Unit 6

On completion of the unit you should be able to:

1. balance chemical equations.
2. interpret balanced equations in terms of moles, mass units and number of particles.
3. given the number of moles (or mass or number of particles) of one substance calculate the number of moles (or mass or number of particles) of another substance in the balanced equation.
4. define limiting and excess reactants.
5. identify the following types of reactions:
    - synthesis
    - decomposition
    - combustion
    - single-replacement
    - double-replacement
    - neutralization
6. define endothermic and exothermic reactions.
7. define acids and bases.

Today's focus.

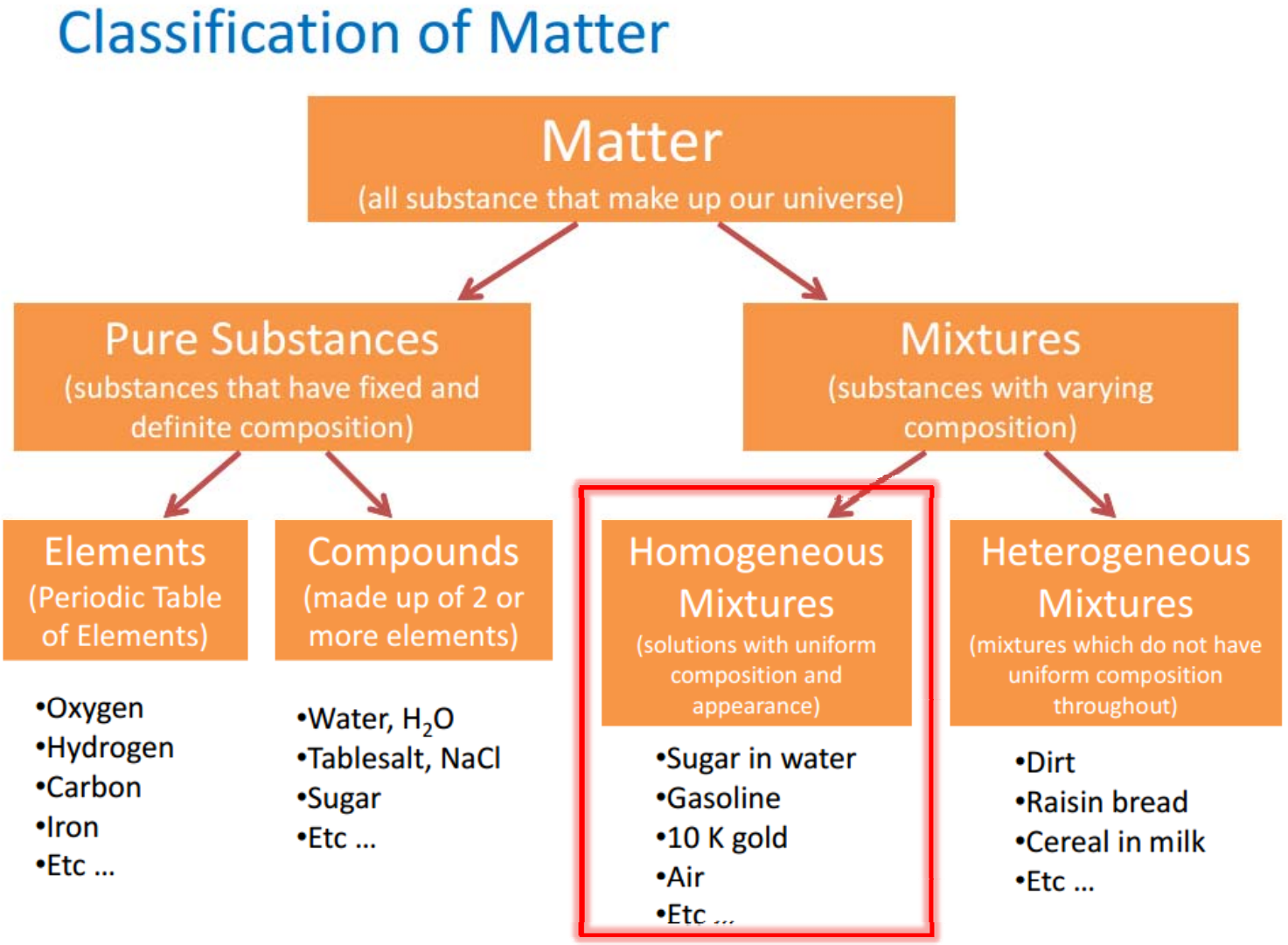
6.4 **What is an aqueous solution?**

Dissolving NaCl (1st video) $NaCl\ (s) \longrightarrow Na^{+}\ (aq) + Cl^{-}\ (aq)$

Dissolving NaCl (2nd video) $NaCl\ (s) \longrightarrow Na^{+}\ (aq) + Cl^{-}\ (aq)$

Dissolving copper(II) chloride $CuCl_2\ (s) \longrightarrow Cu^{+2}\ (aq) + 2\ Cl^{-}\ (aq)$

Solution


Classification of Matter
Matter
(all substance that make up our universe)
Pure Substances
(substances that have fixed and definite composition)
Mixtures
(substances with varying composition)
Elements
(Periodic Table of Elements)
Compounds
(made up of 2 or more elements)
Homogeneous Mixtures
(solutions with uniform composition and appearance)
Heterogeneous Mixtures
(mixtures which do not have uniform composition throughout)
•Oxygen
•Hydrogen
•Carbon
•Iron
•Etc …
•Water, H_2O
•Tablesalt, NaCl
