Engineering Chemistry
General Revision on solution

Part 1

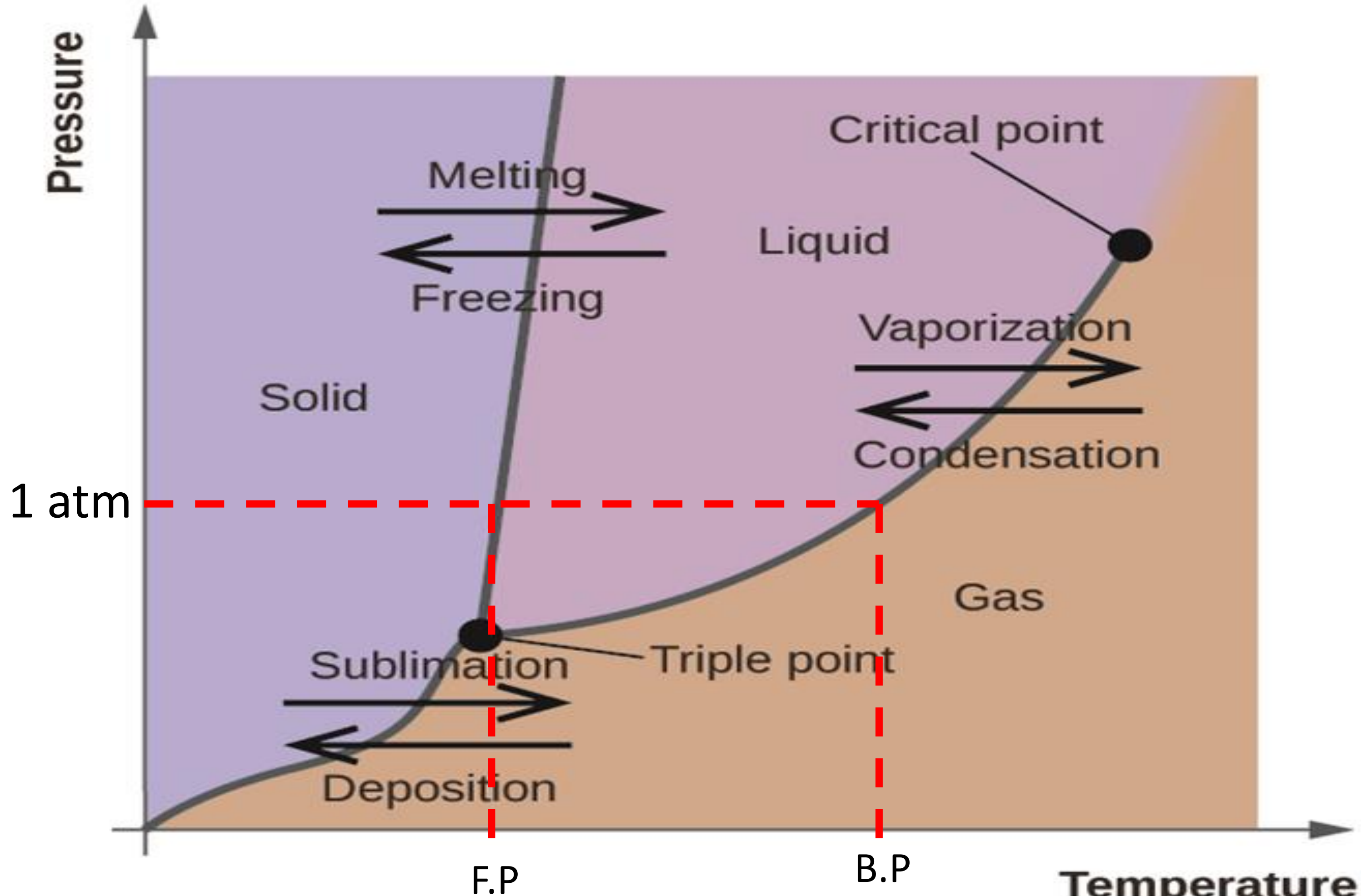
Assoc. Prof. Dr. Hanaa Abulmagd

http://bu.edu.eg/staff/hanaahmed3-courses/14802/files

Find also Problems Idea 2020, Answer of practices, cement

Chapter 1: Solutions

State of matter - Phase transition - Phase Diagram of a matter

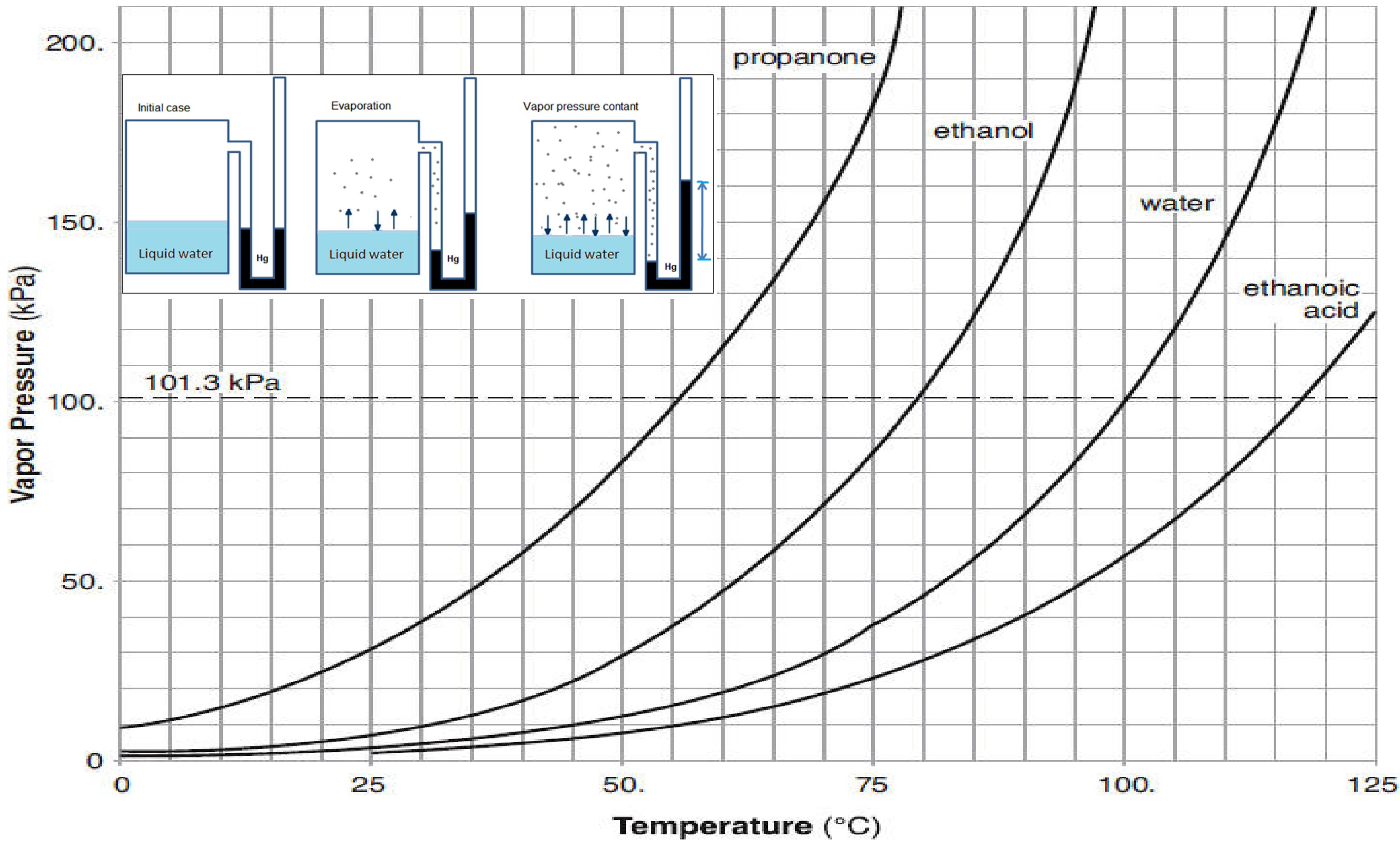


Phase Diagram of a matter

Vapor pressure of a volatile liquid page 27

* Temperature ↑ V.P.↑

** Molecular force ↓ volatility ↑ V.P. ↑ B.P. ↓



Solubility Factors

Mixtures

{Definitions (pages: 18,19, 20)}

Homogeneous (solutions)

heterogeneous

gas in liquid

- ✓Factors affecting their solubility
- ✓**Hennery's law (page 32)**
- ✓imitations of the law (**33**)

liquid in liquid

Their types:

- ✓Completely immiscible
- ✓Partially miscible
- ✓**Completely miscible:**
- ❖ Raoult's law
- ✓ Distillation

solid in liquid

- ✓Factors affecting their solubility
- ✓**Colligative properties:**
- - V.P ↓, B.P↑, F.P ↓
- - Osmotic pressure:
- ✓ Reverse osmosis (water treatment)

Solubility: (page 21) **Likes dissolve likes**

- Factors affecting solubility extent: T, P, - Polarity(likes dissolve likes rule)
- Factors affecting solubility rate: particle size of the solute - presence of solubilizing agents, mixing way

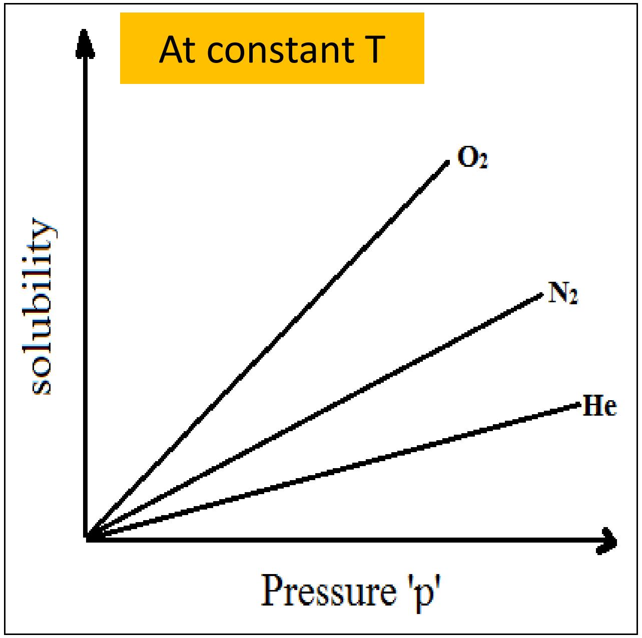
Factors affecting the solubility of gas in liquid solutions

✓ **Pressure**

✓ **Temperature**

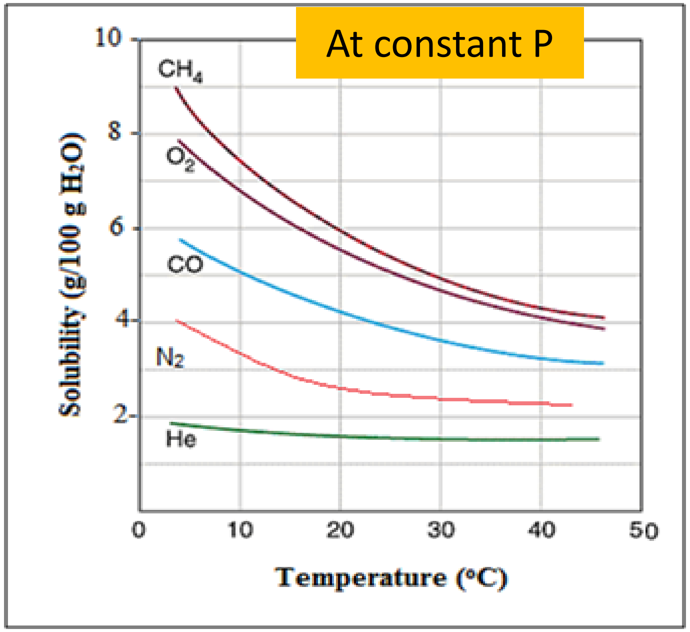
✓ **Nature of gas & liquid** (no more details)

