



SNS academy

**an International CBSE Finger Print School
Coimbatore**



SUBJECT – CHEMISTRY

GRADE-XII

SOLUTIONS

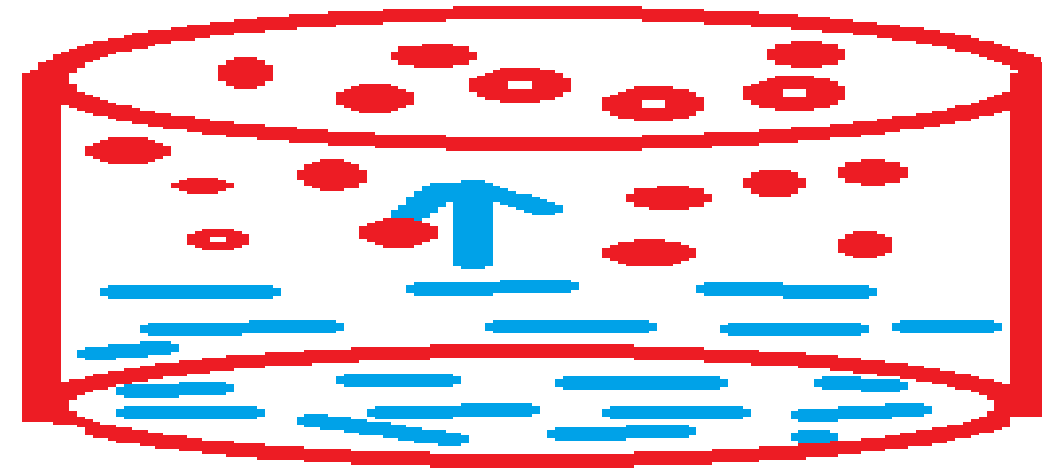
TOPIC – LATTICE ENERGY & HYDRATION ENERGY

SOLUTIONS

LATTICE ENERGY, HYDRATION ENERGY

Did you observe this?

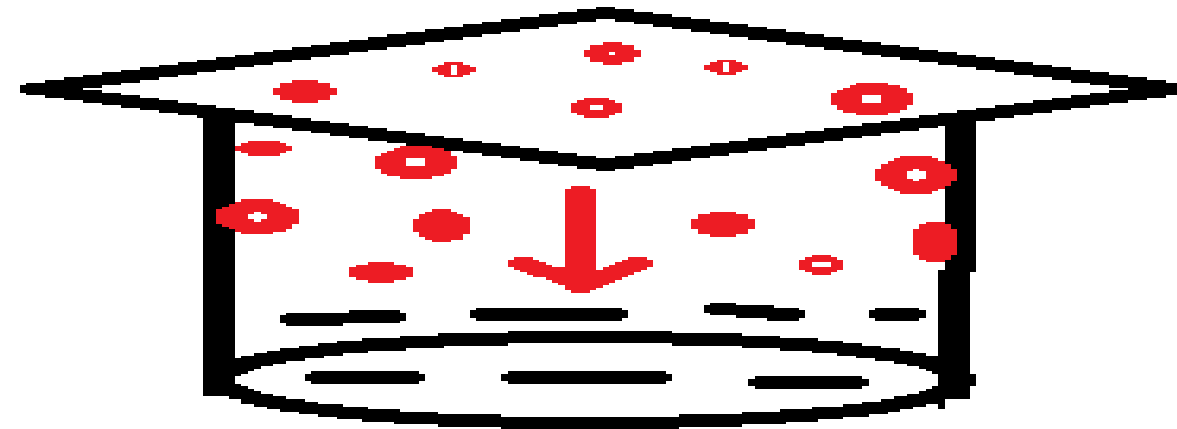
When a liquid in an open glass vessel is exposed to sky (i.e. left open without covering with a liquid) after the some time the level of liquid in vessel is found to decrease. This process is called evapouration.



Evaporation of a liquid
in an open vessel
liquid molecules escaping
into atmosphere