•Sugar
•Etc …
•Sugar in water
•Gasoline
•10 K gold
•Air
•Etc …
•Dirt
•Raisin bread
•Cereal in milk
•Etc …

Solution

Solutions are homogeneous mixtures of two or more substances. The substance present in the lesser amount is called the **solute**. The substance present in the greater amount is called the **solvent**. A common solvent that is used is water. However, there are other solvents such as acetone, hexane, methanol that are commonly used as cleaners and to dissolve grease.

Solutions are not only limited to liquid solutions. For example:

- air is a gaseous solution of oxygen, argon, carbon dioxide, and water vapor in nitrogen gas.
- 10K gold is a solid solution of silver,copper and zinc in gold.
- carbonated soft drinks is a liquid solution of carbon dioxide gas, sugar in water.
- vinegar is a liquid solution of vinegar in water.

Solution

Soluble/Insoluble

Sugar is soluble in water. This means that you can dissolve a large quantity of sugar into water. How much is "a large quantity"?

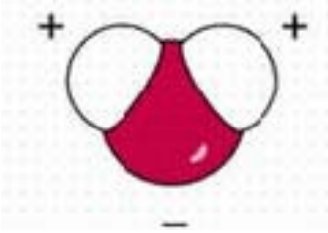
We use the term solubility to quantify the amount of solid solute will dissolve in a given quantity of solvent at a specific temperature.

The solubility of sodium chloride, table salt, is 36 grams per 100 grams of water at 20°C.

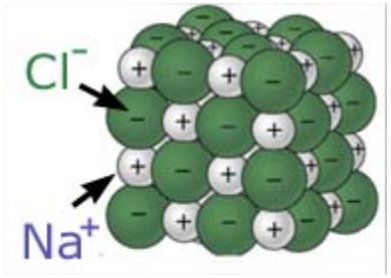
In general, **"like dissolves like"** describes the general principle of solubility.

Like refers to the polarity of the compounds.

H_2O is a **polar** solvent.



NaCl is a **polar** compound.