At constant T



Hennery's law

At constant P



T ↑ solubility ↓

Kinetic energy of gas molecules ↑ as temperature ↑ so, gas molecules have the ability to escape from solution, and hence the its solubility ↓

Hennery's law: m = k P { K = Hennery's constant, P = pressure of gas}

m: solubility of gas in liquid = mass of a gas in 100 mL (or 100 g) of a liquid at certain temp. $\mathbf{m_1/m_2 = P_1/P_2}$

Solutions of liquid in liquid

{Definitions (pages: 35)}

Completely miscible

alcohols with water

two liquids mix in all proportions

Completely immiscible

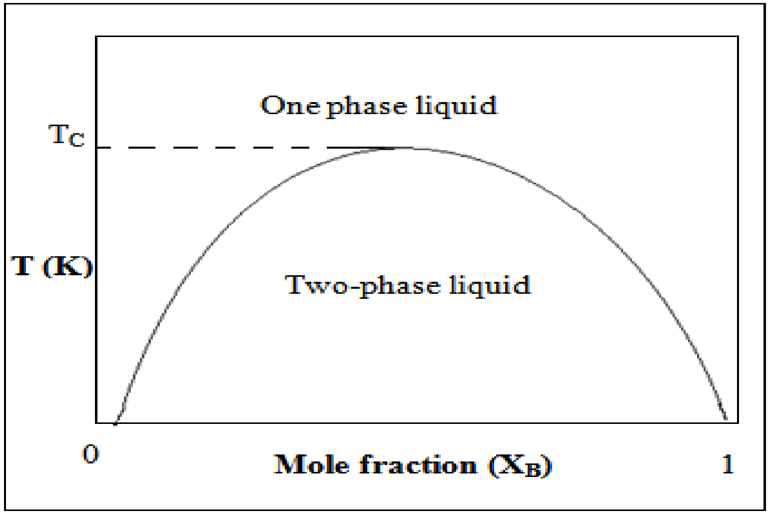
chlorobenzene and water

two liquids not mixed at all

Partially miscible

ether with water

two liquids mix in limited proportions only



Solutions of liquid in liquid

{Definitions (pages: 35)}

Completely miscible liquids

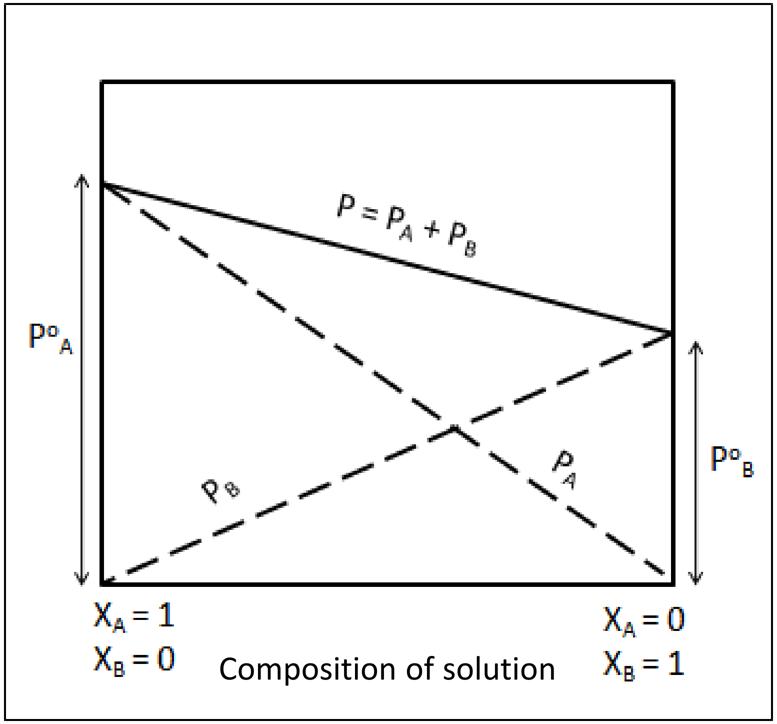
Ideal solutions (*Raoult's Law*) (page 37)