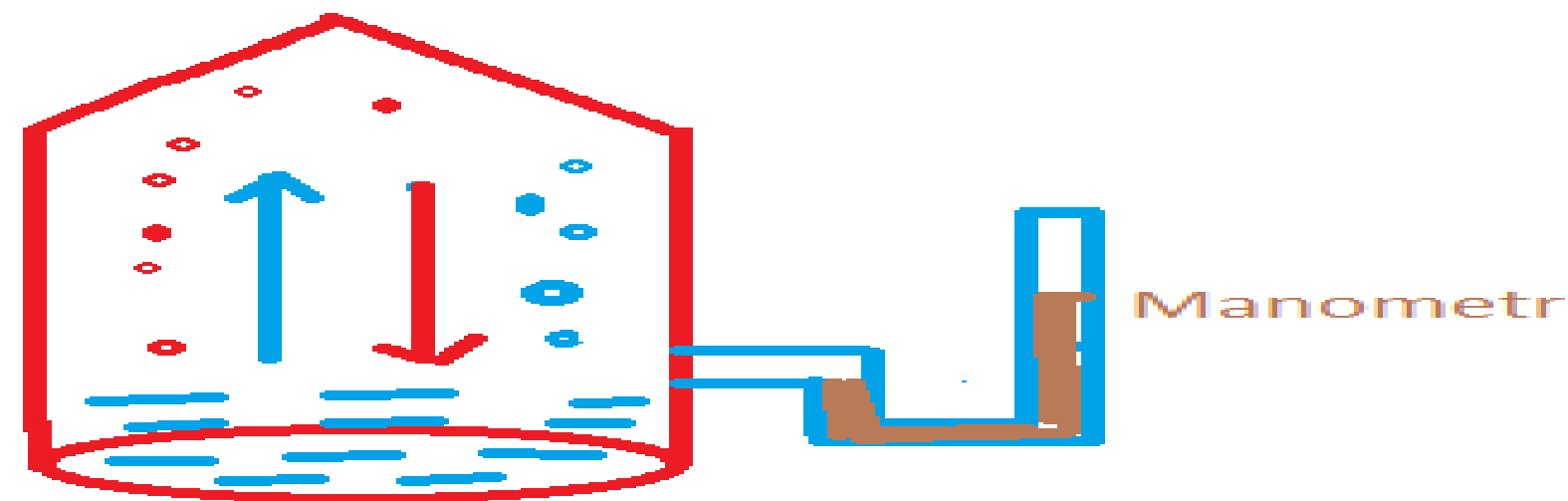
Did you observe this ?

If the liquid is placed in closed glass vessel after some time it is observed that droplets of liquid can be collected on the walls. This process is called condensation.



vessel covered with a lid
liquid droplets condense
on walls and are falling
back

- **When a vessel is connected a manometer, the liquid level in it raises indicating that there is effect of pressure as the vapour of the liquid exerts a pressure on liquid in the manometer column.**



vapor pressure
rate of evaporation=rate of condensation
manometer reads a constant value
indicating equilibrium is attained
forward process evaporation indicated by
an upward arrow and condensation by
downward arrow.

- **When a vessel is connected a manometer, the liquid level in it raises indicating that there is effect of pressure as the vapour of the liquid exerts a pressure on liquid in the manometer column.**
- **The pressure exerted by the vapour over liquid surface where there exists an equilibrium between vapour and liquid at a particular temperature is called *vapour pressure*.**

- Different liquids have **different** vapour pressures at the **same** temperature

Do you know the reason behind this?

- The attractive forces between molecules are different depending upon the nature of liquid.

MCQs

1. Lattice energy & Hydration energy are respectively

a) Endothermic , endothermic

b) exothermic, endothermic

c) exothermic, exothermic

✓ d) endothermic, exothermic

VAPOUR PRESSURE OF LIQUID SOLUTIONS

VAPOUR PRESSURE OF LIQUID SOLUTIONS:

- 1. Liquid solutions are formed when solvent is a liquid. The solute can be a gas, liquid or solid.**
- 2. The solution containing two components (Binary).**