Saturated/Unsaturated Solution

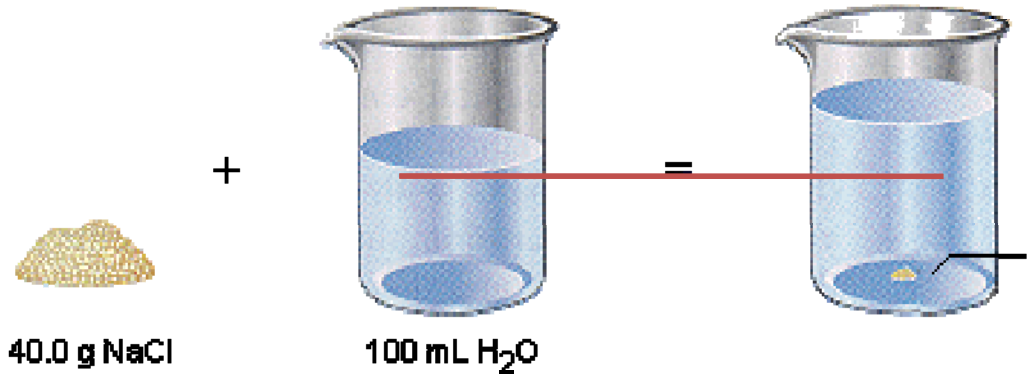
The solubility of sodium chloride, table salt, is 36 grams per 100 grams of water at 20°C.

At 20°C,

Note:

1. All the NaCl is dissolved.
2. Volume of solution increased.

Homogeneous NaCl (aq) solution



Note:

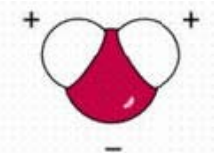
1. Not all the NaCl is dissolved.
2. Volume of solution increased.

Heterogeneous NaCl (aq) solution

What happens when NaCl dissolves in water?

"The attack of the water molecules!"

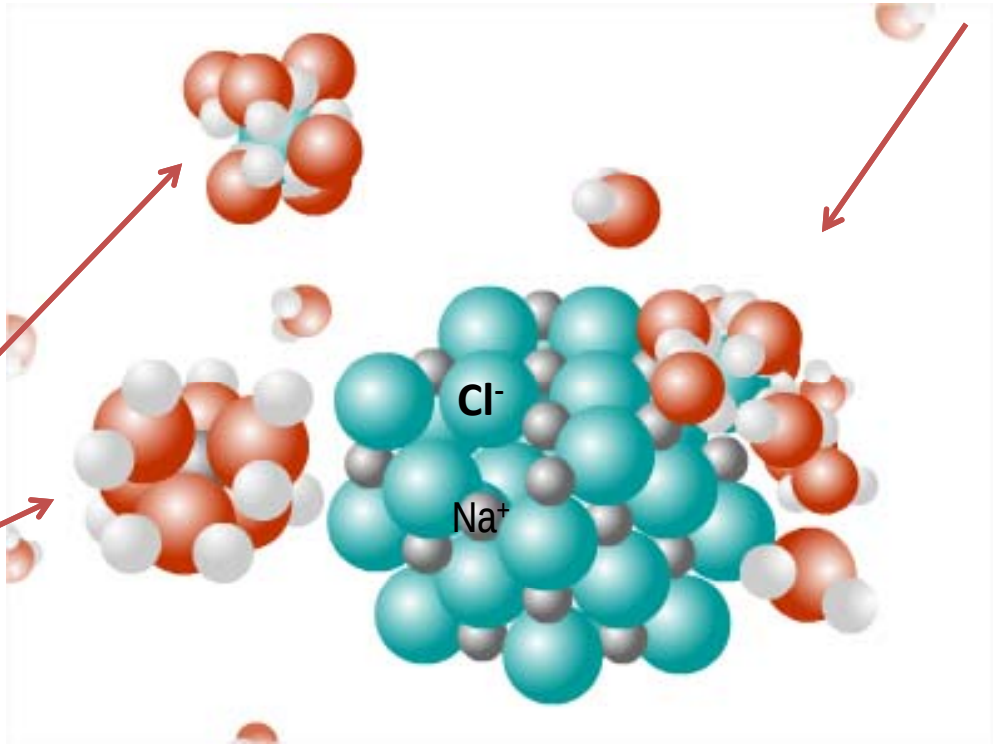
Starring:



Watch for two processes:

