LAKSHYA JEE

LAKSHYA KO HAR HAAL ME PAANA HAI

SOLUTION

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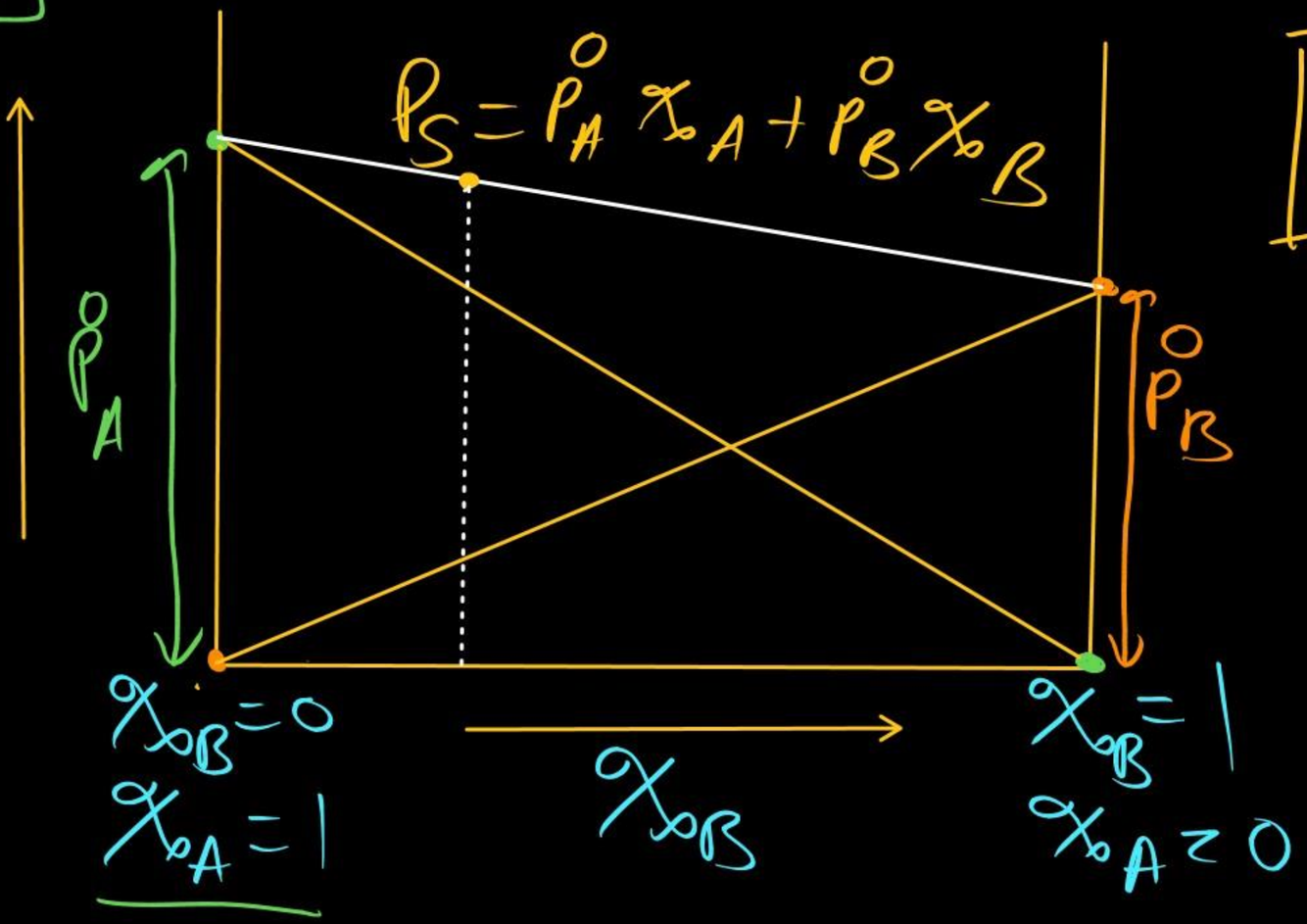
TODAY'S GOALS

