{P^0_{H_2O} \cdot M_{H_2O}}{P^0_A \, M_A}$$

$$\frac{75}{25} = \frac{707 \times 18}{30 \times M_A} \Rightarrow M_A = 707/5$$

141.4


THANK
YOU