$$P_A = X_A P^0_A \quad , \qquad P_B = X_B P^0_B$$

$$P_{soln} = P_t = X_A P^0_A + X_B P^0_B$$

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

$$x_A + x_B = 1$$



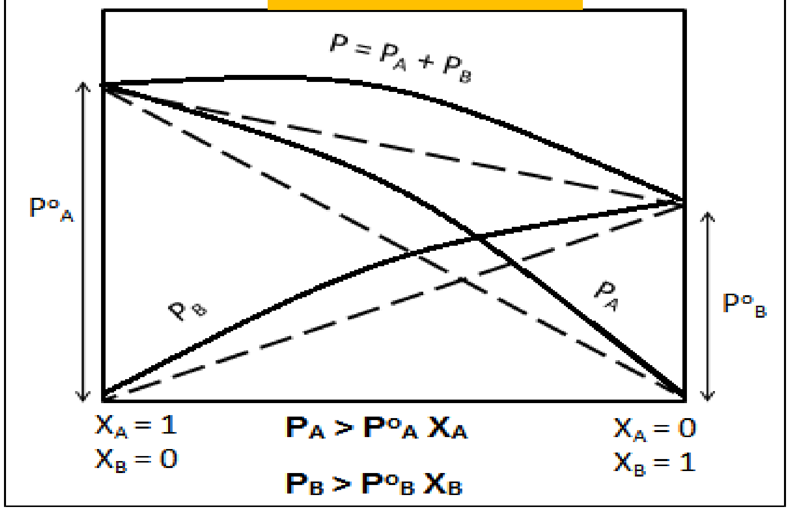
Examples: (benzene with toluene),
(n-hexane with n-heptane)

Characteristics of Ideal solutions…page 37:

- ✓ A-A, B-B are not affected by mixing
- ✓ $\Delta V_{mix} = 0$
- ✓ $\Delta H_{mix} = 0$
- ✓ Their V.P, ρ, B.P are intermediates between those of the pure liquids.

Deviation from Ideality

+ve deviation



Measured pressure > calculated by Raoult's Law

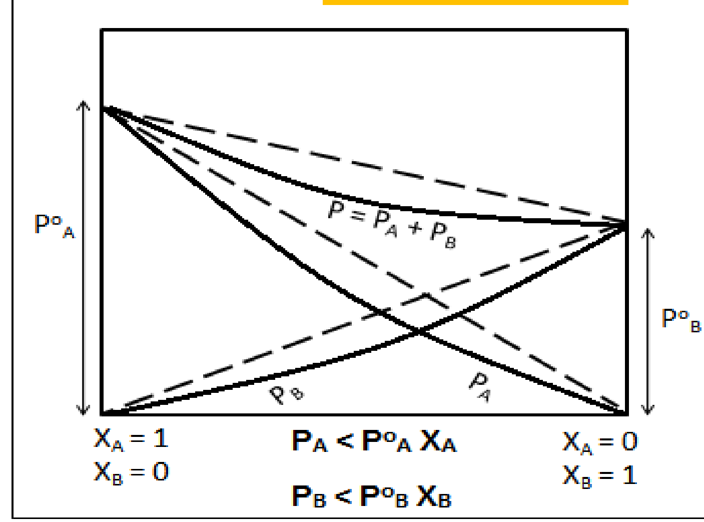
$P_A > P^0_A\, x_A$ and $P_B > P^0_B\, x_B$

A-B attraction forces **<** A-A, B-B

$\Delta H_{mix} < 0$, $\Delta v_{mix} > 0$

Ex. (methanol with water), (acetone with ethanol)