Short Tricks For Numericals

Fractional Distillation

$P_A^\circ > P_B^\circ$

V.P



$y = mx$

$P_A = P_A^\circ x_A$

$P_B = P_B^\circ x_B$

$y = m x$

if $P_A^0 = 500 \text{ mm of Hg}$ & $P_B^0 = 300 \text{ mm of Hg}$

$x_B = 0.4$ $\Rightarrow$ $x_A = 1 - x_B = 0.6$

$$P_S = 50\phi \times \frac{6}{10} + 30\phi \times \frac{4}{10}$$

$$\boxed{P_S = 300 + 120 = 420 \text{ mm of Hg}}$$

if $\boxed{P^{\circ}_A > P^{\circ}_B}$ $\longrightarrow$ A is more Volatile

$$\boxed{P^{\circ}_B < P_S < P^{\circ}_A}$$

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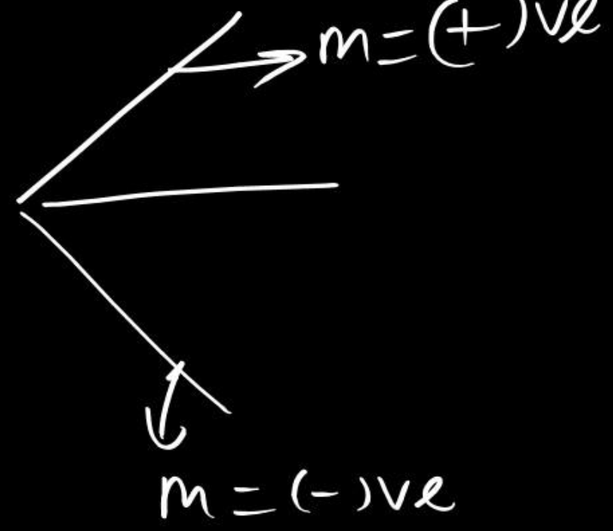
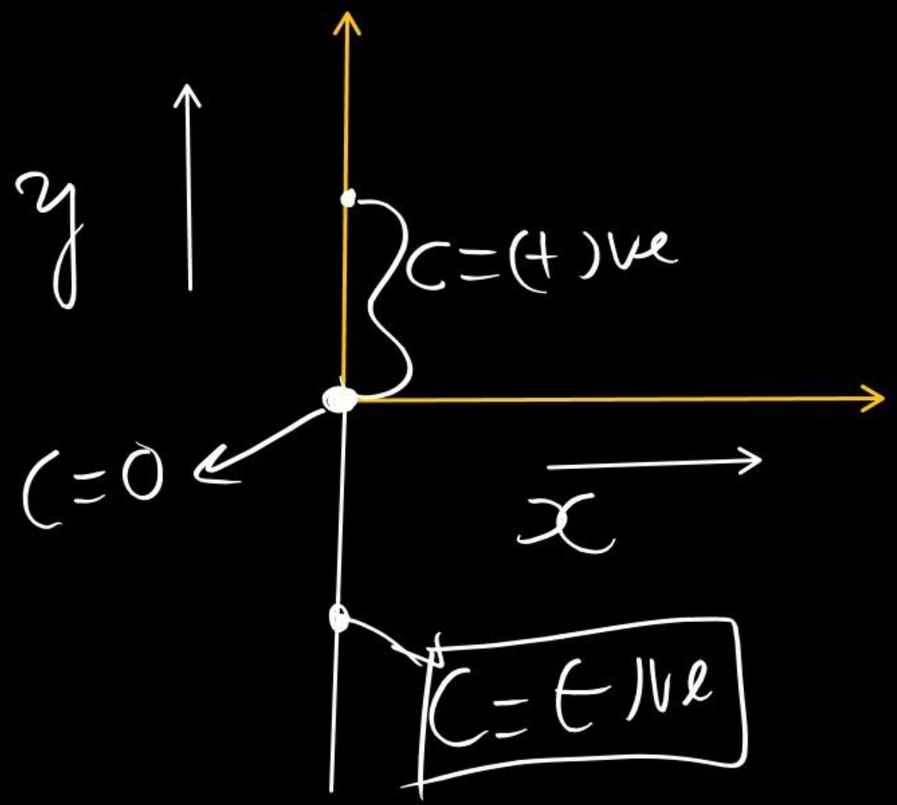
if $P^{\circ}_B > P^{\circ}_A \longrightarrow$ B is more Volatile

