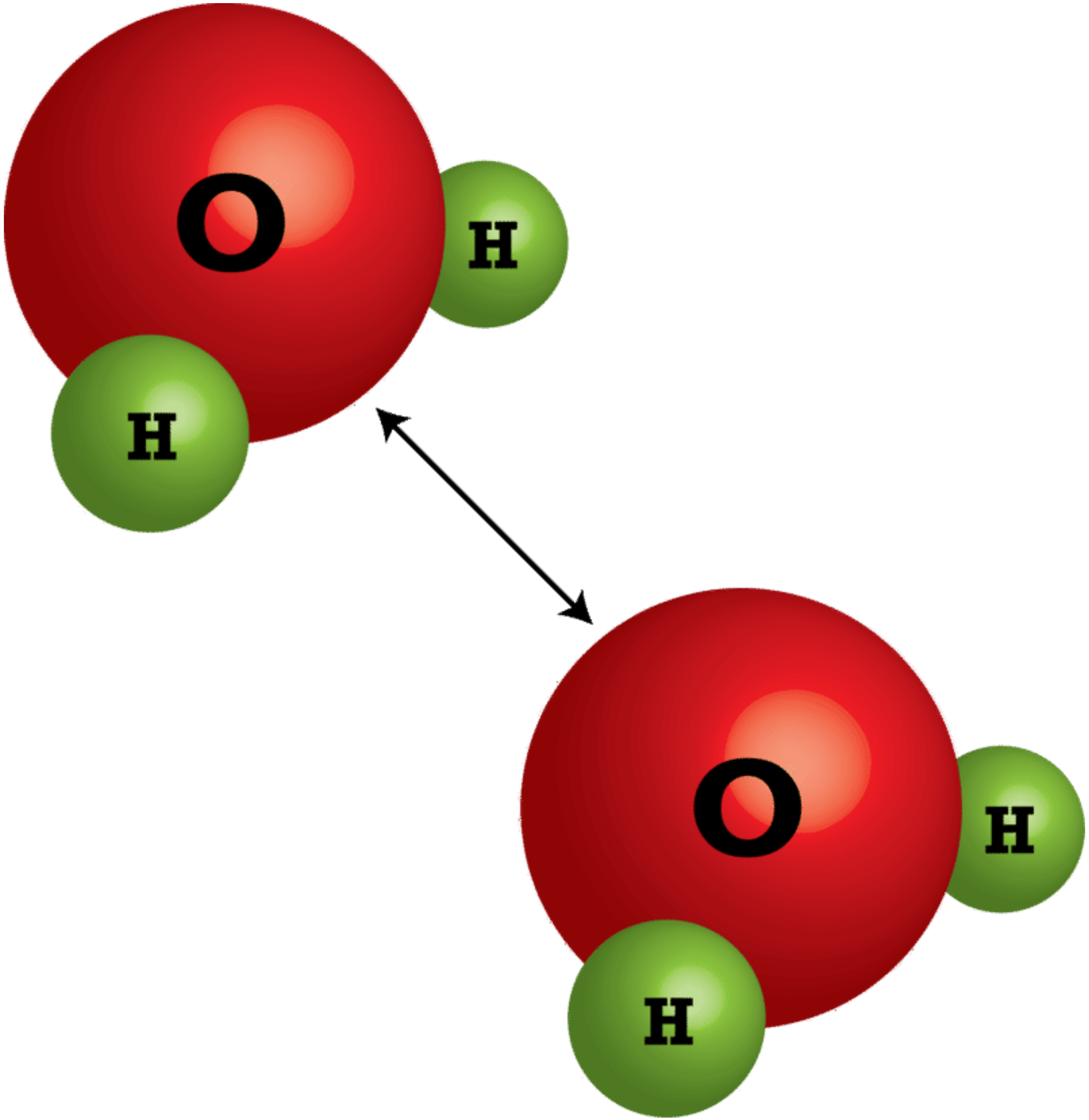


Unit 3

Intermolecular Forces

3.7 Solutions & Mixtures
3.8 Representations of Solutions

- Types of Solutions
- Expressing Concentrations

Terminology

Suspension or Mechanical Mixture

- A heterogeneous mixture of 2 or more substances (i.e. sand & water)
- Macroscopic properties are different at different locations within the sample.
  - The sizes, shapes and concentrations of particles can vary.
- In some cases, components can be separated through filtration.