1. Water bonds to the NaCl.

2. Water pulls apart NaCl.



http://group.chem.iastate.edu/Greenbowe/sections/projectfolder/flashfiles/thermochem/solutionSalt.html

What happens when NaCl dissolves in water?

https://www.youtube.com/watch?v=EBfGcTAJF4o&NR=1

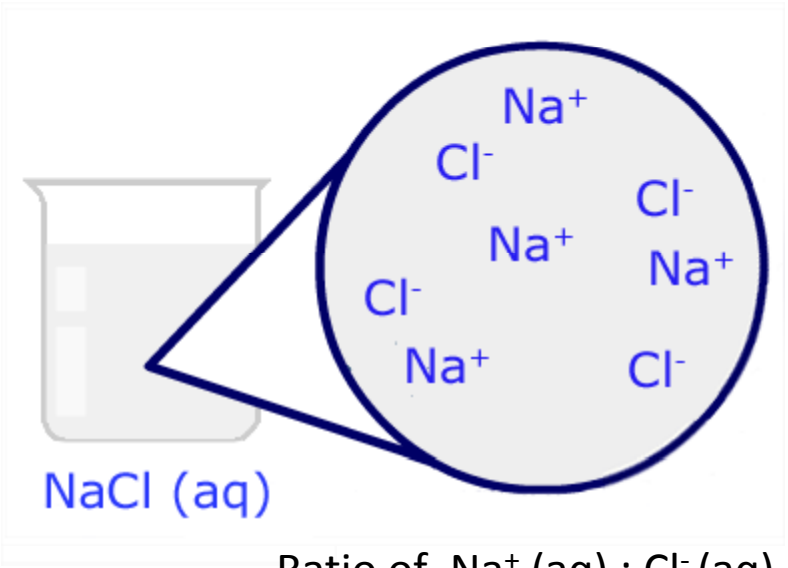
Aqueous Solutions

NaCl (s)

+

H_2O (l)

=



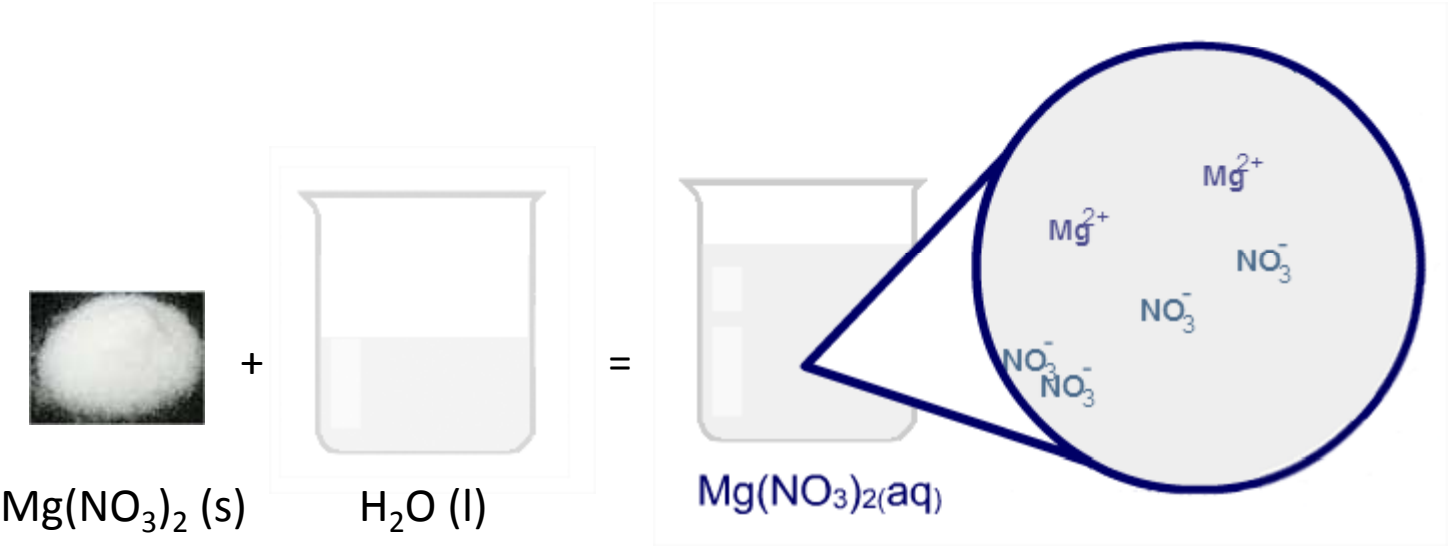
Ratio of Na^+ (aq) : Cl^- (aq)