$$\boxed{P^{\circ}_A < P_S < P^{\circ}_B}$$

$$y = mx + c$$

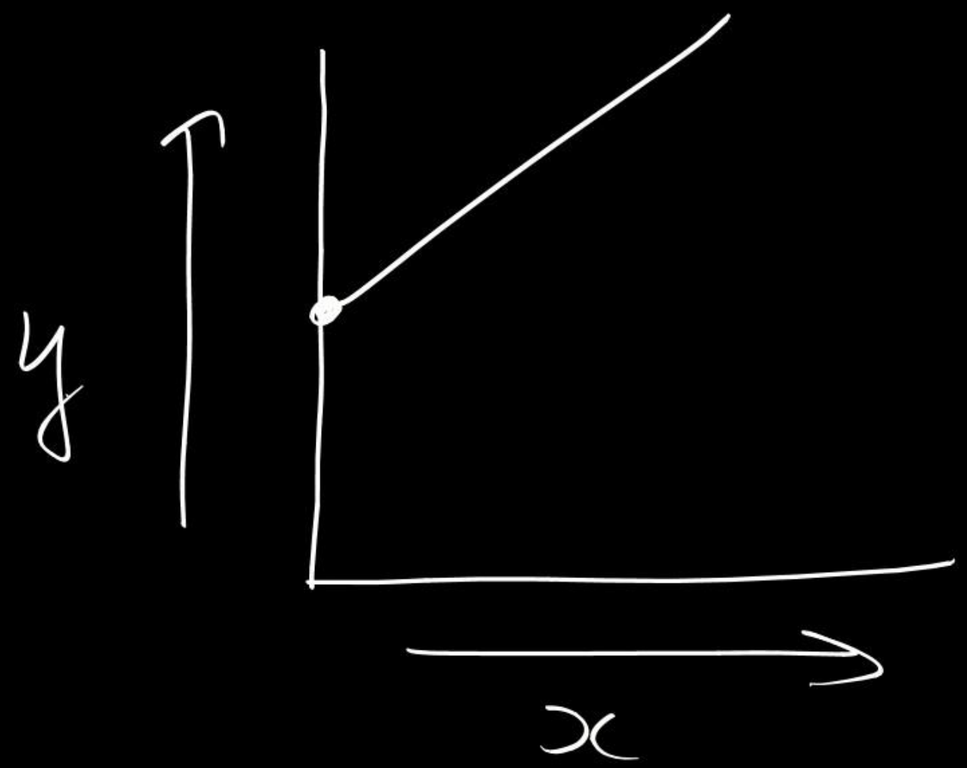
m = slope





C = Intercept

C = (+)ve



$y = mx + c$

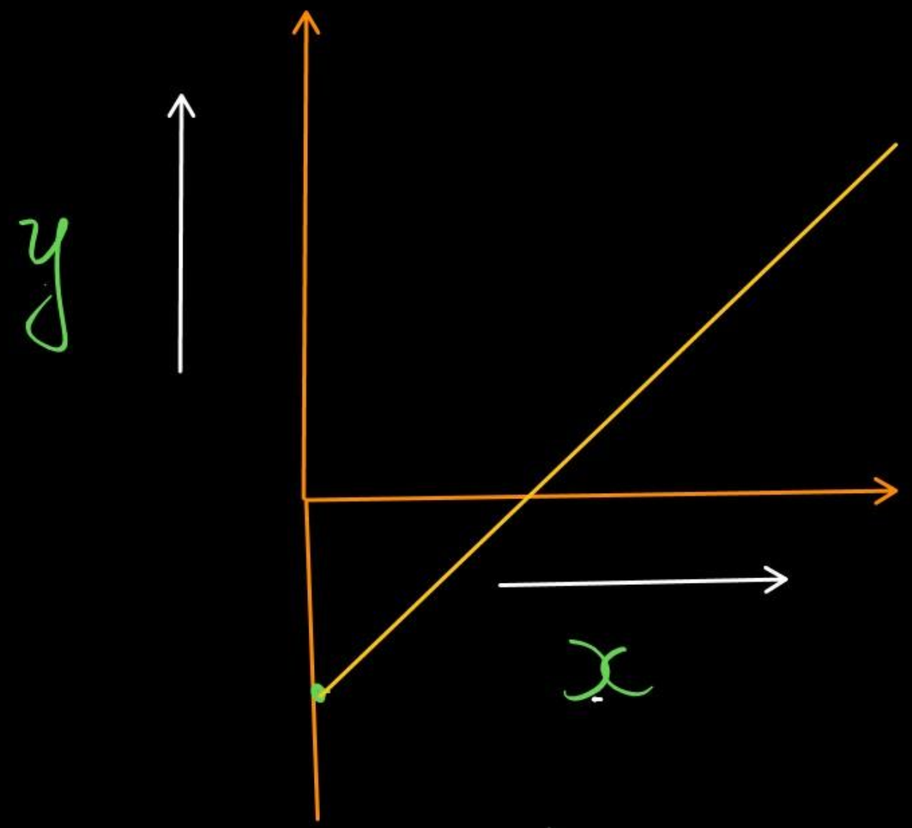
m = (+ve)