Solution or Homogeneous Mixture

- Homogeneous mixture of 2 or more substances (i.e. sugar & water)
- Macroscopic properties do not vary within the sample.
- Components cannot be separated by filtration.
- Components can be separated by methods that alter IMFs (distillation or chromatography)
- No components are large enough to scatter visible light.

Terminology

Solvent

- The substance that is more plentiful in a solution.

Solute

- The substance that is less plentiful in a solution.

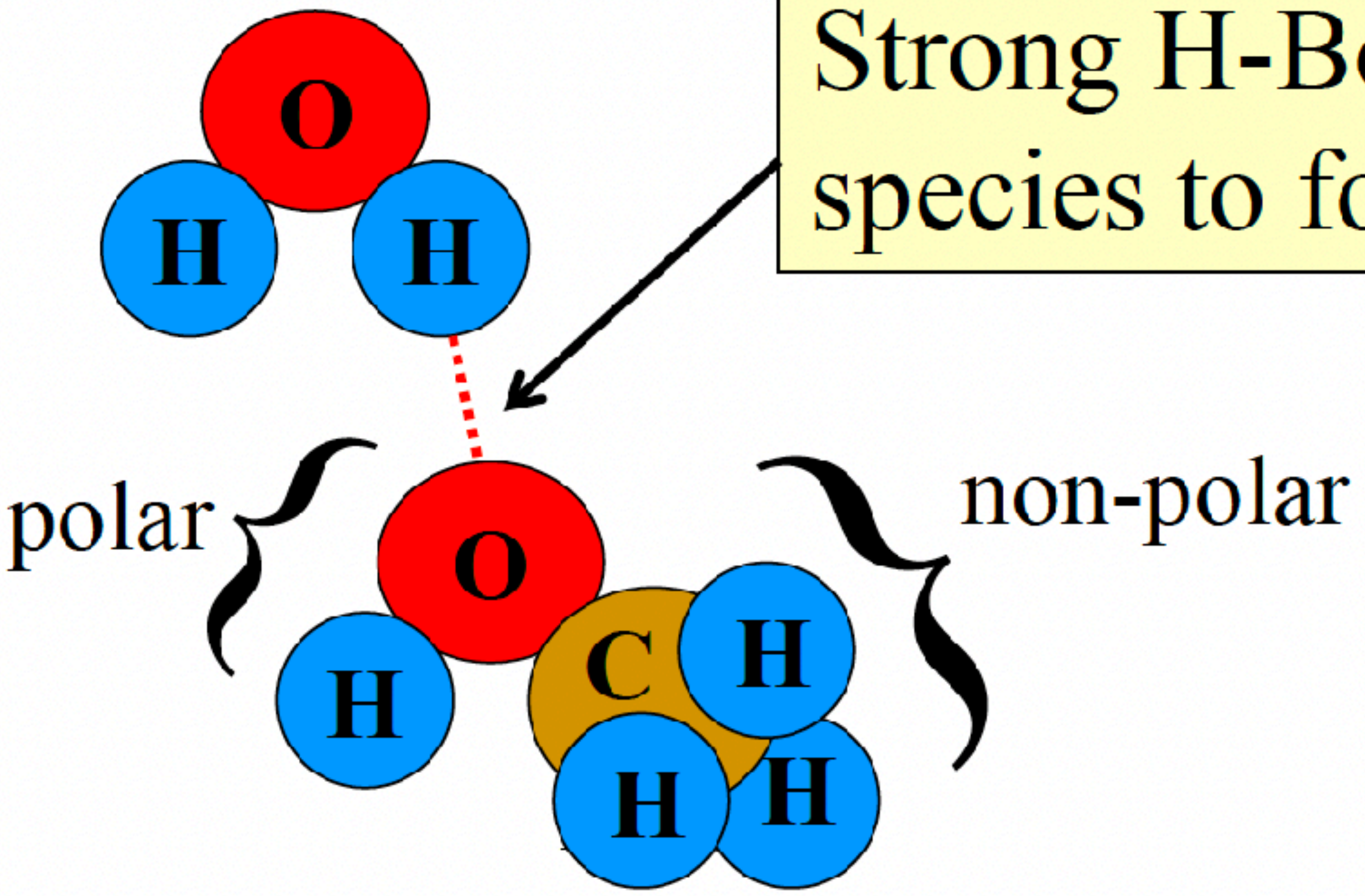
When sugar dissolves in water, sugar is the solute and water is the solvent.

