Chapter 2 - Solutions

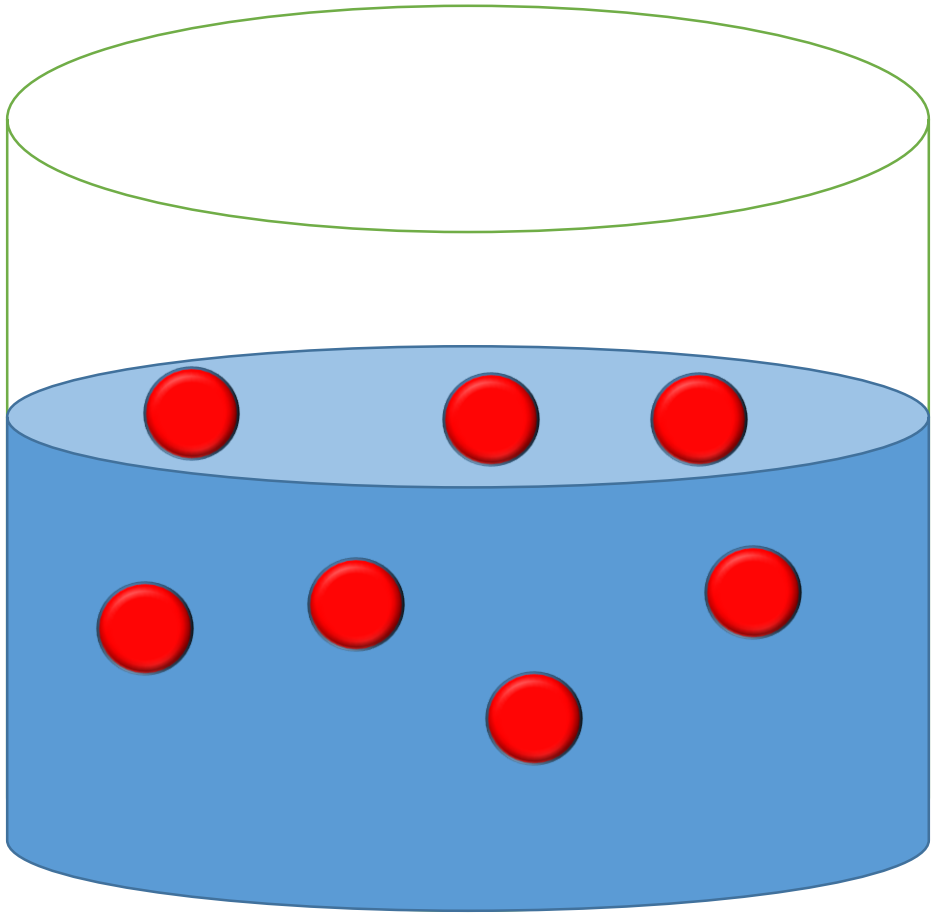
Homogenous mixture of two or more Components. And components gets uniformly mixed