1 : 1

Chemical Equation:

$$NaCl\ (s) \rightarrow Na^+\ (aq) + Cl^-\ (aq)$$

Aqueous Solutions



$Mg(NO_3)_2$ (s) H_2O (l)

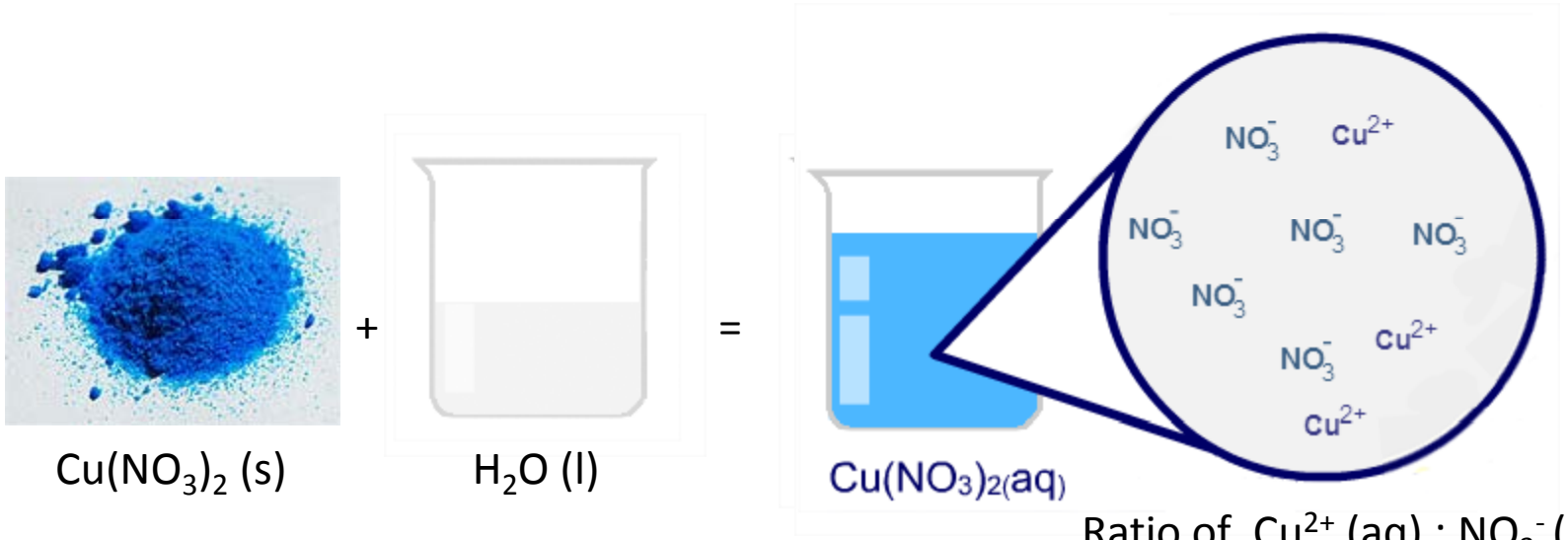
Ratio of Mg^{2+} (aq) : NO_3^- (aq)

1 : 2

Chemical Equation:

$$Mg(NO_3)_2\ (s) \rightarrow Mg^{2+}\ (aq) + 2\ NO_3^-\ (aq)$$

Aqueous Solutions



$Cu(NO_3)_2$ (s) H_2O (l)