Saturated Solution

- When the solvent has dissolved the maximum amount of solute possible at a certain temperature, and some solid particles remain undissolved.
- This is an equilibrium system where solid particles continually dissolve in the solvent and dissolved particles fall out of solution.

Types of Solutions

Liquid - Liquid Solutions (CH_3OH and H_2O)



Strong H-Bonds allow these species to form a solution

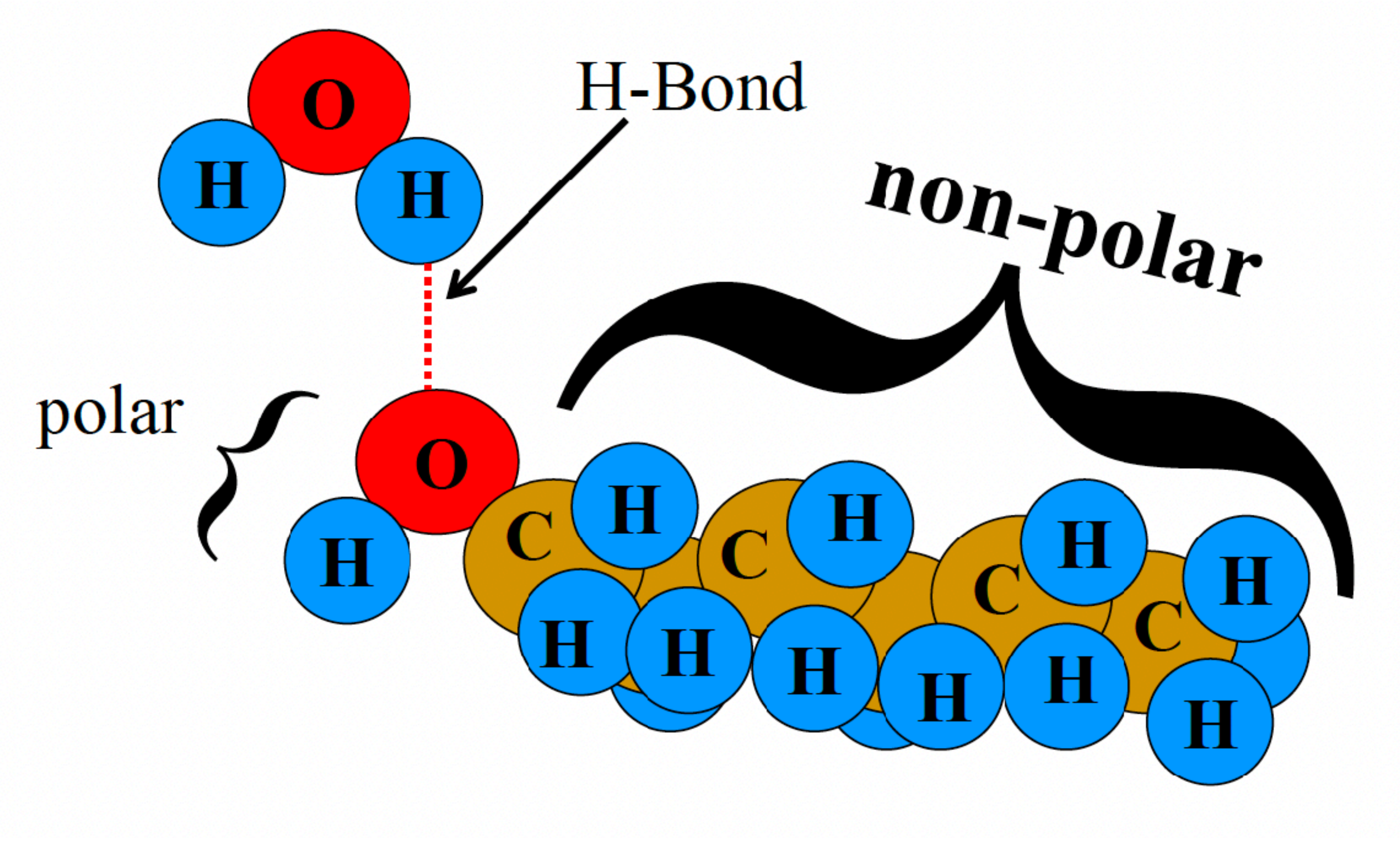
CH_3OH and H_2O are **miscible** (soluble in all proportions).

Miscible solutions never become saturated.