Homogeneous mixture : Sugar + water

Components gets uniformly mixed

This mixture is Called as true solution

Heterogeneous mixture : Sand + water



Components are not uniformly mixed and hence it is not a true solution

Binary solutions

Binary solution consists of two components only

Solute **Solvent**

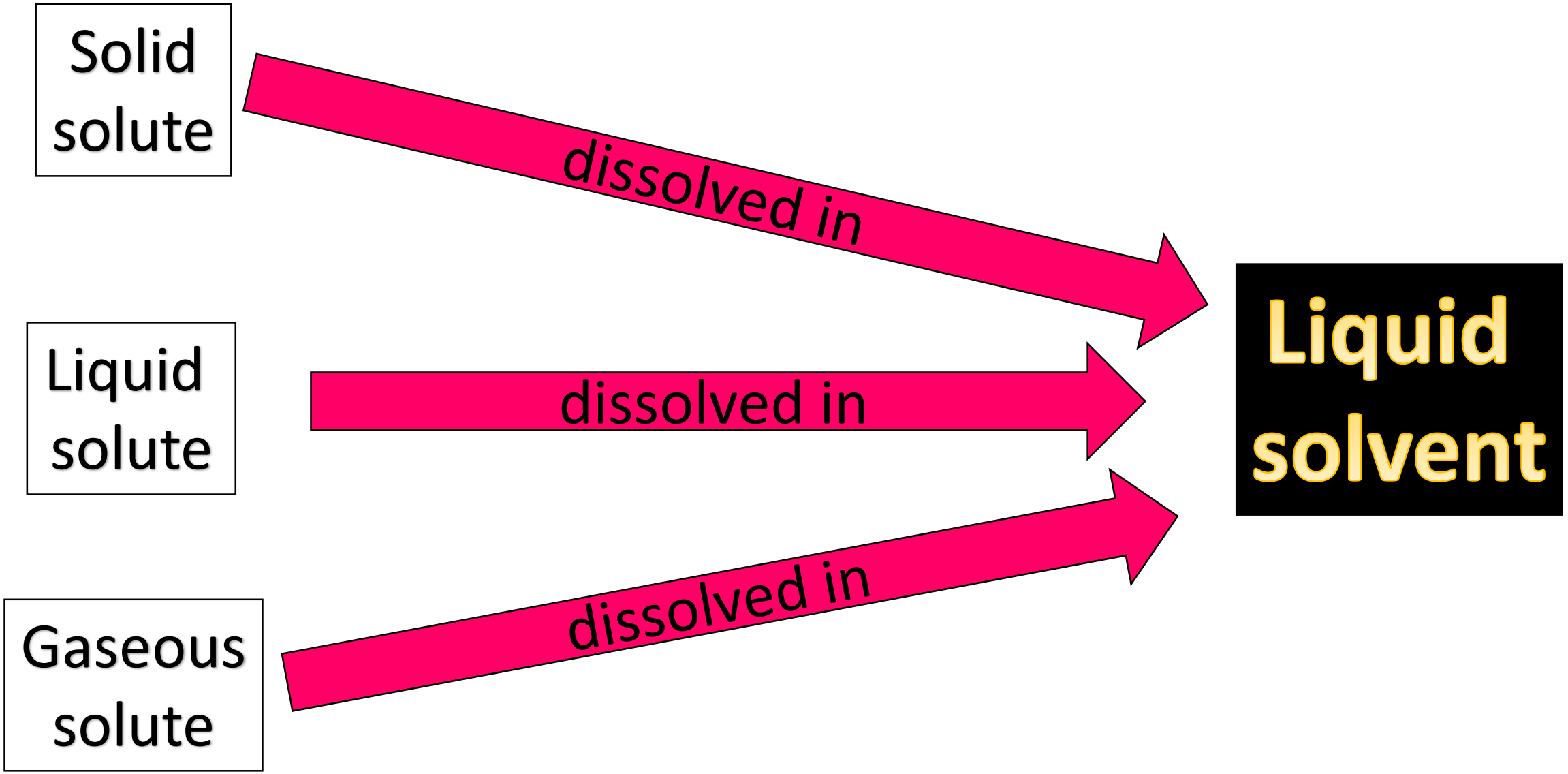
Solute is the component present in less quantity

Solvent is the component present in more quantity

Solute can be solid , liquid or gas and
Similarly solvent can be solid liquid or gas

Solution may involve any combination of these three states of solute and solvent

Total 9 types of solutions are possible based on states of solute and solvent


Solid solute
dissolved in
Liquid solute
dissolved in
Gaseous solute
dissolved in
Liquid solvent

Sr No	Solute	Solvent	Examples
1	Solid	Solid	Alloy of one metal in another metal
2	Liquid	Solid	Amalgam alloy (mercury in another metal)
3	Gas	Solid	H_2 in palladium
4	Solid	Liquid	Sugar in water
5	Liquid	Liquid	Ethanol in water
6	Gas	Liquid	O_2 in water , CO_2 in water
7	Solid	Gas	Iodine in air
8	Liquid	Gas	Chloroform in air
9	Gas	Gas	Air (O_2 , N_2 , CO_2 etc)

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7	Solid	Gas	Iodine in air
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2.3 Capacity of solution to dissolve solute

Chemists need to know the capacity of solutions to dissolve a solute. Suppose that a solute is added to a solvent. It dissolves readily at first. The dissolution then slows down as more solute is added. If we continue the addition of solute, the dissolution stops.