Ratio of Cu^{2+} (aq) : NO_3^- (aq)

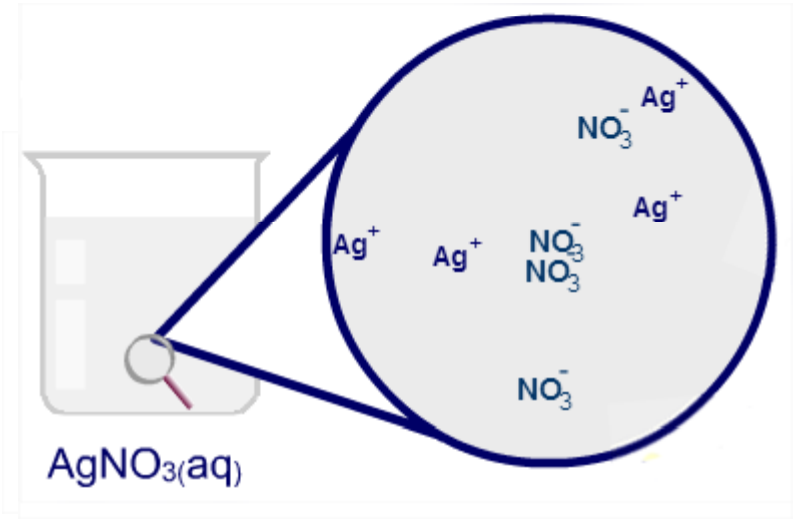
1 : 2

Chemical Equation:

$$Cu(NO_3)_2\ (s) \rightarrow Cu^{2+}\ (aq) + 2\ NO_3^-\ (aq)$$

Aqueous Solutions

$AgNO_3$ (s) + H_2O (l) =



Ratio of Ag^+ (aq) : NO_3^- (aq)

1 : 1

Chemical Equation:

$$AgNO_3\ (s) \rightarrow Ag^+\ (aq) + NO_3^-\ (aq)$$

What happens when NaCl dissolves in water?

"The attack of the water molecules!"

We watched for these two processes:

1. Water bonds to the NaCl.

⇒ When water molecules are attracted to and bond to the solute, energy is released.

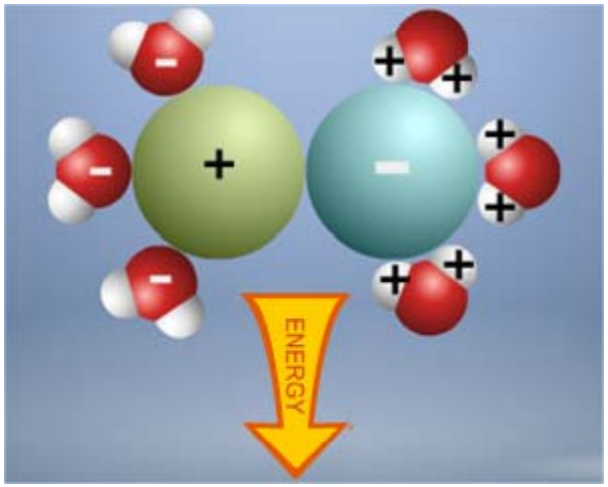
⇒ Energy goes into the solution. As a result, the solution warms. The temperature of the solution RISES.

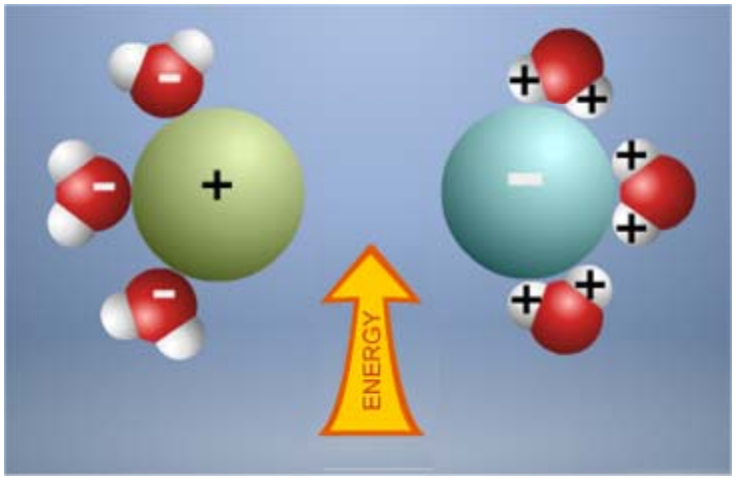
2. Water pulls apart NaCl.