Differences in intermolecular forces can cause the solution's volume to differ from the sum of the volumes before mixing.

Types of Solutions

Liquid - Liquid Solutions ($C_6H_{13}OH$ and C_6H_{14})

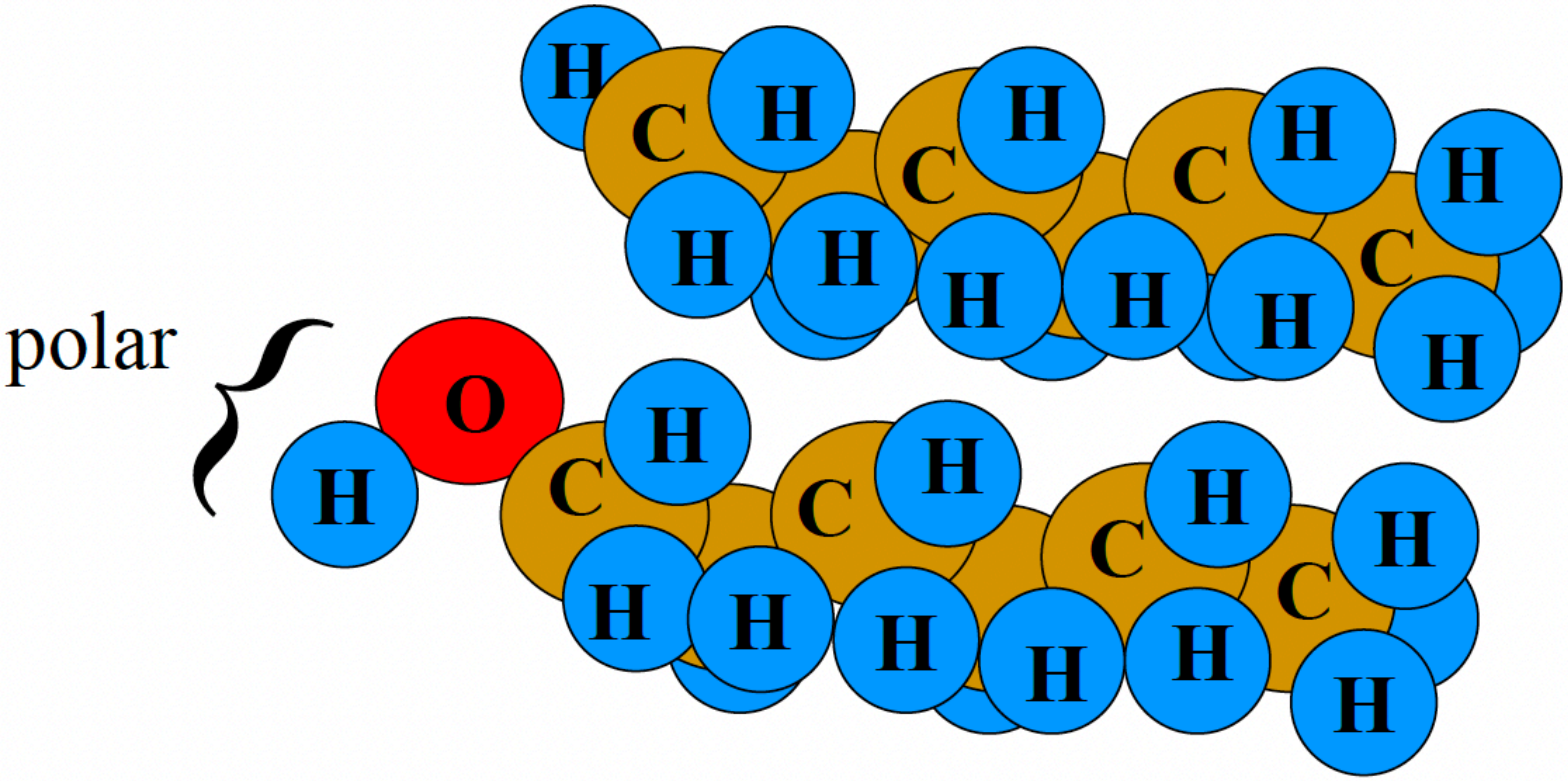


Hexanol and water are **<u>not miscible</u>**.

Some will dissolve in water but solubility is limited due to long non-polar carbon chain.

Types of Solutions

Liquid - Liquid Solutions ($C_6H_{13}OH$ and C_6H_{14})



Hexane and Hexanol are **visible**.