(+ve)

$y = mx + c$

m : (+)ve

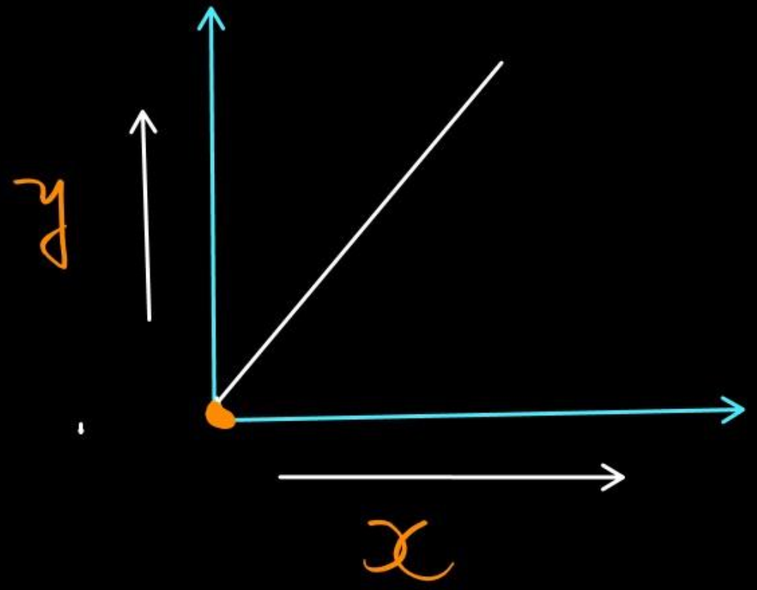
c : (−)ve



$y = mx + c$

m : (+)ve

c : (0)



Q If $P_A^\circ = 200$ mm of Hg & $P_B^\circ = 300$ mm of Hg

which of the following Cannot be P_S for two miscible liquids following Ideal behaviour?

(a) 230 mm of Hg (b) 270 mm of Hg (c) 170 mm of Hg

(d) 225 mm of Hg

$$P_S = P_A^\circ \chi_A + P_B^\circ \chi_B$$

If P_A^0 & P_B^0 given.

Whichever has higher no. of moles

P_S is closer to that Component V.P

in Pure form.

Q. If $P_A^0 = 200$ mm of Hg & $P_B^0 = 600$ mm of Hg find (P_S) if 2 moles of A & 3 moles of B are mixed?

(a) 200 mm of Hg (b) 300 mm of Hg (c) 550 mm of Hg

(d) 700 mm of Hg

If P_A° & P_B° given.

Same no. of moles.

$$P_S = \frac{P_A^\circ + P_B^\circ}{2}$$

$n_A = n_B = 1$

$$\chi_{oA} = \frac{n_A}{n_A + n_B} = \frac{1}{2}$$

$$\chi_{oB} = 1 - \chi_{oA} = \frac{1}{2}$$

$$P_S = \frac{P_A^\circ}{2} + \frac{P_B^\circ}{2}$$

If P_A^0 = 100 mm of Hg, P_B^0 = 500 mm of Hg and have same no. of moles in solution. Find vapour pressure of solution.

