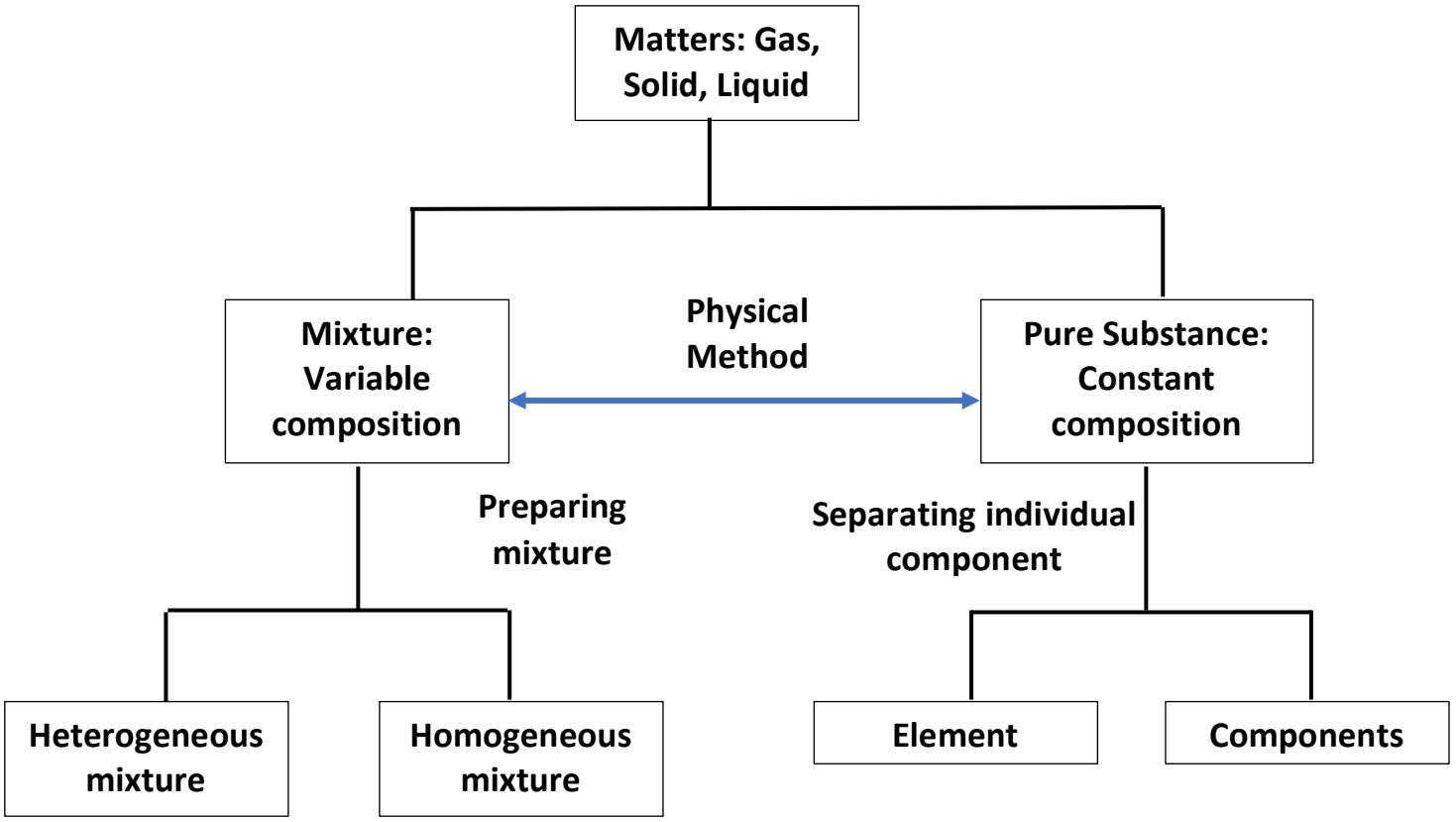
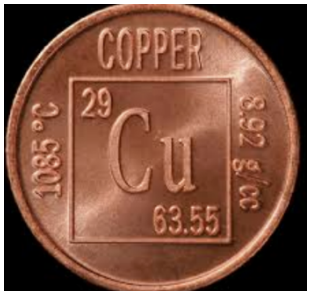
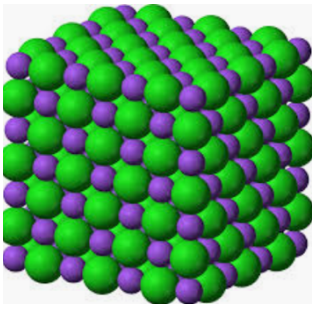
Unit 4: Solutions and solubility
Lesson 1: Classifying Solutions