Hexane is completely non-polar.

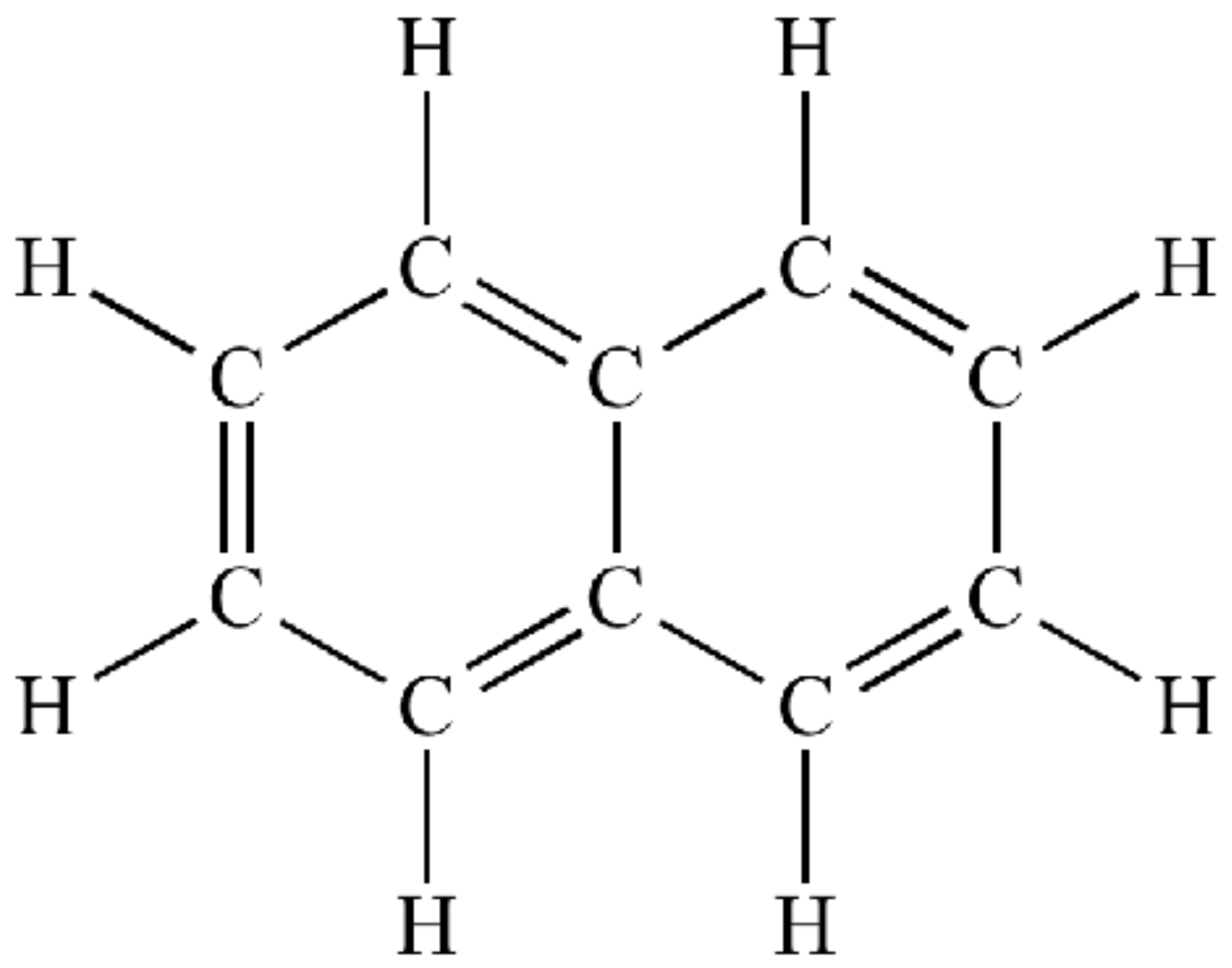
Hexanol is mostly non-polar.

They form strong LDFs for one another.