A dynamic equilibrium can be reached

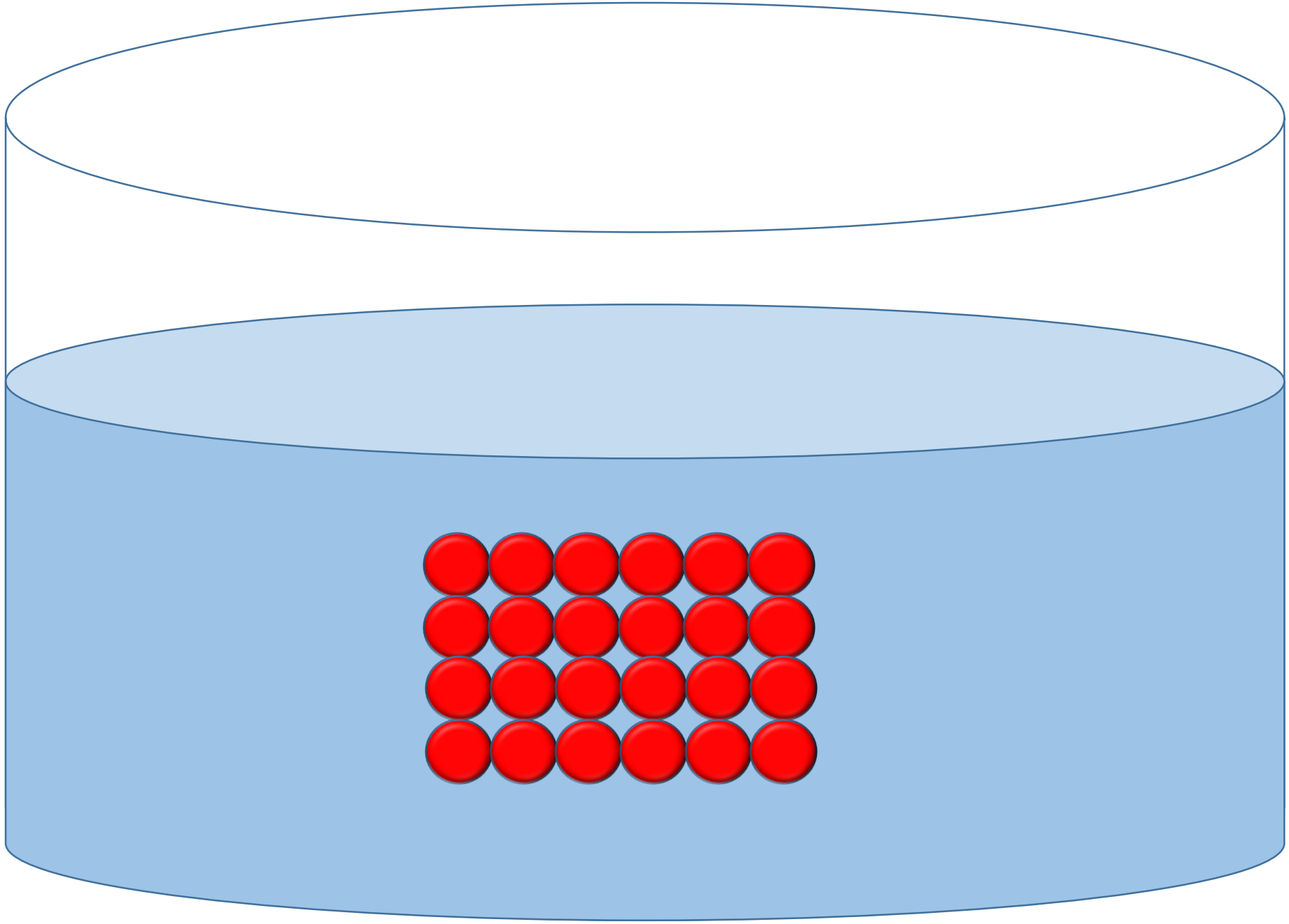
Solution becomes saturated.