Solution is a <u>homogeneous</u> mixture of two or more substances, has a <u>uniform</u> composition.
For example:

- The coffee is an aqueous solution
- The stainless steel spoon is also a solution of metal

Parts of solution:

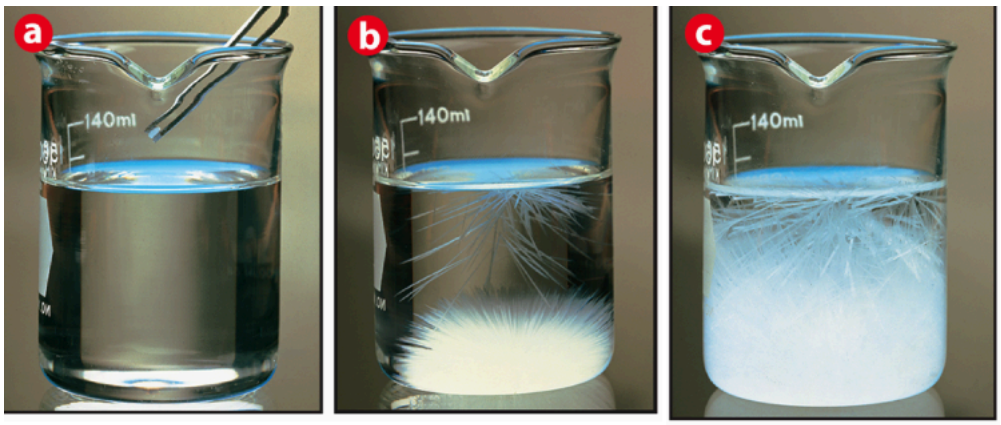
- **Solvent**: The substance in the greatest amount (normally is liquid)
- **Solute**: any other substances in the solution (could be liquid in smaller amount or solid or gas)
- **Aqueous solution**: solution that contain water.
- In a cup of coffee, solvent is water, solute is substance from the coffee bean such as caffeine.

Solubility:

- Solubility: the maximum amount of solute that will dissolve in a given quantity of solvent at specific temperature.
- A solute is described as:
  - **"soluble"** if more than 1 gram in 100 mL of solvent
  - **"slightly soluble"** if between 0.1 gram and 1 gram in 100 mL of solvent
  - **"insoluble"** if less than 0.1 gram in 100 mL of solvent
- For example: at 20 ℃
  - NaCl is soluble in water, given its solubility is 35.9 g / 100mL
  - $Ca(OH)_2$ is slightly soluble in water – 0.183 g / 100 mL
  - $CaCO_3$ is insoluble in water – ~0.005 g / 100 mL

Level of saturation:

- At a specific temperature, a solution is decribed as a:
  - **Saturated solution** if no more solute can be dissolved
  - **Unsaturated solution** if more of the same solute can be dissolved
  - **Supersaturated solution** contains more dissolved solute than a saturated solution at the same temperature.
    - This usually occurs momentary when a temperature change occurs.
    - is unstable, and a disturbance can precipitate out the excess solute