- ve deviation



Measured pressure < calculated by Raoult's Law

$P_A < P^0_A\, x_A$ and $P_B < P^0_B\, x_B$

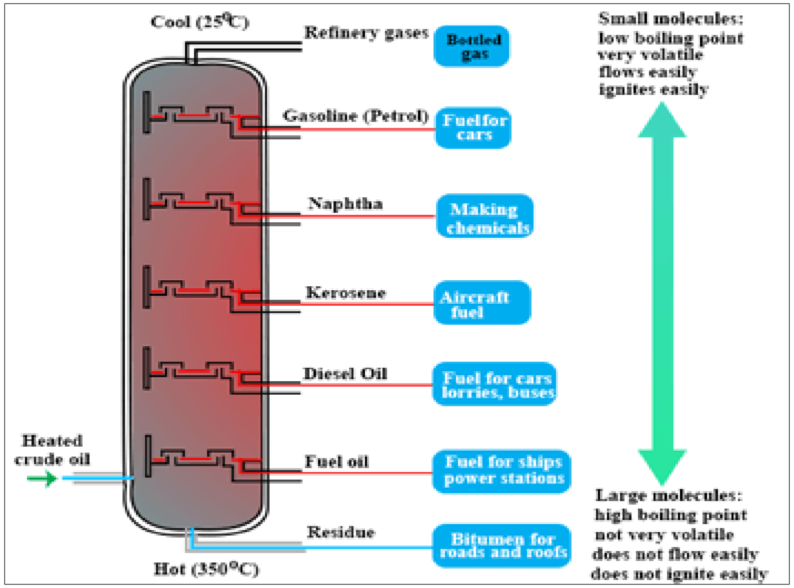
A-B attraction forces **>** A-A, B-B

$\Delta H_{mix} > 0$, $\Delta v_{mix} < 0$

Ex. (HCl with water), (nitric with water)

Application of Raoult's law: distillation of binary miscible liquids

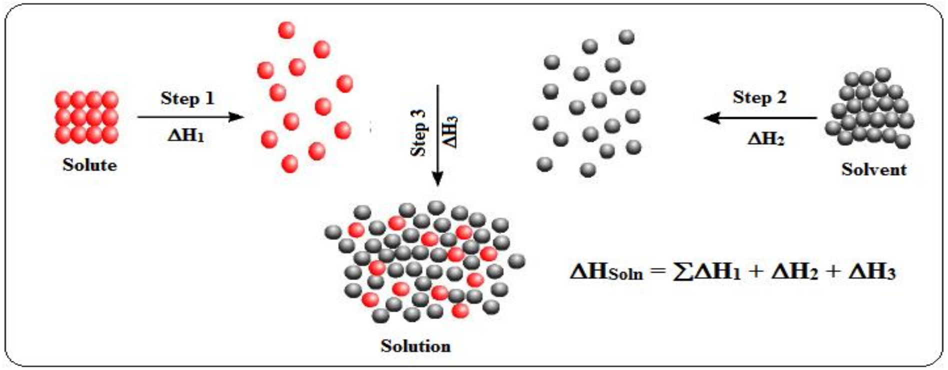
- **Distillation:** is a process by which a mixture of liquids having different boiling points is separated into its components.
- 1- Simple distillation: by heating, the most volatile liquid comes out first (wide different B.P > 100^{o}C). Applied in laboratory
- b) *2*- Fractional distillation*:* different B.P < 100^{o}C. Applied in industry by using fractional distillation column

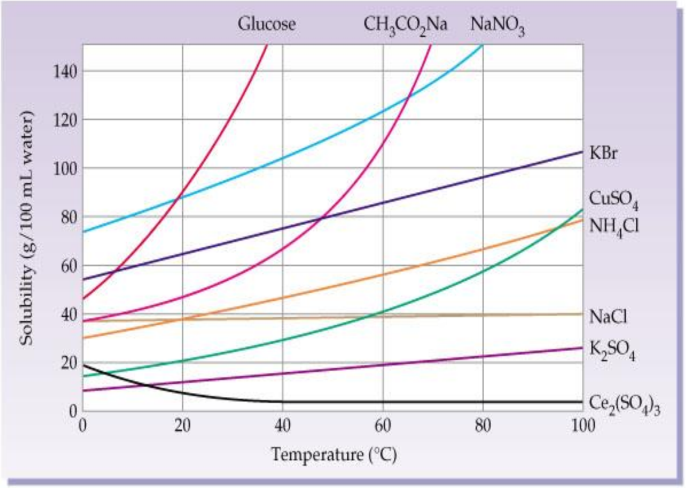


Factors affecting the solubility of solid in liquid solutions

✓Solute-solvent interaction

Temperature





solute-solvent interaction **>>** solute-solute or solvent-solvent interaction, solubility ↑

How does the temperature affect the solubility of solid in liquid solutions?????????