(a) 100 mm of Hg

(b) 150 mm of Hg

(c) 300 mm of Hg

(d) 500 mm of Hg

$$P_S = \frac{100+500}{2} = \frac{600}{2} = 300 \text{ mm of Hg}$$

If P_A° & P_B° given

both have same mass $\Rightarrow$ Whichever has higher no. of moles

$\downarrow$

P_S is closer to V.P. of that component in pure form

If P_A^0 = 100 mm of Hg, P_B^0 = 500 mm of Hg and in solution both have same mass and M_A = 20 g and M_B = 200 g. Find vapour pressure of solution.

(a) 300 mm of Hg

(b) 146.35 mm of Hg

(c) 250 mm of Hg

(d) 400 mm of Hg

As $w_A = w_B = 200\,g$

$M_A = 20\,g$

$M_B = 200\,g$

$n_A = \frac{200}{20} = 10$

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

$$\chi_A = \frac{n_A}{n_A + n_B} = \frac{10}{11}$$

$$\chi_B = 1 - \chi_A = \frac{1}{11}$$

$$P_S = 100 \times \frac{10}{11} + 500 \times \frac{1}{11}$$

$$\boxed{P_S = 146.35 \text{ mm of Hg}}$$

$$\chi_{oB} = \frac{n_B}{n_A + n_B}$$

$$\chi_{oA} = \frac{n_A}{n_A + n_B}$$

$$\chi_{oB} = \frac{2}{11}$$

$$\frac{\chi_{oB}}{\chi_{oA}} = \frac{n_B}{n_A}$$

Let

$$\frac{\chi_{oB}}{\chi_{oA}} = \frac{n_B}{n_A} = \frac{2}{9}$$

$$\chi_{oA} = \frac{9}{11}$$

$$\frac{\chi_{oB}}{\chi_{oA}} = \frac{2}{9} \Rightarrow \boxed{\chi_{oB} = \frac{2}{9}\chi_{oA}}$$

$$\chi_{oA} + \chi_{oB} = 1$$

$$\chi_{oA} + \frac{2}{9}\chi_{oA} = 1$$

$$\frac{9\chi_{oA} + 2\chi_{oA}}{9} = 1$$

$$\boxed{\chi_{oA} = \frac{9}{11}}$$

$$Y_A = \frac{P_A^\circ \chi_{oA}}{P_S}$$

$$Y_B = \frac{P_B^\circ \chi_{oB}}{P_S}$$

$$\frac{Y_A}{Y_B} = \frac{P_A^\circ}{P_B^\circ}\frac{\chi_{oA}}{\chi_{oB}} = \frac{P_A^\circ n_A}{P_B^\circ n_B}$$

Let $\frac{Y_A}{Y_B} = \frac{2}{5}$

$Y_A = \frac{2}{7}$ | $Y_B = \frac{5}{7}$

If vapour pressure of pure A and B are 200 and 500 mm of Hg and in solution has 2 moles of A and 6 moles of B. Find mole fraction of B in vapour phase

(a) $\frac{2}{17}$

(b) $\frac{3}{17}$

(c) $\frac{4}{17}$

(d) $\frac{15}{17}$

$Y_B = ?$

$$\frac{Y_A}{Y_B} = \frac{P_A^\circ n_A}{P_B^\circ n_B} = \frac{200 \times 2}{500 \times 6} \quad 3$$

$$\frac{Y_A}{Y_B} = \frac{2}{15}$$

$$Y_B = \frac{15}{17}$$

$P_A^\circ = 200$ mm of Hg

$P_B^\circ = 500$ mm of Hg

$n_A = 2$

$n_B = 6$

$$x_A = \frac{|P_S - P_B^\circ|}{|P_A^\circ - P_B^\circ|}$$

$$x_B = \frac{|P_S - P_A^\circ|}{|P_A^\circ - P_B^\circ|}$$

Find mole ratio of A and B in vapour phase if V.P. of solution is 160 torr. If V.P. of pure A and B are 100 mm of Hg and 200 mm of Hg.