A saturated solution is the one , which contains maximum amount of solute that can be dissolved in the given amount of solvent , at particular temperature

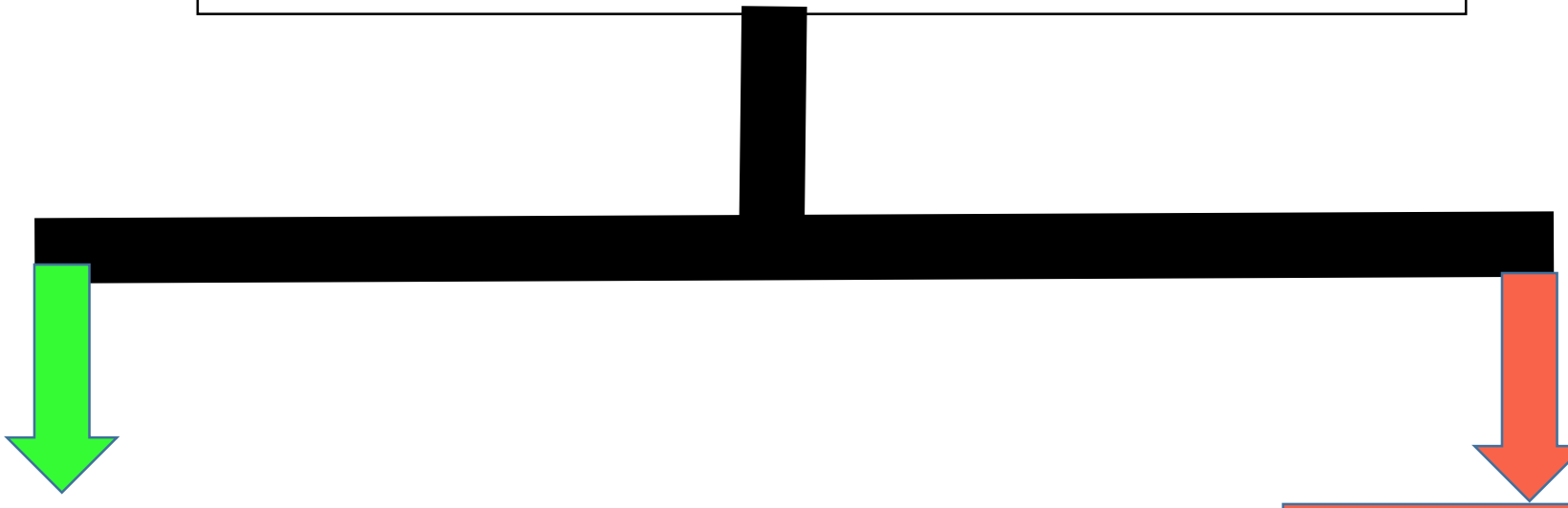
2.4 Solubility : The solubility of a solute is its amount per unit volume of saturated solution at a specific temperature. The solubility of a solute is its maximum concentration and expressed in the concentration units mol L^{-1}.

If 0.5 moles of solute is added in one liter Solvent and out of it 0.3 moles dissolves completely at given temperature

What is solubility ?



Out of 0.5 moles of solute added



0.3 moles dissolves completely in 1 liter of solution

0.2 moles remains insoluble

Solubility of solute is 0.3 mol / lit

Now we needs to understand the factors Which affects solubility of

- **Solid solute in liquid solvent**
- **gaseous solute in liquid solvent**

for Solution of solid in liquid

Factors affecting solubility of solid solute in liquid solvent

There are 3 factors

➢ Nature of solute and solvent

Non polar solutes are more soluble in → **Non polar solvents**

Polar solutes are more soluble in → **polar solvents**

It is principle of like dissolves like

➢ Effect of temperature on solubility

For most of solids there solubility increase with increase in temperature

There are few exceptions

Case 1 : If dissolution of solid is endothermic , solubility of Solid should increase with increase in temperature

Case 2 : If dissolution of solid is exothermic , solubility of Solid should dncrease with increase in temperature e.g Na_2SO_4