Unsaturated Saturated Supersaturated

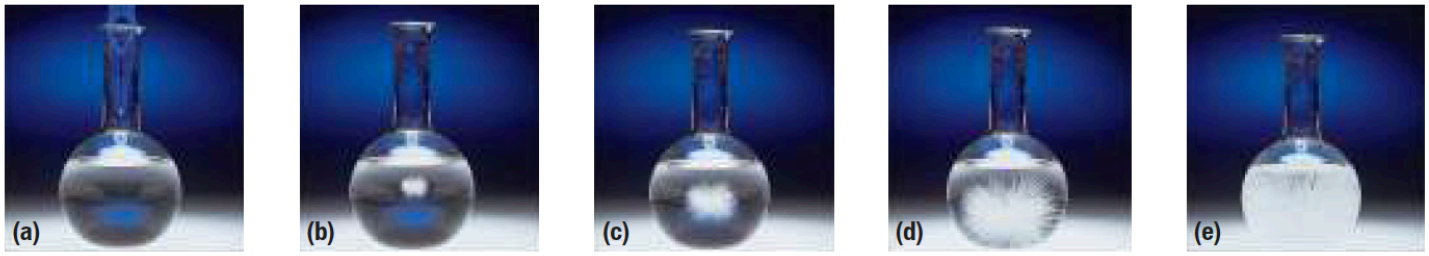


Figure 3 (a) A supersaturated sodium acetate solution is prepared by dissolving sodium acetate in water at a high temperature and then allowing the solution to cool. (b) Adding a seed crystal of sodium acetate causes the excess solute to begin to crystallize. (c)–(e) Crystallization continues until the solution is no longer supersaturated. It is now a saturated solution containing a solid.

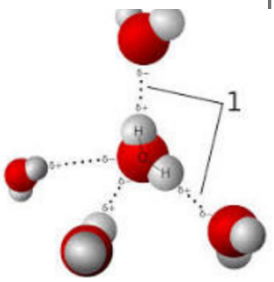
Unit 4: Solutions and solubility
Lesson 2: Factors that affect solubility and rate of dissolving

Solubility and forces between particles

Formation of most solutions depends on the relative strength of 3 categories of forces:

1. Forces between particles of the solute
2. Forces between particles of the solute to particles of the solvent
3. Forces between particles of the solvent

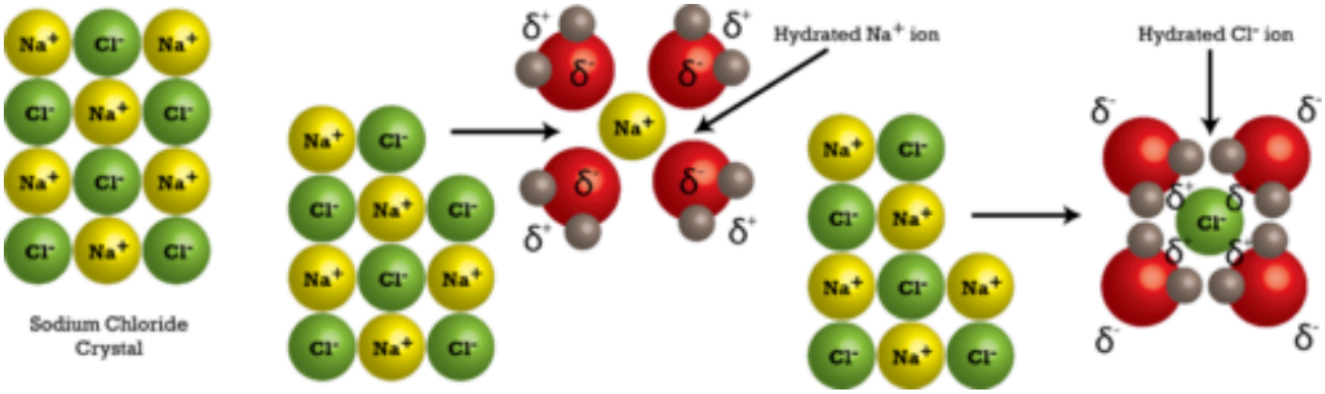
Solubility in water



- Water is a polar solvent
- water molecules bond to each other with hydrogen bonding (the bond between H and O, N, and F)

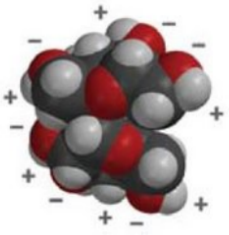
Solubility of Ionic compounds in water

- Most ionic compounds are soluble in water
- Water dipole can pull the compound apart due to opposite partial charge
- Partial positive part of water molecules surround the negative ions
- Partial negative part of water molecule surrounds the positive ions
- Polar water bound ionic compounds crystal will disperse uniformly in water
- Let's check out this video - https://www.youtube.com/watch?v=xdedxfhcpWo