Ans $Y_A = ?$

$Y_B = ?$

$P_S = 160$ torr

$P_A^\circ = 100$ torr $\mid P_B^\circ = 200$ mm of Hg

$$\frac{Y_A}{Y_B} = \frac{P_A^\circ \chi_{oA}}{P_B^\circ \chi_{oB}}$$

$$\underline{x_{0A}} = \frac{|160 - 200|}{|100 - 200|} = \frac{40}{100} = \frac{4}{10} = 0.4$$

$$x_{0B} = 1 - x_A = \frac{6}{10} = 0.6$$

$$\frac{Y_A}{Y_B} = \frac{100 \times 0.4}{200 \times 0.6} = \frac{1}{3}$$

$$Y_A = \frac{1}{4}$$

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

If vapour pressure of solution

$P_S = 6 - 2\chi_B$

Find P_A^0 and P_B^0 ?

Ans

$P_S = 6 - 2\chi_B$

$P_S = P_A^0 + (P_B^0 - P_A^0)\chi_B$

$P_S = P_A^0(\chi_A) + P_B^0\chi_B$

$\chi_B = 0 \Rightarrow \chi_A = 1$

$P_S = 6 = P_A^0$

$\chi_B = 1 \Rightarrow \chi_A = 0$

$P_S = 6 - 2 = 4 = P_B^0$

If n moles each of A & B are present in an Ideal Solution & half of the solution is vaporised then

$$P_S = \sqrt{P_A^\circ \, P_B^\circ}$$

If in a solution 1 moles each of A and B are mixed. Find vapour pressure of solution if half of the total moles are vaporised (P_A^0 = 500 mm of Hg and P_B^0 = 20 mm of Hg)

Ans

$n_A = 1 = n_B$

$P_S = ?$

$P_A^0 = 500 \text{ mm of Hg}$

$P_B^0 = 20 \text{ mm of Hg}$

If half of total moles are vaporised

$$P_S = \sqrt{P_A^0 P_B^0}$$

$$P_S = \sqrt{500 \times 20} = \sqrt{10000} = 100$$

$$P_S = 100 \text{ mm of Hg}$$

$$Y_A = \frac{P_A^{\circ} x_A}{P_S} \Rightarrow x_A = \frac{Y_A P_S}{P_A^{\circ}}$$

$$Y_B = \frac{P_B^{\circ} x_B}{P_S} \Rightarrow x_B = \frac{Y_B P_S}{P_B^{\circ}}$$