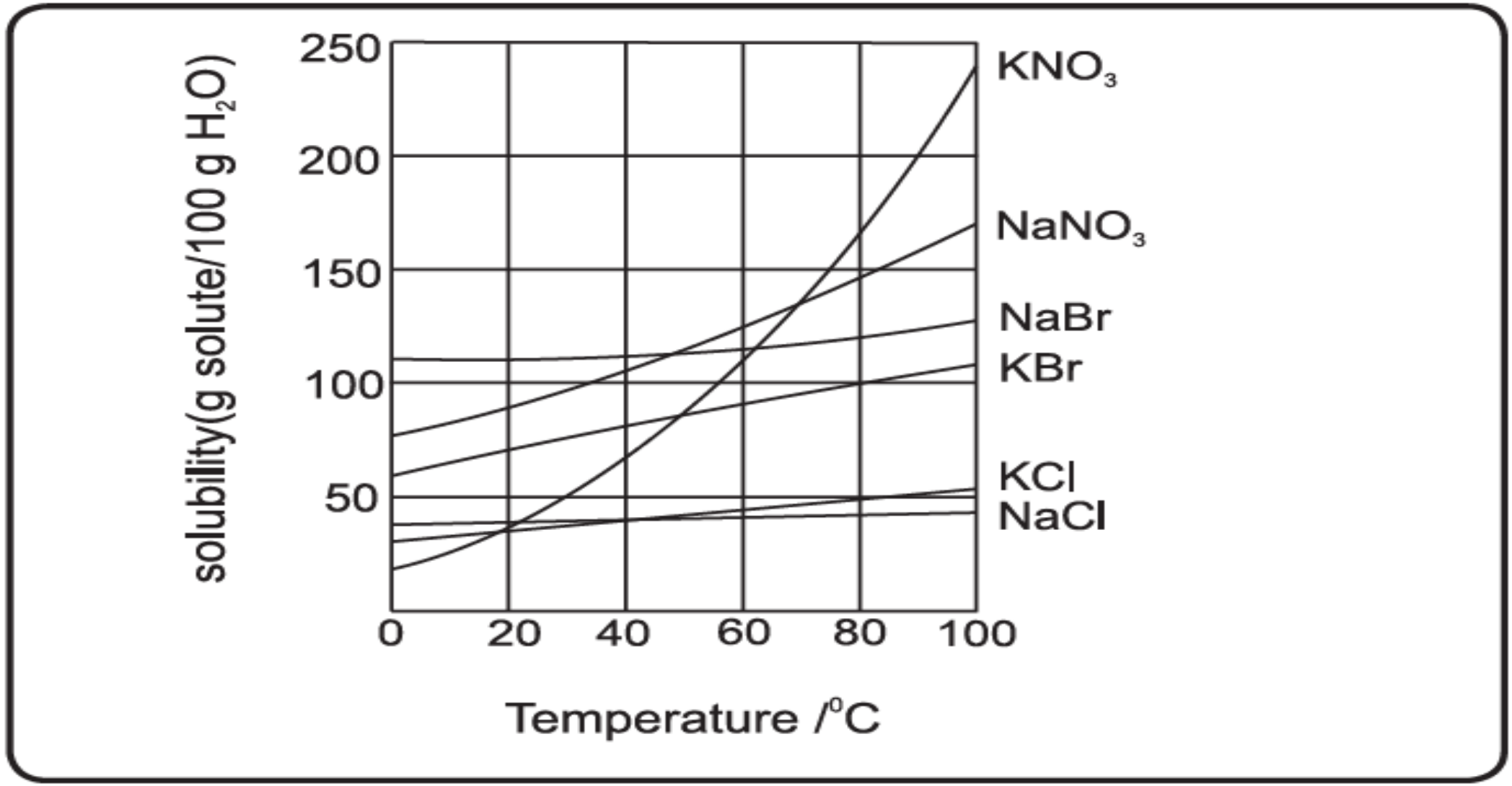