⇒ It takes energy for the water molecules to pull on the solute to cause it to separate.

⇒ Energy comes from the solution. As a result, the solution cools. The temperature of the solution DROPS.

Energy flow





Dissolving process: Endothermic or Exothermic?

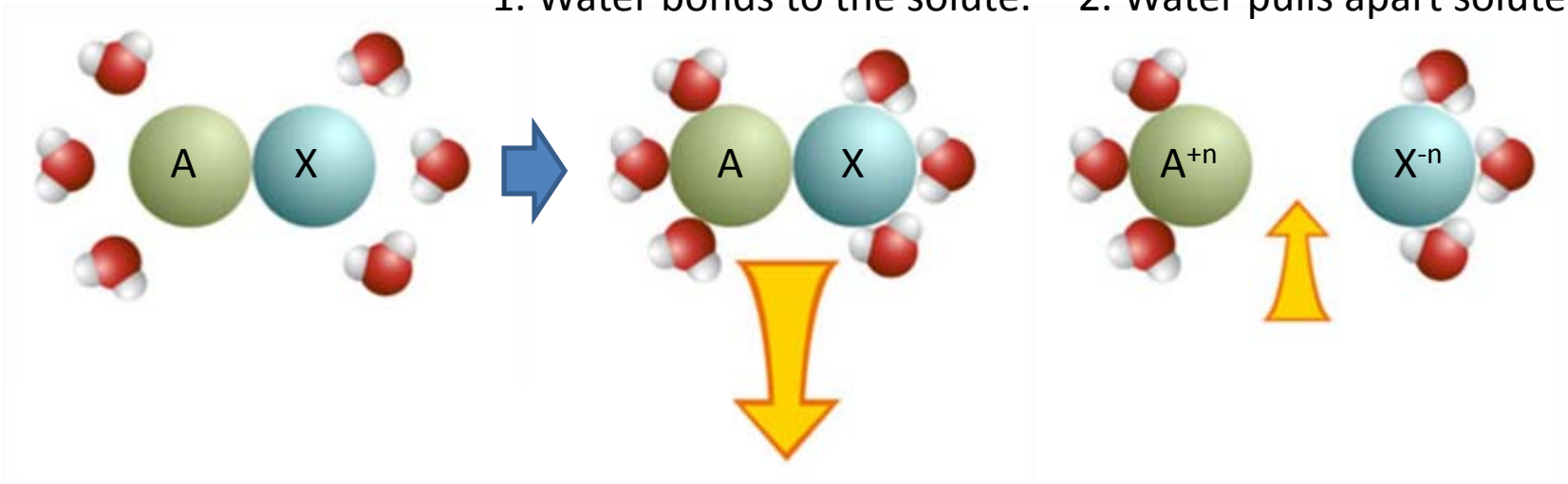
For a general dissolving process:

$$AX\,(s) \rightarrow A^{+n}\,(aq) + X^{-n}\,(aq) \quad + \text{Heat}$$

If more energy is released when water bonds to the solute than it takes to separate the solute, the dissolving process is exothermic and the temperature of the solution increases.