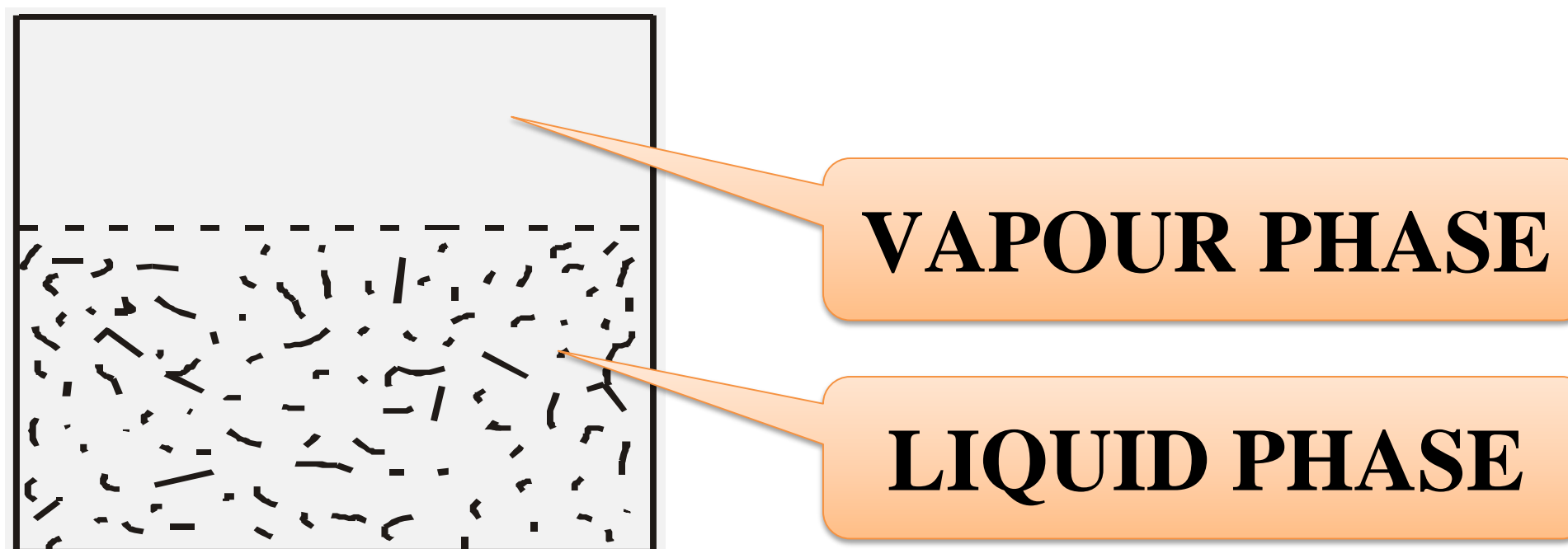
These are

i) Liquids in liquids

ii) Solids in liquids

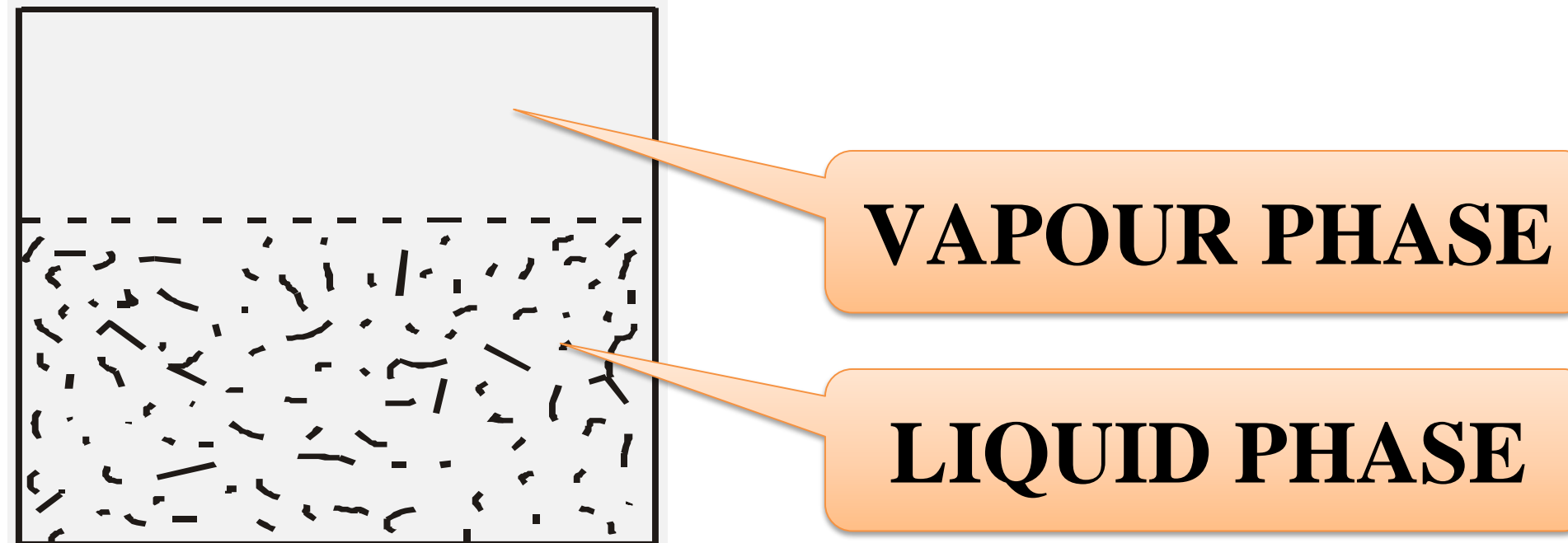
VAPOUR PRESSURE OF LIQUID - LIQUID SOLUTIONS:

- **A binary solution containing two volatile liquids.**
These are components 1 & 2 taken in a closed vessel.



VAPOUR PRESSURE OF LIQUID - LIQUID SOLUTIONS:

- Both the components vapourise and equilibrium state is established between vapour phase and liquid phase.



VAPOUR PRESSURE OF LIQUID - LIQUID SOLUTIONS:

In a binary solution of two liquids:

Let P_1 be the partial vapour pressure of the first component,
 P_2 be the partial vapour pressure of the second component and
 P_{total} be the total vapour pressure of the solution.

VAPOUR PRESSURE OF LIQUID - LIQUID SOLUTIONS:

The total vapour pressure (P_{total}) becomes equal to the sum of the partial pressures of two components 1 & 2 respectively.

$$\therefore P_{\text{total}} = P_1 + P_2$$

NOTE

The partial pressures are related to mole fractions X_1 and X_2 of the two components 1 and 2 respectively.