$$x_{oA} + x_{oB} = 1$$

$$P_S \left(\frac{Y_A}{P^o_A} + \frac{Y_B}{P^o_B} \right) = 1$$

$$\boxed{\frac{1}{P_S} = \frac{Y_A}{P^o_A} + \frac{Y_B}{P^o_B}}$$

⋮

Graph b/w $\frac{1}{Y_A}$ & $\frac{1}{x_A}$

$$Y_A = \frac{P_A^\circ x_A}{P_A^\circ x_A + P_B^\circ (1 - x_A)}$$

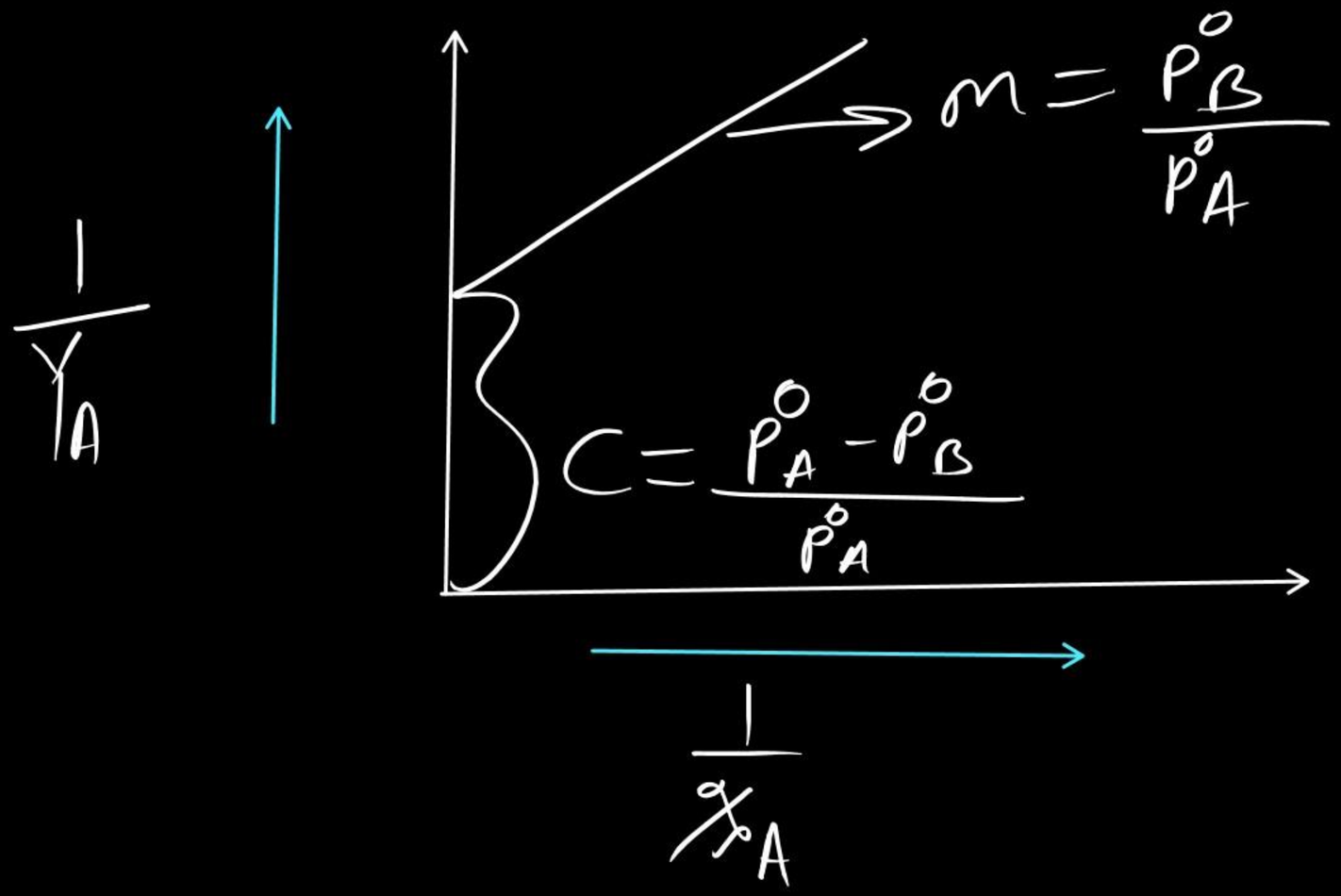
$$\frac{1}{Y_A} = \frac{P_A^\circ x_A + P_B^\circ - P_B^\circ x_A}{P_A^\circ x_A}$$

$$\frac{1}{Y_A} = \frac{P_B^\circ + (P_A^\circ - P_B^\circ) x_A}{P_A^\circ x_A}$$