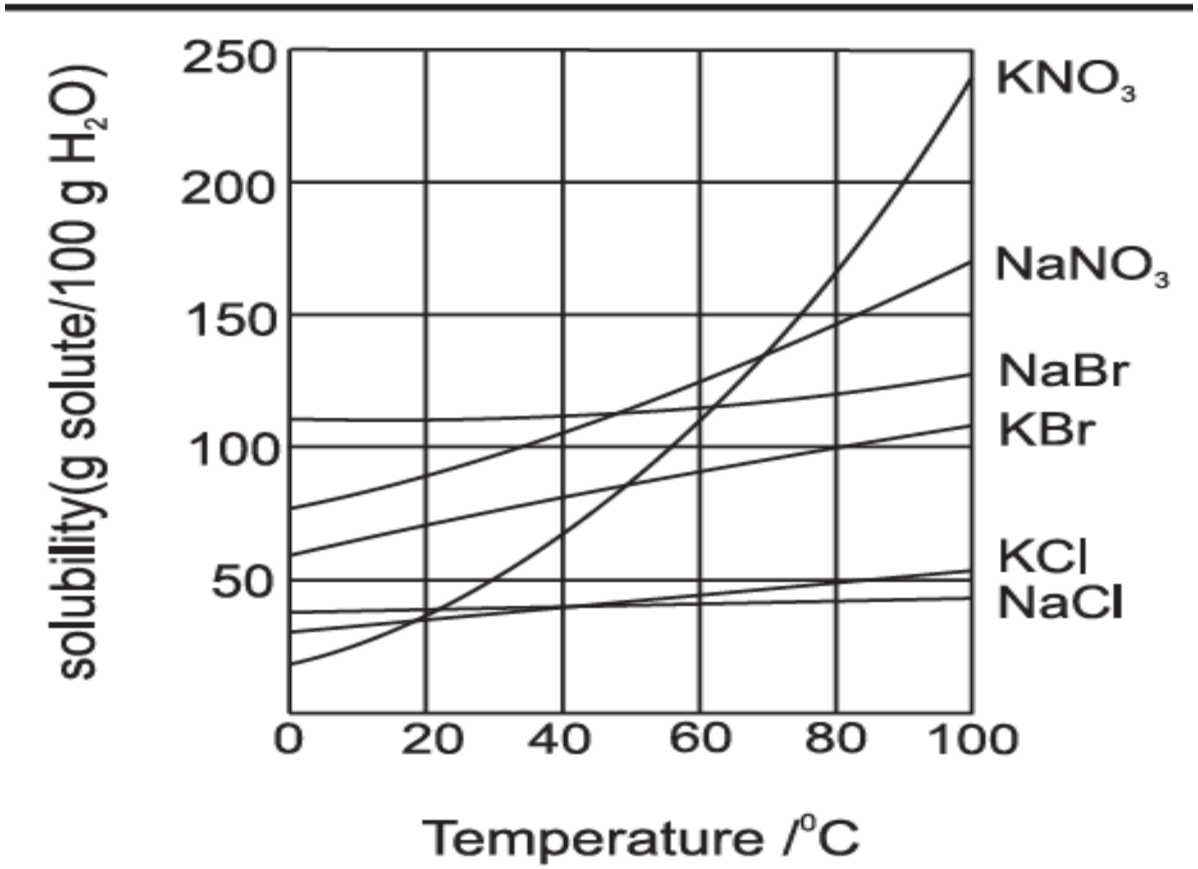