1. Water bonds to the solute.

2. Water pulls apart solute.



Large amount of energy released to the solution

Small amount of energy absorbed from the solution

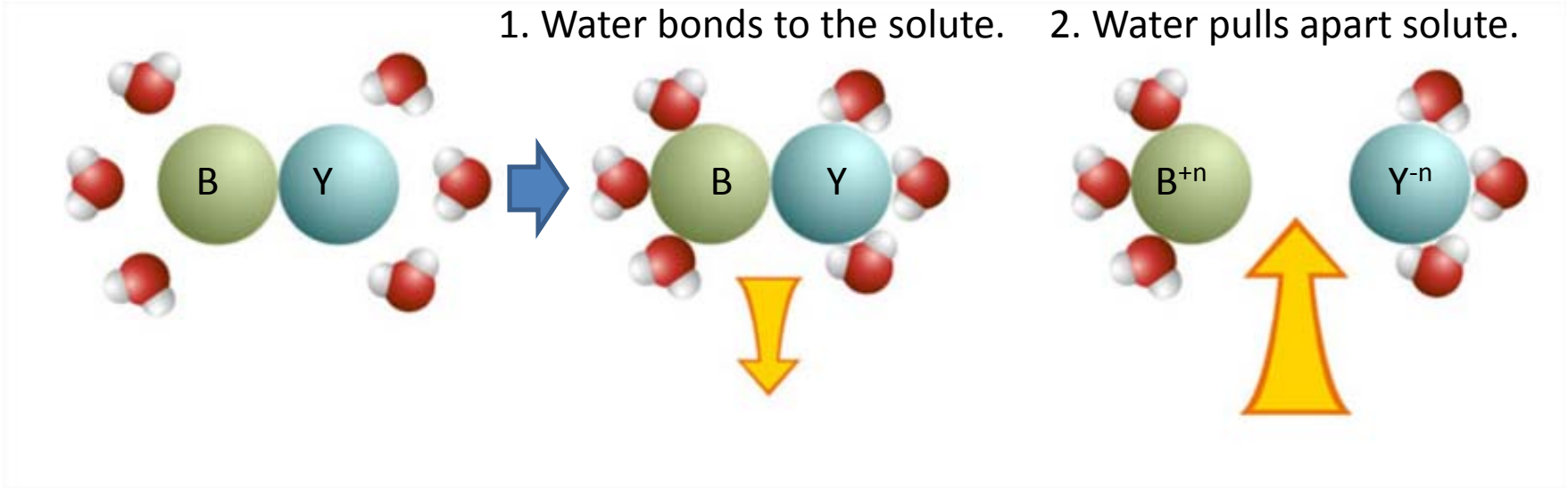
Exothermic: Temperature of solution increases

Dissolving process: Endothermic or Exothermic?

For a general dissolving process:

$$\text{Heat} + BY\,(s) \rightarrow B^{+n}\,(aq) + Y^{-n}\,(aq)$$

If less energy is released when water molecules bond to the solute than it takes to separate the solute, the dissolving process is endothermic and the temperature of the solution decreases.



Small amount of energy released to the solution

Large amount of energy absorbed from the solution

Endothermic: Temperature of solution decreases

Applications

Experiment 7 – Energy Accompanying Reactions

When the dissolving process is **endothermic**, the temperature of the solution will decrease as it is accompanied by a net absorption of energy. Heat can be included on the **left-hand side** of the chemical equation. When the dissolving process is **exothermic**, the temperature of the solution will increase as it is accompanied by a net release of energy. Heat can be included on the **right-hand side** of the chemical equation.

An application of an endothermic reaction is used to manufacture athletes' chemical ice packs, which usually contains water and a packet of ammonium chloride. The cold pack is activated by breaking the barrier which separates the ammonium chloride, and water. Once the barrier is broken, ammonium chloride begins to dissolve in water, and almost immediately, the pack becomes cold as the chemical reaction absorbs heat from its environment.

Applications

Hand warmer

Hand warmer is made with a very concentrated solution of a salt called sodium acetate, $NaC_2H_3O_2$. When the solution is triggered, the sodium and acetate ions are ready to bond with each other and with water molecules to form a crystal. As a result, energy is released.

Continue to try practice problems
in Maple TA.

Use Dimensional Analysis in ALL your
calculations!!