Types of Solutions

Solid - Liquid Solutions

- Many ionic compounds dissolve in polar solvents (ion-dipole)
- Polar solids, such as glucose, dissolve in polar solvents (dipole-dipole or H-bonds)
- Non-polar solids, such as naphthalene ($C_{10}H_8$) dissolve in non-polar solvents (dispersion)



Types of Solutions

Gas - Liquid Solutions

- Carbonated drinks

$$H_2O(l) + CO_2(g) \rightarrow H_2CO_3(aq)$$

- Oxygen gas dissolves in water

$$O_2(g) \rightarrow O_2(aq)$$

Types of Solutions

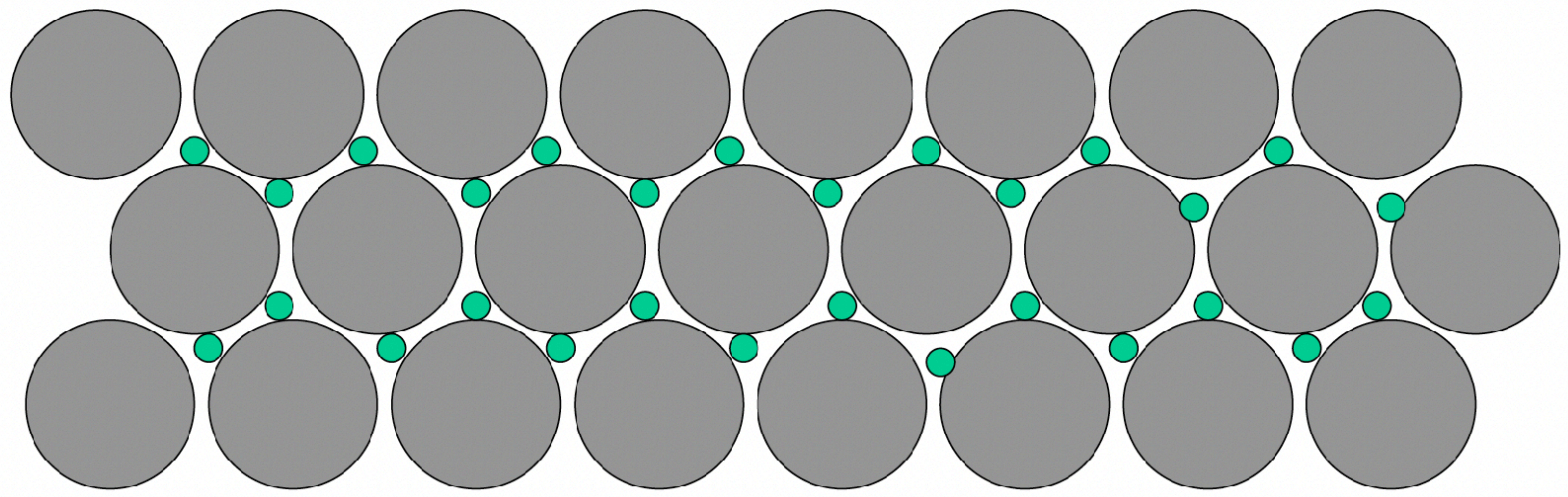
Gas - Gas Solutions

- Gases are always infinitely soluble in one another.
- Air
    - N_2, O_2, CO_2, H_2O, etc.

Types of Solutions

Gas - Solid Solutions

- H_2 gas can occupy the spaces between some metal atoms such as iron and palladium



Types of Solutions

Solid - Solid Solutions

- Alloys: formed by melting, mixing and solidifying
  - Interstitial (Steel - Fe/C) and Substitutional (Brass - Cu/Zn)

Expressing Concentration

Two methods for expressing concentration:

$$\text{molarity } (M) = \frac{\text{moles solute}}{\text{liters solution}}$$

Molarity can change with temperature.

$$\text{mole fraction} = X_A = \frac{\text{moles A}}{\text{moles A} + \text{moles B} + \ldots + \text{moles Z}}$$

Mole fractions do not change with temperature.

Example #1 - Molarity (*M*)

A 3.75 g sample of NaCl is dissolved in water. The total volume of the solution is 768mL. What is the molarity of the solution?

Example #2 - Molarity (*M*)

How many mL of 0.245 *M* NaOH are needed to deliver 1.75 moles of NaOH?

Example #3 - Molarity (*M*)

Suppose you needed to prepare 100.00 mL of 1.00 *M* NH_3 using 1.25 *M* NH_3, distilled water and a 100 mL graduated cylinder. How would you do this?

1. Find the number of moles of NH_3 required.
2. Find the volume of 1.25 M NH_3 required.

Example - Mole Fraction

Find X_{KOH} and X_{water} in a solution that is prepared by dissolving 1.5 mol KOH in 1.0 kg H_2O.

1. Find moles of H_2O.
2. Find mole fractions.