Fig. 2.1 : Variation of solubilities of some ionic solids with temperature

i. Solubilities of NaBr, NaCl and KCl change slightly with temperature.

ii. Solubilities of KNO_3, $NaNO_3$ and KBr increase appreciably with increasing temperature.

iii. Solubility of Na_2SO_4 decreases with increase of temperature.



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➢ Effect of pressure on solubility of solid in liquid

There in no effect of pressure on solubility of solid in liquids
Because solid state and liquid states both are incompressibe

now solubility of gas in a liquid

Factors affecting solubility of gaseous Solute in liquid solvent

➢ Effect of temperature on solubility

Solubility of gases in water decreases with increase in temperature

$$\textbf{Solubility of gas} \; \alpha \; \frac{1}{Temperature}$$

Reason

When gases are dissolved in water, the gas molecules in liquid phase are condensed. The condensation is an exothermic process. The solubility of gases in water must decrease as temperature is raised.

Adverse effect on aquatic animals , if river Water is used for industrial cooling

In united states about 1000000 billion galons of water from rivers and lakes are used for industrial cooling. The cooling process heats water. The hot water then returns to rivers and lakes. The solubility of oxygen decreases in hot water thereby affecting the life of cold blooded animals like fish.

➢ Effect of pressure on solubility

Solubility of gases in water increases with increase in pressure of gas above water

Solubility of gas in liquid α Pressure of gas above soution

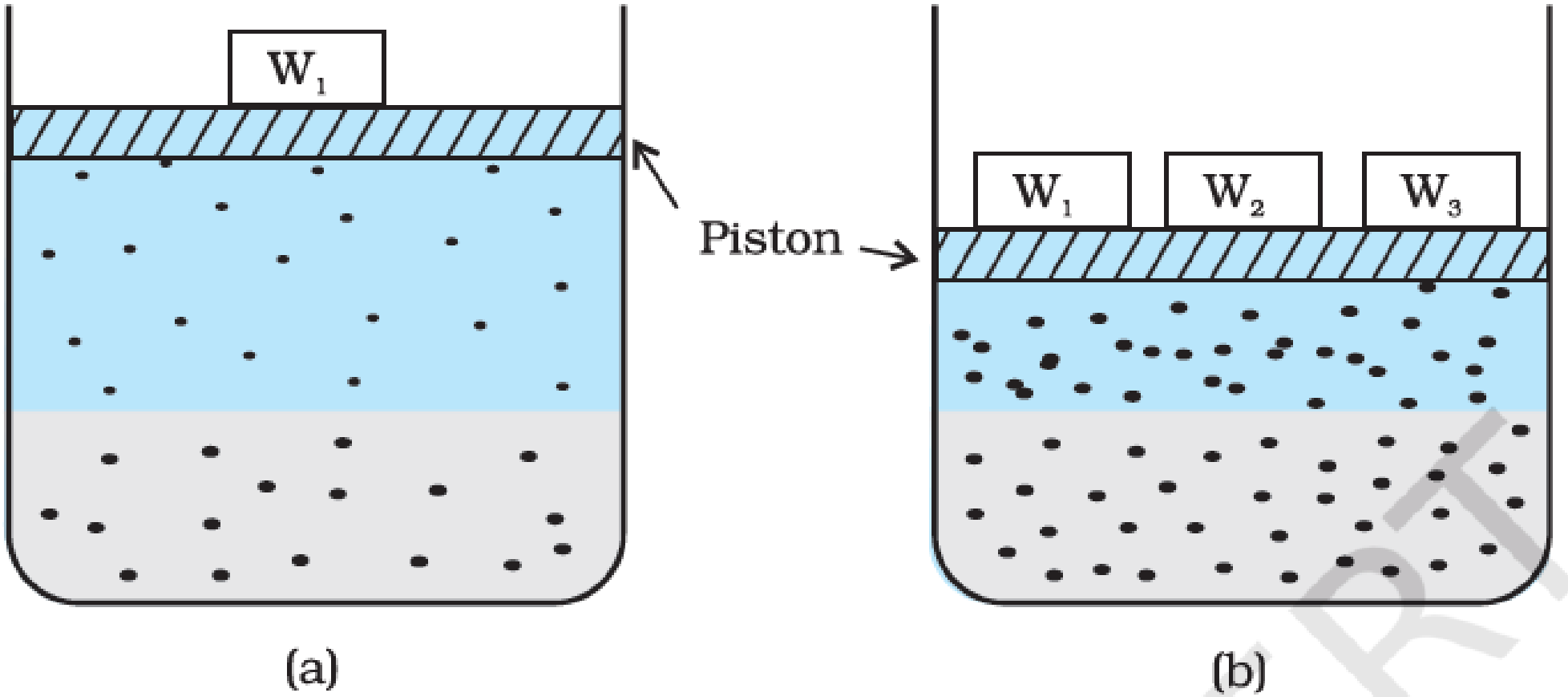

Fig. 2.1: Effect of pressure on the solubility of a gas. The concentration of dissolved gas is proportional to the pressure on the gas above the solution.

The quantitative relationship between gas solubility in a liquid and pressure is given by Henry's law.

Henry's law: It states that the solubility of a gas in a liquid is directly proportional to the pressure of the gas over the solution. Thus,

$$S \propto P$$

$$S = K_H P$$

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where, S is the solubility of the gas in mol L^{-1}, P is the pressure of the gas in bar over the solution. K_H, the proportionality constant is called Henry's law constant.

Units of K_H : $K_H = \frac{S}{P} = \frac{\text{mol } L^{-1}}{\text{bar}}$

$= \text{mol } L^{-1} \text{ bar}^{-1}$

$$S = K_H P$$

If P = 1 bar ,

$$S = K_H$$

Thus K_H is solubility of a gas in a liquid , when Pressure of gas above the liquid is 1 bar