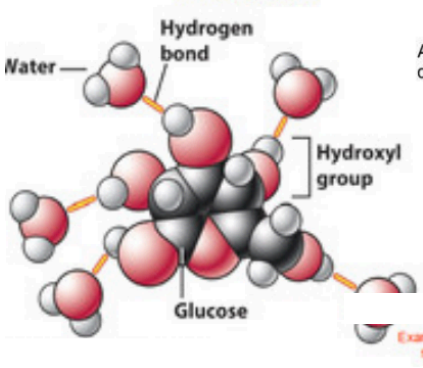


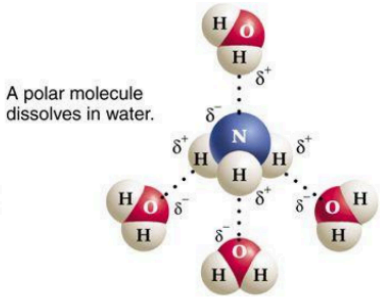
Solubility of Polar Molecular compounds in water

- Most polar compounds is able to dissolve in water
- This is because the attraction between the partial charge of water molecules and the partial charge of polar molecules.



Sucrose space-filling model

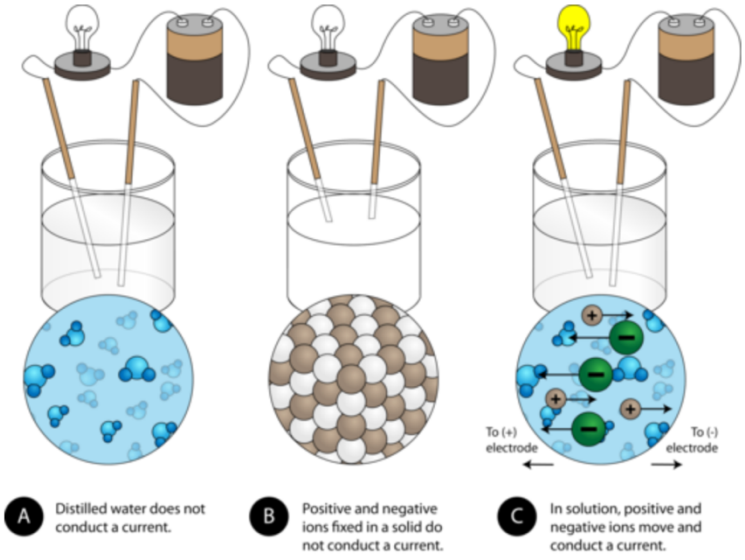




- Non-polar molecules do not dissolve in water, why?

Conductivity of aqueous solutions

- Ionic compounds will conduct an electricity when dissolved in water because ions carry charges
- whereas molecular compounds will not conduct electricity when dissolved in water because the molecular compounds remain intact.



Predicting whether an ionic compound is soluble in water

- Ion charge: the greater the charge on each ion, the less soluble the compound will be
  - For example: oxide compounds are less soluble than fluoride compounds
- Ion Size: as ion size increase solubility increases (usually)
  - For example: AgCl is insoluble, but AgNO3 is soluble because the nitrate ion is larger.

Solubility Guidelines

		Anions						
		Cl^-, Br^-, I^-	S^{2-}	OH^-	SO_4^{2-}	CO_3^{2-}, PO_4^{3-}, SO_3^{2-}	$C_2H_3O_2^-$	NO_3^-
Cations	High solubility (aq) ≥0.1 mol/L (at SATP)	most	Group 1, NH_4^+ Group 2	Group 1, NH_4^+ Sr^{2+}, Ba^{2+}, Tl^+	most	Group 1, NH_4^+	most	all
		All Group 1 compounds, including acids, and all ammonium compounds are assumed to have high solubility in water.						
	Low Solubility (s) <0.1 mol/L (at SATP)	Ag^+, Pb^{2+}, Tl^+, Hg_2^{2+}, (Hg^+), Cu^+	most	most	Ag^+, Pb^{2+}, Ca^{2+}, Ba^{2+}, Sr^{2+}, Ra^{2+}	most	Ag^+	none

Predicting whether a molecular compound is soluble in water

- Polar molecular compounds are soluble in water
- nom-polar molecular compounds are insoluble
- Which of the following will be the most soluble molecule?

  CH_3OH, CH_3CH_2OH, $CH_2CH_2CH_2OH$? Why?

Like Dissolve like

- Polar substances can often dissolve ionic and polar substances

		Solute	
		Polar or Ionic	Non-Polar
Solvent	Polar		
	Non-Polar		

- For molecules that have both polar and non-polar components can dissolve in both polar and non-polar solvents
  - Example: Soap and detergent – can wash off dirt and grease