MCQs

1.If P_1, P_2, P_3 are the partial pressures then $P_{\text{total}} =$

a) $P_{\text{total}} = P_1 + P_2 + P_3$

b) $P_{\text{total}} = P_1 - P_2 + P_3$

c) $P_{\text{total}} = P_1 + P_2 - P_3$

d) $P_{\text{total}} = \frac{P_1 + P_2}{P_3}$



RAOULT'S LAW (PART-I)

Raoult's law:

Francois Marte Raoult (1886) gave the quantitative relationship between partial pressure and molefraction .

It states that “the partial vapour pressure of each component in the solution of volatile liquids is directly proportional to molefraction of it in the solution”.

Raoult's law:

$$\therefore p_1 \propto x_1 \quad \& \quad \therefore p_2 \propto x_2$$

x_1 & x_2 are mole fractions of 1 & 2 components

$$\therefore p_1 = p_1^0 \cdot x_1 \rightarrow 1$$

$$p_2 = p_2^0 \cdot x_2 \rightarrow 2$$

p_1^0 & p_2^0 are vapour pressure of pure components 1 & 2 respectively.

Raoult's law:

According to Dalton's Law of partial pressures "the total pressure over the solution phase in the container will be the sum of the partial pressures of the components of the solution".

Therefore, the final relation

$$\therefore P_{\text{total}} = p_1 + p_2$$

Raoult's law:

substitute the values of p_1 and p_2

$$\therefore P_{\text{total}} = p_1^0 \cdot x_1 + p_2^0 \cdot x_2$$

Sum of the Mole fraction of $x_1 + x_2 = 1$

$$x_1 = (1 - x_2)$$

$$\therefore P_{\text{total}} = (1 - x_2) p_1^0 + p_2^0 \cdot x_2$$

$$= p_1^0 - x_2 \cdot p_1^0 + x_2 p_2^0$$

$$\therefore P_{\text{total}} = p_1^0 + x_2(p_2^0 - p_1^0)$$

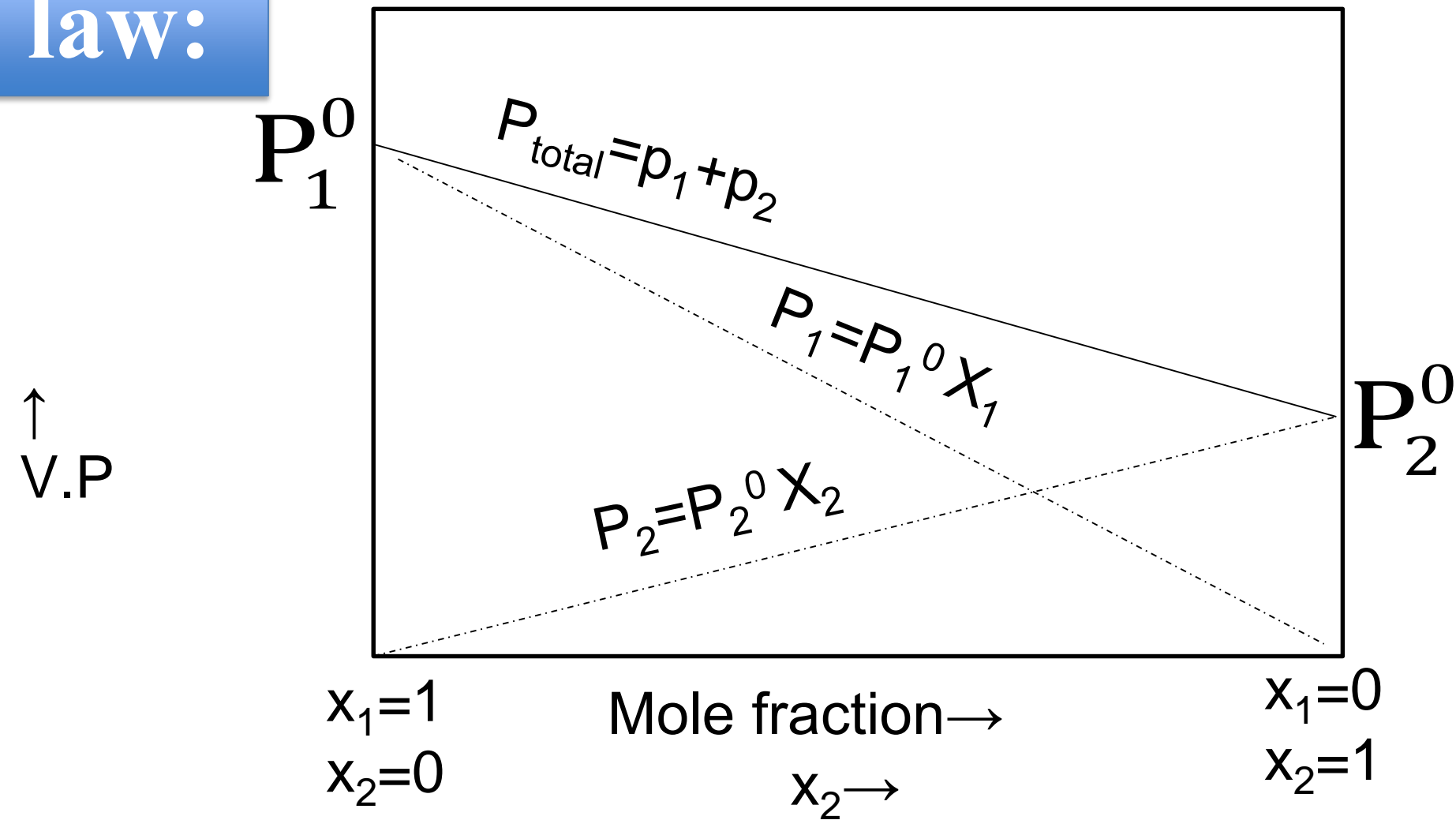
Raoult's law:

From the above equations the following conclusions can be drawn:

- (a) Total vapour pressure over the solution can be related to the mole fraction of any component.**
- (b) Total vapour pressure over the solution varies linearly with the mole fraction of any component (1 or 2).**
- (c) Depending on the vapour pressure of the pure components 1 & 2, total vapour pressure over the solution either decreases or increases with the increase of the mole fraction of either component (1 or 2).**



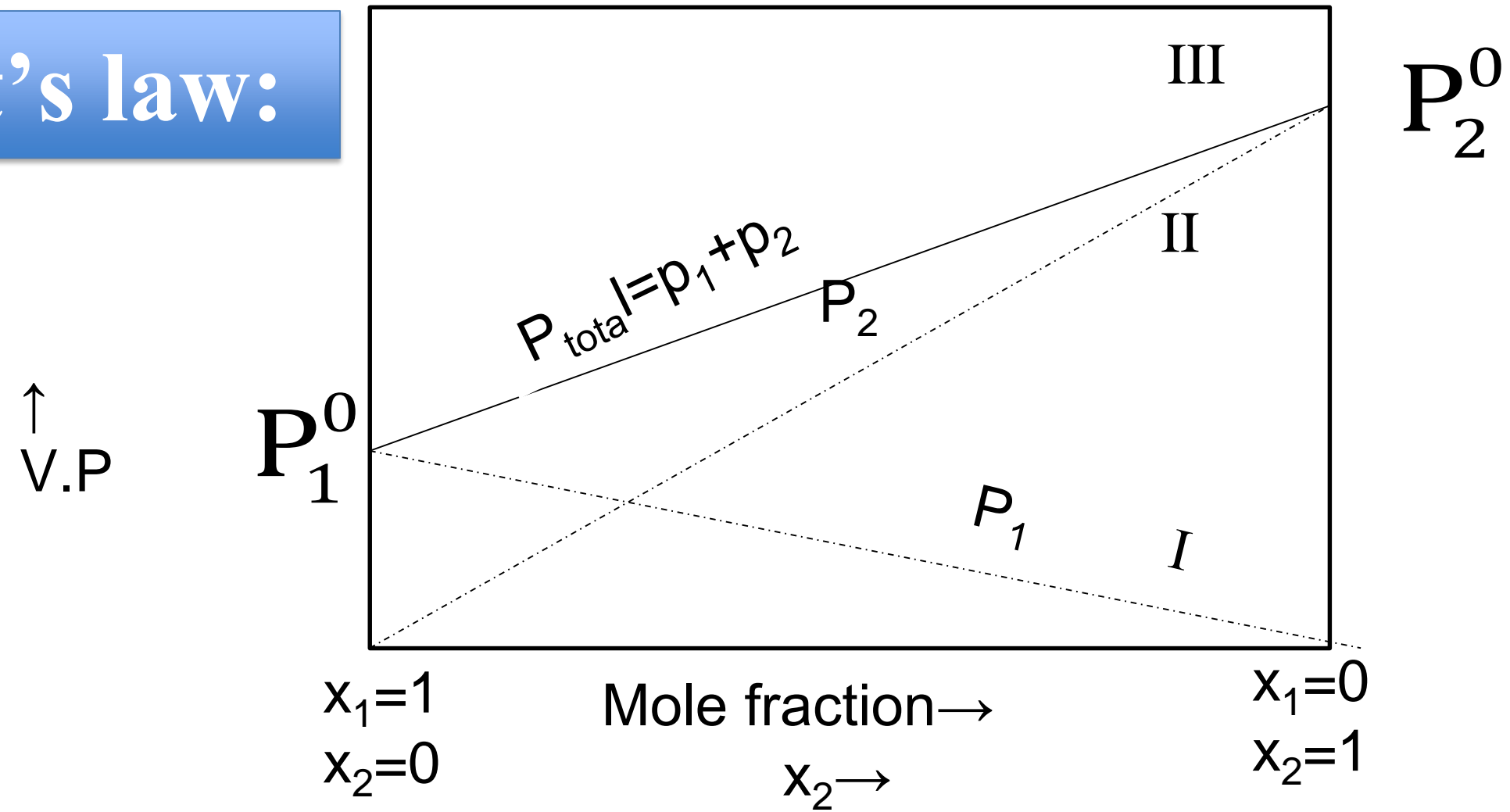
Raoult's law:



x_1 =mole fraction of solvent
 x_2 =mole fraction of solute

- The graphical representation of vapour pressure versus mole fraction of an ideal solution at constant temperature.

Raoult's law:



- The dotted lines I & II represent the partial pressure of the components.

- The thick line curve represents the total vapour pressure of the components..
- The minimum value of the P_{total} is equal to P_1^0 and the maximum value is equal to P_2^0 that is (i.e) $P_1^0 < P_2^0$.
- Using the Dalton's Law of partial pressure.

Partial pressure (P_i) = Mole fraction (X_i) x Total pressure (P).

$$\therefore P_i = x_i \cdot p$$

Very important point

The composition of vapour phase in equilibrium with the solution is determined by the partial pressures of the components. If y_1 and y_2 are the mole fractions of the components 1 and 2 respectively in the vapour phase then, using Dalton's law of partial pressures.

$$P_1 = y_1 \cdot P_{\text{total}}$$

$$P_2 = y_2 \cdot P_{\text{total}}$$

Raoult's law a special case of Henry's Law

“The partial pressure of the volatile component or gas is directly proportional to its mole fraction in solution.

$$\therefore p \propto x$$

$$\therefore p = K_H \cdot x$$

p = partial pressure of the gas

x = mole fraction of its solution

K_H = Henry's law constant

Which K_H becomes equal to P_i^0

MCQs

1. Rate of evaporation depends upon

- a) Nature of liquid**
- b) Surface area of the liquid**
- c) temperature**
- d) Flow of air current over the surface**

The correct answer is

1) a,b only 2) b,c only 3) a,b and c only 4) a,b,c and d





RAOULT'S LAW (PART-II)

Q) Vapour pressure of chloroform(CHCl_3) and dichloro methane (CH_2Cl_2) at 298 K are 200 mm and 415 mm of Hg respectively. Calculate the v.p of the solution prepared by mixing 25.5 g of CHCl_3 and 40 g of CH_2Cl_2 at 298K.

SOLUTION

$$\text{Molar mass of } \text{CHCl}_3 = 119.5 \text{ g}$$

$$\text{Molar mass of } \text{CH}_2\text{Cl}_2 = 85 \text{ g}$$

$$\begin{aligned} \text{No. of moles of } \text{CHCl}_3 &= \frac{\text{weight}}{\text{Molar mass}} & \text{No. of moles of } \text{CH}_2\text{Cl}_2 &= \frac{\text{weight}}{\text{Molar mass}} \\ &= \frac{25.5}{119.5} = 0.213 & &= \frac{40}{85} = 0.47 \end{aligned}$$

Q) Vapour pressure of chloroform(CHCl_3) and dichloro methane (CH_2Cl_2) at 298 K are 200 mm and 415 mm of Hg respectively. Calculate the v.p of the solution prepared by mixing 25.5 gms of CHCl_3 and 40 gms of CH_2Cl_2 at 298K.

SOLUTION

$$\therefore \text{Total no. of moles} = 0.213 + 0.47$$

$$= 0.683 \text{ moles}$$

$$\text{Mole fraction of } \text{CHCl}_3 = \frac{0.213}{0.683}$$

$$= 0.312$$

Q) Vapour pressure of chloroform(CHCl_3) and dichloro methane (CH_2Cl_2) at 298 K are 200 mm and 415 mm of Hg respectively. Calculate the v.p of the solution prepared by mixing 25.5 gms of CHCl_3 and 40 gms of CH_2Cl_2 at 298K.

SOLUTION

$$\begin{aligned}\text{Mole fraction of } \text{CH}_2\text{Cl}_2 &= \frac{0.47}{0.683} \\ &= 0.688\end{aligned}$$

Q) Vapour pressure of chloroform(CHCl_3) and dichloro methane (CH_2Cl_2) at 298 K are 200 mm and 415 mm of Hg respectively. Calculate the v.p of the solution prepared by mixing 25.5 gms of CHCl_3 and 40 gms of CH_2Cl_2 at 298K.