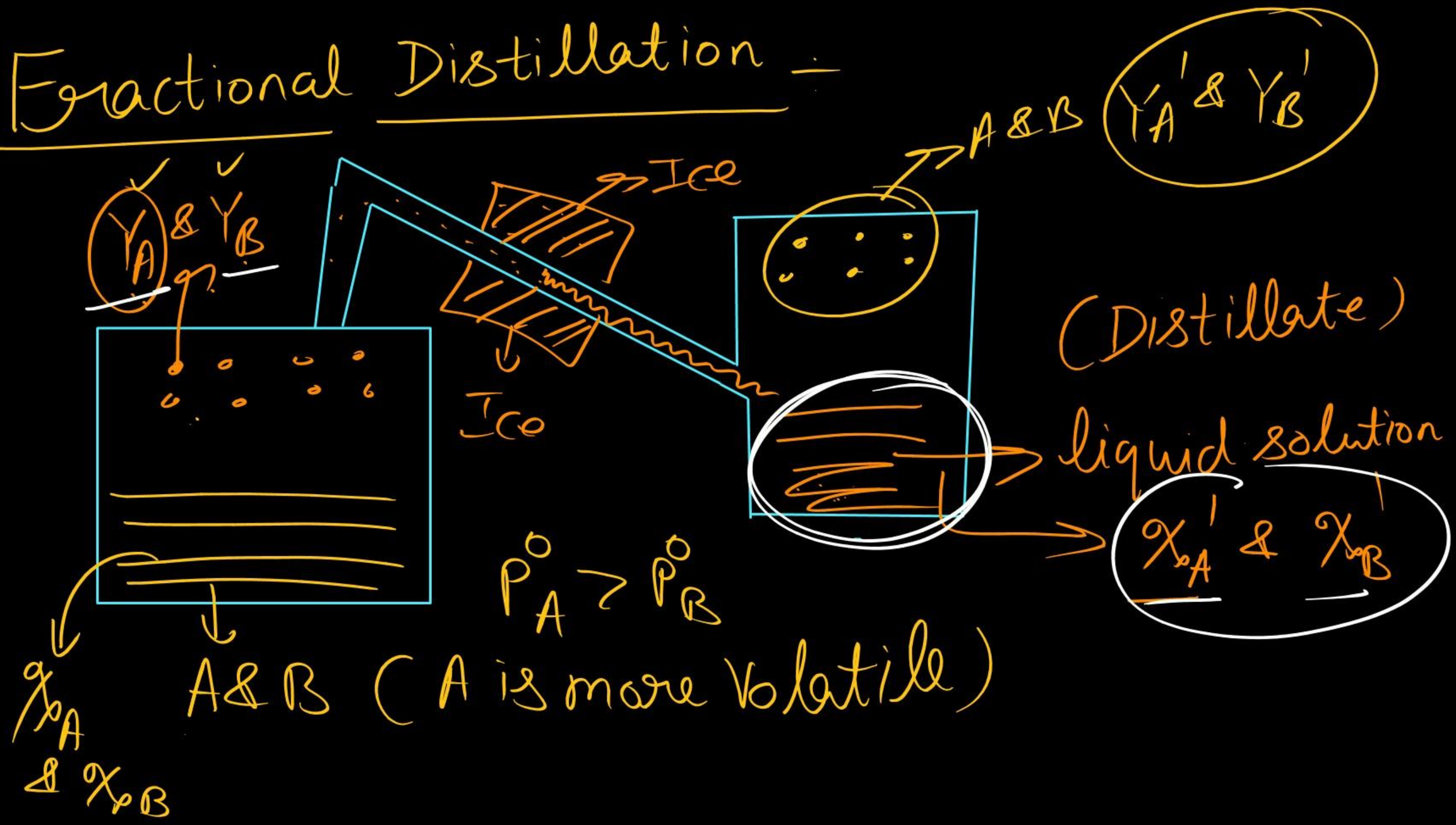
$$\frac{1}{Y_A} = \frac{P_B^\circ}{P_A^\circ x_A} + \frac{(P_A^\circ - P_B^\circ) x_A}{P_A^\circ x_A}$$

$$\frac{1}{Y_A} = \frac{P_B^\circ \times 1}{P_A^\circ x_A} + \frac{(P_A^\circ - P_B^\circ)}{P_A^\circ}$$

$$y = mx + c$$


$m = \frac{P_B^\circ}{P_A^\circ}$
$\frac{1}{Y_A}$
$C = \frac{P_A^\circ - P_B^\circ}{P_A^\circ}$
$\frac{1}{x_A}$

Fractional Distillation :-



If P_A^o = 200 mm of Hg and P_B^o = 500 mm of Hg if 2 moles of A and B moles of are added

(a) find mole fraction of A and B in vapour phase in original solution.

(b) find mole fraction of A and B in liquid phase in Ist Condensate (distillate)

(c) Find vapour pressure of solution in Ist Condensate (distillate)

Ans @ $P_A^o = 200$ mm of Hg, $n_A = 2$

$P_B^o = 500$ mm of Hg, $n_B = 2$

$$\frac{Y_A}{Y_B} = \frac{P_A^\circ \, n_A}{P_B^\circ \, n_B} = \frac{200 \times 2}{500 \times 2} = \frac{2}{5}$$

$$Y_A = \frac{2}{7}$$

$$Y_B = \frac{5}{7}$$

(b) $x_A' = \frac{2}{7}$, $x_B' = \frac{5}{7}$

© $P_S = P_A^0 \chi_A' + P_B^0 \chi_B'$

$= \left(200 \times \frac{2}{7} + 500 \times \frac{5}{7}\right)$ mm of Hg

Thank You Lakshyians