Solubility of solid in liquid solutions is greatly affected by temp change.

- In most, solubility increases as temp increases.
- Few cases, solubility decreases as T increases such as $Ce_2(SO_4)_3$.
- Solubility of some solutes changed strongly with temp (such as glucose).
- Solubility of other solutes have little variation with temp (such as NaCl).

Colligative properties

Lowering in V.P

$\Delta P = X_B \cdot P^o_A$??

$P_A = X_A \cdot P^o_A$

$P_{soln} = X_A \cdot P^o_A$

lowering in V.P:

$= \Delta P = P^o_A - P_{soln}$

$= P^o_A - X_A \cdot P^o_A$

$= P^o_A (1 - X_A)$

$\Delta P = X_B \cdot P^o_A$

Elevation in B.P

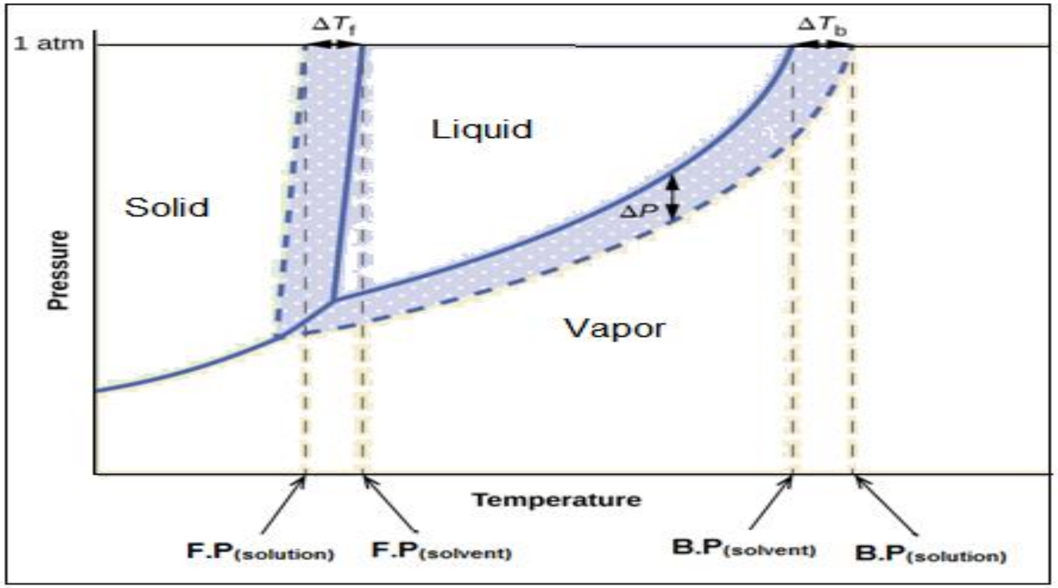
$\Delta T_b = K_b \cdot m \cdot i$

B.P(solution)=B.P(solvent)+ΔT_b

Depression in F.P

$\Delta T_f = K_f \cdot m \cdot i$

F.P(solution)=F.P(solvent)+ΔT_f



molality = m = n_{solute} / $mass_{(solvent)}$ (kg), Apply in ΔT_b or ΔT_f , Use **K** for solvent

for non-electrolyte, $i = 1$, for electrolyte, i = number of ions, For ex. i of NaCl = 2

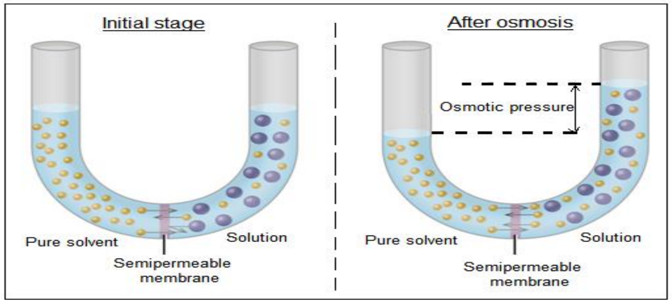
Osmosis, Osmotic Pressure, reverse osmosis, water treatment

Osmosis: the process by which solvent molecules pass through a "semi-permeable membrane", from dilute solution to the concentrated one.