SOLUTION

using equation

$$\therefore P_{\text{total}} = p_1^0 + (p_2^0 - p_1^0) x_2$$

$$P_{\text{total}} = 200 + (415 - 200) \times 0.688$$

$$= 200 + 147.9$$

$$= 347.9 \text{ mm Hg}$$

VAPOUR PRESSURE OF SOLUTIONS OF SOLIDS IN LIQUIDS

VAPOUR PRESSURE OF SOLUTIONS OF SOLIDS IN LIQUIDS

Vapour Pressure:

- The pressure exerted by the vapour molecules of a liquid when they are in equilibrium with the liquid of a given temperature is called *Vapour pressure* of the liquid at that temperature.
- Vapour pressure of the liquid is measured by barometric method.

VAPOUR PRESSURE OF SOLUTIONS OF SOLIDS IN LIQUIDS

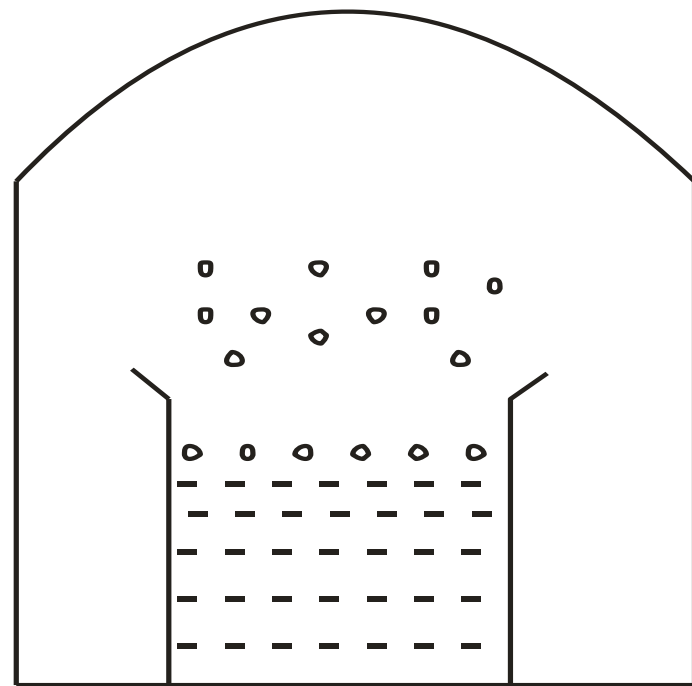
Vapour Pressure:

- **The vapour pressure of the solution is always less than that of pure solvent.**
- **In solution some of the non-volatile solute molecules occupies the surface of the solution. Therefore the fraction of the surface covered by the solvent molecules get reduced.**

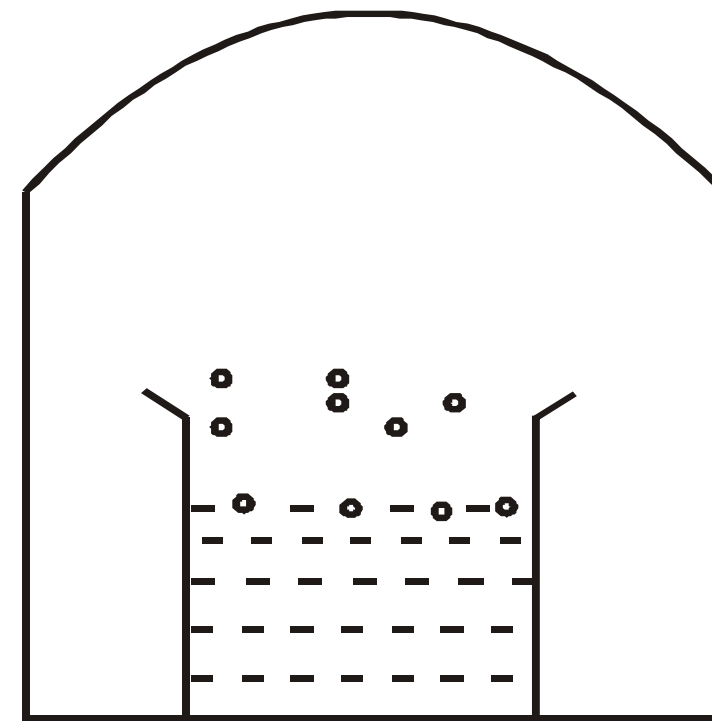
VAPOUR PRESSURE OF SOLUTIONS OF SOLIDS IN LIQUIDS

Vapour Pressure:

- **The vapour pressure of the solution is always less than that of pure liquid.**



PURE SOLVENT



SOLUTE+SOLVENT=SOLUTION

VAPOUR PRESSURE OF SOLUTIONS OF SOLIDS IN LIQUIDS

Vapour Pressure:

- **The decrease in a vapour pressure of solvent depends on the quantity of non-volatile solute present in the solution.**

VAPOUR PRESSURE OF SOLUTIONS OF SOLIDS IN LIQUIDS

Vapour Pressure:

e.g.-

One mole of urea is dissolved in 1 kg of water exerting vapour pressure is same as that of one mole of sucrose is dissolved in one kg of water at the same temperature.

