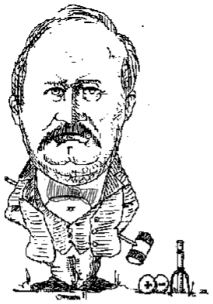
Chem 20 Unit C - Solutions, Acids and Bases

# Explaining Solutions



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Dr. Martyn Poliakoff
Proudly Presents:

# The Periodic Table Movie of the Day!!!

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# POS Checklist:

- ☐ explain dissolving as an endothermic or exothermic process with respect to the breaking and forming of bonds.
- ☐ differentiate between electrolytes and nonelectrolytes.

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**Review: Which of the following are solutions?**

**a) Milk**


**b) Pop**


**c) Pure Water**


**d) Smokey Air**

**e) Silty Water**

**f) Rainwater**

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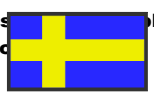
# Explaining Solutions

**One question that plagued early chemists was:**

**Why some solutions electrolyte and other no electrolyte?**

**"Why some subs le but others no s**

**For the answer, we turn to Sweden!**



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## Svante Arrhenius

- **in 1887, Arrhenius proposed that when an ionic substance dissolved, it breaks into ions in the solvent (water)**
- **he called this dissociation**

**Dissociation: the separation of ions when an ionic compound dissolves in water.**

- **these ions can carry a charge, allowing the solution to conduct electricity (= electrolyte)**

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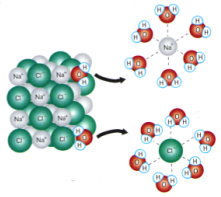
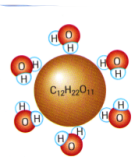
**Dissociation only occurs in ionic compounds, where ions are already present before dissolving.**



Dissociation
(ions are released into solution)




Not dissociation
(no ions released)

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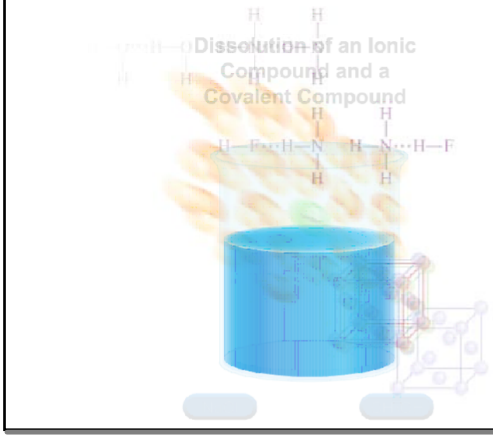


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**This can be shown using a dissociation equation:**

ex) $NaCl_{(s)} \longrightarrow Na^{+}_{(aq)} + Cl^{-}_{(aq)}$

ex) $K_2PO_{4(s)} \longrightarrow 2\,K^{+}_{(aq)} + PO_4^{2-}{}_{(aq)}$

***Note that the solvent water does not appear in the equations. It is indicated as being present by the state (aq).**

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**Pg 198 #2**

**ex) Write equations to represent the dissociation of the following ionic compounds when they are placed in water:**

**a) sodium fluoride**

**b) sodium phosphate**

**c) potassium nitrate**

**d) cobalt (II) chloride**

**e) aluminum sulfate**

**f) ammonium hydrogen phosphate**

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# Term Time

**Another term closely linked to dissociation is ionization:**

**Ionization: the process by which a molecule is converted to an ion.**

**You often hear that "bases dissociate, acids ionize".**

**I use the terms interchangeably, and at this point, its not important to worry about the difference.**

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**Arrhenius later expanded his theory to explain some basic properties of bases and acids.**

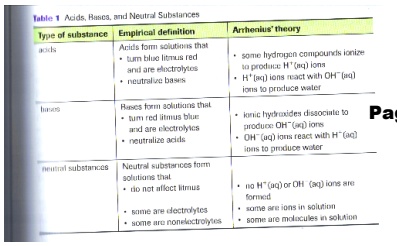

Table 1 Acids, Bases, and Neutral Substances

| Type of substance | Empirical definition | Arrhenius' theory |
|---|---|---|
| acids | Acids form solutions that<br>• turn blue litmus red and are electrolytes<br>• neutralize bases | • some hydrogen compounds ionize to produce $H^+(aq)$ ions<br>• $H^+(aq)$ ions react with $OH^-(aq)$ ions to produce water |
| bases | Bases form solutions that<br>• turn red litmus blue and are electrolytes<br>• neutralize acids | • ionic hydroxides dissociate to produce $OH^-(aq)$ ions<br>• $OH^-(aq)$ ions react with $H^+(aq)$ ions to produce water |
| neutral substances | Neutral substances form solutions that<br>• do not affect litmus<br>• some are electrolytes<br>• some are nonelectrolytes | • no $H^+(aq)$ or $OH^-(aq)$ ions are formed<br>• some are ions in solution<br>• some are molecules in solution |

**Page 199 Table 1**

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He believed that the hydroxide ion was (is) responsible for the properties of bases:

ex) $KOH_{(s)} \longrightarrow K^+_{(aq)} + OH^-_{(aq)}$

makes a base a base

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and that acids ionized to form hydrogen ions:

ex) $HCl_{(g)} \longrightarrow H^+_{(aq)} + Cl^-_{(aq)}$

makes an acid an acid

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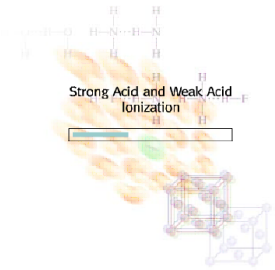


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## Energy Changes in Solutions

When compounds are mixed with water to create a solution, energy changes most often take place. The energy changes can be:

**endothermic - absorbs energy**

**exothermic - releases energy**

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Typically, the breaking of bonds requires energy (endothermic) and the forming of new bonds releases energy (exothermic).

When a substance goes into solution, bonds are both broken and formed.

**For example...**

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# Demo:

solution of calcium chloride

endothermic - absorbs energy
or
exothermic - releases energy

solution of sodium nitrate

endothermic - absorbs energy
or
exothermic - releases energy

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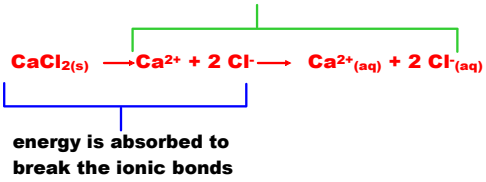
In $CaCl_2$:

energy is released as the ions form bonds with water




energy is absorbed to break the ionic bonds

**Overall, it takes more energy to make new bonds than to break the old ones, giving an exothermic reaction.**

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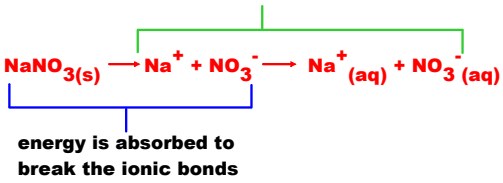
In $NaNO_3$:

energy is released as the ions form bonds with water




energy is absorbed to break the ionic bonds

**Overall, it takes more energy to break the old bonds then to make new bonds, giving an endothermic reaction.**

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**HW: Read Page 200-201 "Substances in Water"**

**Practice: page 202 #2, 4**

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