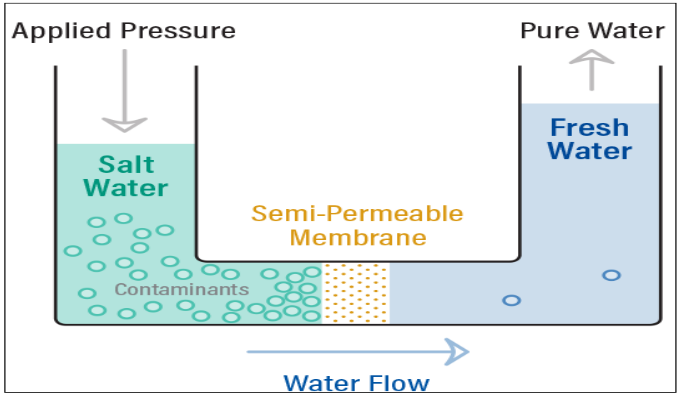
Semi-permeable membranes: natural or synthetic materials, allow only the pass of small molecules such as "solvents".

Osmotic pressure: the pressure that applied to the more concentrated solution to prevent the flow of solvent to the solution. $\pi = M . R . T$

since: **π**: osmotic pressure (atm), **M**: molarity of solution, **R**: universal gas constant = 0.0821 (L . atm/mol. K), **T**: Absolute temp = t + 273



Reverse Osmosis: the process by which a greater pressure is applied so that the water molecules can go from the more concentrated solution to a less concentrated one (pure water).



Purification of water by the reverse osmosis is a way of **desalination** method in which ions, molecules and larger particles can be removed through a semi-permeable membrane from drinking water.

Problems in solution: see all files in my webpage (Idea and answers of practices

1- Predict whether each of the following solid compounds is soluble or insoluble in water:

- (a) Fructose, $C_6H_{12}O_6$ (b) lithium carbonate, Li_2CO_3
- (c) Naphthalene, $C_{10}H_8$ (d) Anthracene, $C_{14}H_{10}$
- (e) Cupric sulfate, $CuSO_4$ (f) lactic acid, $C_3H_6O_3$

2- Predict whether each of the following solvents is miscible or immiscible with water:

- (i) Methanol, CH_3OH (ii) Toluene, C_7H8
- (iii) Methylene chloride, CH_2Cl_2 (iv) Glycerin, $C_3H_5(OH)_3$

1- Based on the rule "like dissolves like, and since H_2O is polar , so only polar or ionic solids will dissolve in water, thus,

a) , (f) are polar, i.e., they are soluble in water

(b) , (e) are ionic , i.e., they are soluble in water

(c) , (d) are nonpolar, i.e., they are not soluble in water.

2- based on the rule "likes dissolve likes" that controls the solution formation.

- i) Methanol and water are polar, so they are miscible.
- ii) Toluene and water are non-polar, so they are immiscible.
- iii) Methylene chloride and water are non-polar, so they are immiscible.
- iv) Glycerin and water are polar, so they are miscible.

من ملخص الاسمنت المرفوع على صفحتي

cement

- **Definitions:** Building material & Types - Pozzolanic activity – Cement
- **Chemical composition of cement (its oxides and their %)**
- **Raw materials in cement & its manufacture**
- **Functions of Cement Constituents** **Or** **Functions of Cement compounds**
- **Chemical reactions during the cement hydration**
- **Environmental impacts of cement industry**:

Emissions to air **or** **(B) Noise emissions & Ways to reduce each .**

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