VAPOUR PRESSURE OF SOLUTIONS OF SOLIDS IN LIQUIDS

Vapour Pressure:

- Raoult's law is in general “for any solution the partial vapour pressure of each volatile component in the solution is directly proportional to the mole fraction.”

$$\therefore P_i \propto x_i \text{ and } P_i = p_1^0 \cdot x_i$$

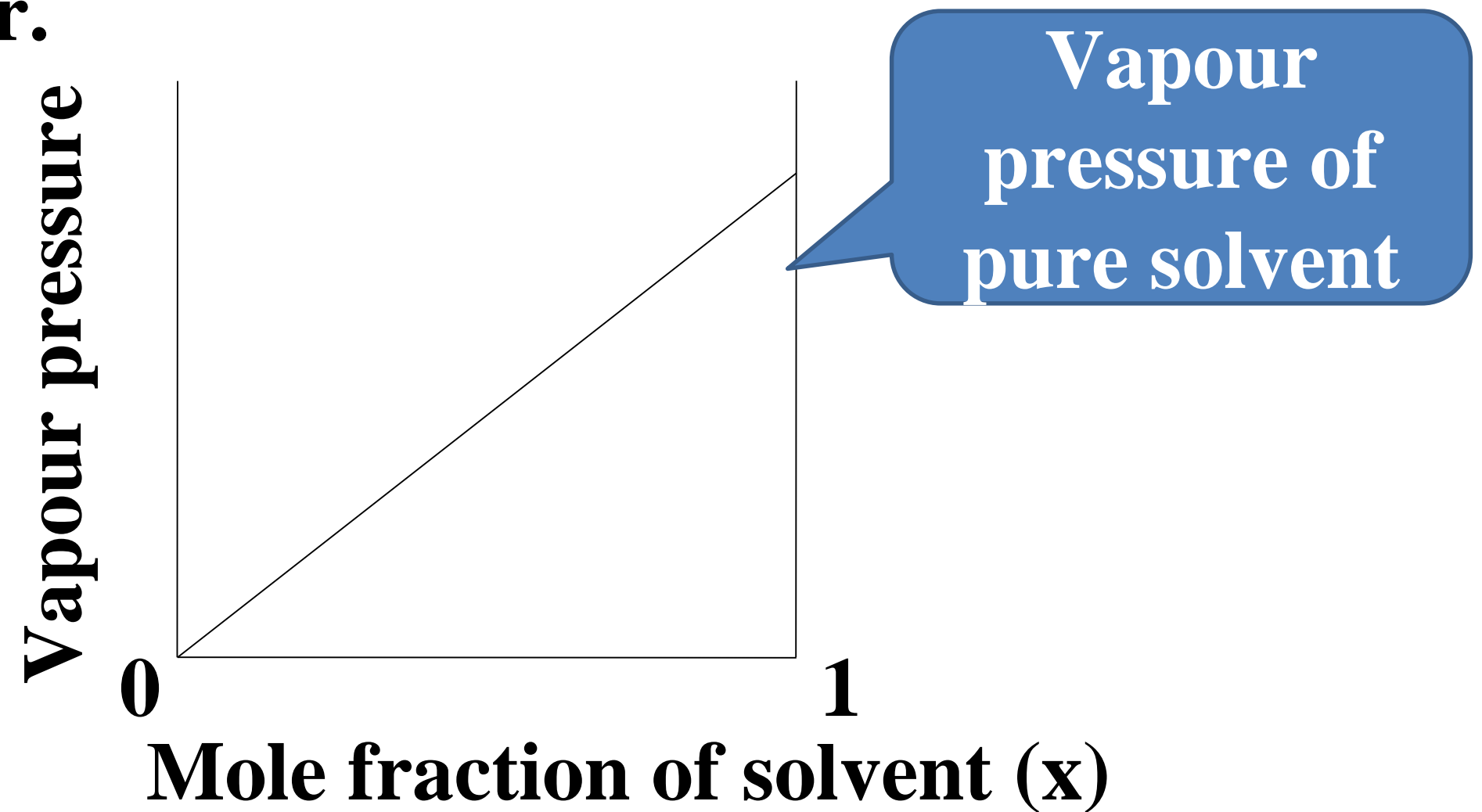
$$P_1^0 = \text{Proportional constant.}$$

It is equal to vapour pressure of pure solvent

VAPOUR PRESSURE OF SOLUTIONS OF SOLIDS IN LIQUIDS

Vapour Pressure:

- Plot a graph between vapour pressure and mole fraction of the solvent and the shape of curve is linear.



MCQs

1. As temperature increases , vapour pressure of a liquid

a) Increases linearly

b) Decreases linearly

 **c) Increases exponentially**

d) Decreases exponentially

