

SOLUTIONS

1: SOLUBILITY

Dr. Sapna Gupta

SOLUTIONS

Solutions are made of at least one solute and one solvent that dissolve in each other. The solvent is the higher quantity, and solute is in smaller quantity.

- Two soluble substances will appear homogeneous; two substances that don't mix, are immiscible, will look like heterogeneous mixture.
- Solute and solvent can be in any phases.

Solute	Solvent	Resulting solution state	Example
Gas	Gas	Gas	Air
Gas	Liquid	Liquid	Carbonated water
Gas	Solid	Solid	H ₂ gas in Palladium
Liquid	Liquid	Liquid	Ethanol in water
Liquid	Solid	Solid	Mercury in silver
Solid	Liquid	Liquid	Saltwater
Solid	Solid	Solid	Brass

TYPES OF SOLUTIONS

- Dilute (unsaturated) – There is small amount of solute in solvent. It's possible to dissolve more solute, if needed.
- Concentrated – Has more solute than dilute solution but not to the maximum solubility.
- Saturated – Has maximum amount of solute at a given temperature (This amount is termed the solubility of the solute.)
- Supersaturated – Solvent now has more solute than a saturated solution hence is an unstable condition.

heat
↓
dilute/unsaturated saturated supersaturated
(don't see any solute) (will see solute) (don't see any solute)



IM FORCES IN SOLUTIONS

When solutions are formed intermolecular (IM) forces are key.

- “LIKE DISSOLVES LIKE”
- Polar substances dissolve in polar solvents
- Nonpolar substances will not dissolve in polar solvents

H_2O and I_2 (soluble)

H_2O and CH_2Cl_2 (insoluble)

Both have dipole-dipole interactions

dipole-dipole and dispersion forces with I_2

Note that I_2 in water is yellow/orange color, while in CH_2Cl_2 , I_2 shows a violet color. Two things happened here: 1) iodine is more soluble in CH_2Cl_2 because of dispersion forces, and 2) it shows its true color in the solvent it is more soluble in.



EXAMPLE: SOLUBILITY

Identify the solute(s) and solvent(s) in the following solutions and indicate if they will be soluble in each other.

- a. 80 g of Cr and 5 g of Mo
- b. 5 g of MgCl_2 dissolved in 1000 g of H_2O
- c. 39% N_2 , 41% Ar, and the rest O_2

Answer:

- a. The 5 g of Mo is the solute; the 80 g of Cr is the solvent.

Both are metals – they can be mixed – form an alloy.

- b. MgCl_2 is the solute; H_2O is the solvent.

MgCl_2 is ionic and water is polar so both will dissolve.

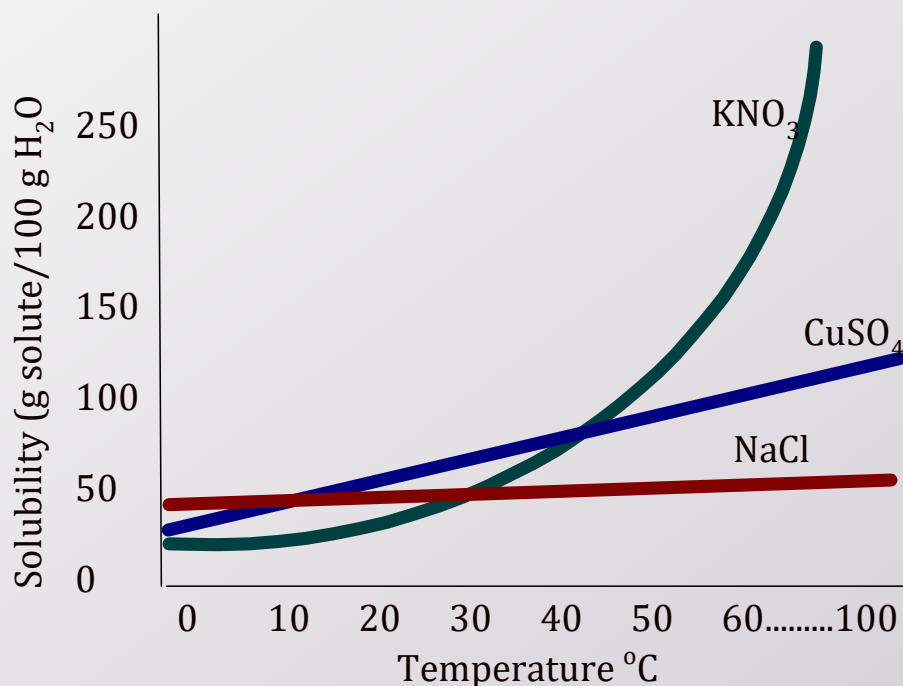
- c. O_2 and N_2 are the solutes; Ar is the solvent.

All are nonpolar gases so they should form a mixture.

SOLUBILITY AND TEMPERATURE

In general solubility of a substance will increase with temperature.

- In most cases dissolving is an endothermic process so temperature of solution decreases with solubility – so increasing temperature increases solubility. (Cold packs are endothermic processes.)
- In cases where dissolving is an exothermic process, the solution needs to be cooled in order to increase solubility (e.g., NaOH in water) (Hot packs are exothermic processes).



SOLUBILITY AND GASES

Solubility depends on two conditions: pressure and temperature

- Henry's Law: solubility of gases increases with the partial pressure of the gas above the solution.
- The other aspect of gas solubility is that solubility of gases decreases with temperature.

KEY CONCEPTS

- Predict solubility of substances in different solvents
- Predict solubility of substances with temp.