Outcomes:

- Describe and give examples of various types of solutions. Include: all nine possible types
- Describe the structure of water in terms of electronegativity and the polarity of its chemical bonds.
- Explain the solution process of simple ionic and covalent compounds, using visual, particulate representations and chemical equations. Include: crystal structure, hydration, dissociation
- Explain heat of solution with reference to specific applications. Examples: cold packs, hot packs
Solutions Intro Vocabulary:

1. Solute – The substance that **Dissolves** in a solution. (what is **Being dissolved**) Usually the **smaller part** of a solution

2. Solvent – The substance that **Dissolves a solute** to form a solution. (What **does** the dissolving) Usually the **larger part** of the solution

3. Solution – A **uniform** mixture that may contain solids, liquids, or gases. It is **homogeneous**. It is made up of at least a **solute** and a **solvent**.

Solutions

Homogeneous Solutions:
• a mixture that has a **UNIFORM COMPOSITION** throughout and always has a **SINGLE PHASE**. A **SOLUTION** is homogeneous.

Examples:

- Lemonade, sugar, cookie, jello, milk, hot dog, O.S. w/o pulp, tap water, kool-aid, pop

Heterogeneous Solutions
• a **MIXTURE** that **DOES NOT** have a **UNIFORM** composition. Heterogeneous **MIXTURES** are **NOT SOLUTIONS**.

Examples:

- C. Chip cookie, O.S. w/o pulp, bubble tea, spaghetti and meatballs, raisin bread, vomit, salad

http://newsexaminer.net/crime/one-person-dead-after-argument-over-favorite-kool-aid-flavor/

http://www.womansday.com/food-recipes/cooking-tips/tips/g1102/orange-juice/
# Types of Gas Solutions

<table>
<thead>
<tr>
<th>Solvent</th>
<th>Solute</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (gas)</td>
<td>Oxygen (gas)</td>
<td>Air</td>
</tr>
<tr>
<td>Air (gas)</td>
<td>Water (liquid)</td>
<td>Moist/Humid Air</td>
</tr>
<tr>
<td>Air (gas)</td>
<td>Carbon (solid)</td>
<td>Smoke</td>
</tr>
</tbody>
</table>
# Types of Liquid Solutions

<table>
<thead>
<tr>
<th><strong>Solvent</strong></th>
<th><strong>Solute</strong></th>
<th><strong>Example</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Water (liquid)</td>
<td>Carbon Dioxide (gas)</td>
<td>Carbonated water</td>
</tr>
<tr>
<td>Water (liquid)</td>
<td>Ethylene glycol (liquid)</td>
<td>Antifreeze</td>
</tr>
<tr>
<td>Water (liquid)</td>
<td>Sodium chloride (solid)</td>
<td>Ocean Water</td>
</tr>
</tbody>
</table>
# Types of Solid Solutions

<table>
<thead>
<tr>
<th>Solvent</th>
<th>Solute</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon (solid)</td>
<td>Poisonous Gases (gas)</td>
<td>Charcoal Filter</td>
</tr>
<tr>
<td>Silver (solid)</td>
<td>Mercury (liquid)</td>
<td>Tooth Filling</td>
</tr>
<tr>
<td>Copper (solid)</td>
<td>Zinc (solid)</td>
<td>Brass</td>
</tr>
</tbody>
</table>
Structure of Water:

Electronegativity:
- Indicates the relative ability of an element’s atoms to **ATTRACT ELECTRONS** in a chemical bond.

Polarity:
- The **POSITIVE** and **NEGATIVE CHARGES** in a molecule from **UNEQUAL SHARING** of electrons.

Draw a polar water molecule showing which ends are positive and negative.

The oxygen is more electronegative so the electrons in the chemical bond orient themselves more completely around the oxygen atom.

Note: “δ” Means “Partial”

https://socratic.org/questions/why-is-ammonia-hydrophilic
More Solutions Vocabulary:

Soluble:
- **ABILITY** of a substance to **DISSOLVE** in another substance
- Ex) **SALT** and **SUGAR** will dissolve in water.

Insoluble
- **INABILITY** of a substance to **DISSOLVE** in another substance.
- Ex) **DIAMONDS (CARBON)** are insoluble in water.

Miscible
- Ability of a **LIQUID** to form a solution with another **LIQUID** in all proportions
- Ex) **WATER** and **VINEGAR** will mix

Immiscible
- Inability of a **LIQUID** to form a solution with another **LIQUID** in all proportions.
- Ex) **OIL** and **WATER** will not mix
The Dissolving Process - Ionic

Here is what a crystal of NaCl looks like at the molecular level:

Here is what water looks like at the molecular level:
The Dissolving Process - Ionic

Questions:

1. Why do you think sodium chloride will dissolve in water?
   
   *The polar water molecules are attracted to the Na⁺ and Cl⁻ ions.*

2. Where on the salt would the process of dissolving occur?
   
   *At the surface of the solid.*
The Dissolving Process - Ionic

Here is the dissolving of NaCl in water.

1. the **BREAKING** of attractions between **SOLUTE** particles,
2. the **BREAKING** of attractions between **SOLVENT** particles,
3. The **FORMING** of attractions between **SOLUTE** and **SOLVENT** particles.
The Dissolving Process - Ionic

Dissolving IONIC Compounds:
→ Soluble Ionic compounds will dissolve and **dissociate** (break apart)

\[
\text{NaCl}_\text{(s)} \rightarrow \text{Na}^+\text{(aq)} + \text{Cl}^-\text{(aq)}
\]

**Let’s see how it works!!**

Here is another example

**Dissociation:**
• The **BREAKING UP** of IONIC compounds when they **DISSOLVE**.
• The reaction above is called a **DISSOCIATION REACTION**

**Example:**
Write the balanced dissociation reaction for the dissolving of Aluminum Sulphate:
The Dissolving Process - Covalent

Here is a molecule of common table sugar at the molecular level:

Here is what it looks like when sugar (a covalent molecule) dissolves:

http://chemistry.about.com/od/workedchemistryproblems/a/molecularmass.htm

http://www.dlt.ncssm.edu/core/
The Dissolving Process - Covalent

**Dissolving COVALENT Compounds**

→ Soluble covalent compounds will dissolve as a **WHOLE MOLECULE**

\[
C_{12}H_{22}O_{11} \text{(s)} \rightarrow C_{12}H_{22}O_{11} \text{(aq)}
\]

**Solvation:**

• When **COVALENT** molecules dissolve, they get **SURROUNDED** by the solvent molecules → called **SOLVATION**

**Example:**

Write the solvation reaction for the dissolving of octane (C\(_3\)H\(_8\))

**Note:**

Anytime a substance is dissolved by water, the process can be called **HYDRATION**.
The Dissolving Process - Covalent

Questions:

1. How is the dissolving of covalent compounds different than dissolving ionic compounds?
   - Covalent compounds separate into single molecules
   - Ionic compounds separate into ions

2. Which of the two solutions would most likely conduct electricity? Why?
   - The ionic solution → it has charges that can move!

https://tnrtb.wordpress.com/2013/05/20/water-designed-for-life-part-1-of-7/

Let's put it all together!
The Dissolving Process

Unsaturated Solution
- Contains **LESS SOLUTE** for a given **TEMPERATURE** and **PRESSURE** than a saturated solution. It **CAN** hold **MORE SOLUTE**.

Saturated Solution
- Contains the **MAXIMUM AMOUNT** of dissolved **SOLUTE** for a given amount of solvent at a specific **TEMPERATURE** and **PRESSURE**.

Supersaturated Solution
- Contains **MORE** dissolved **SOLUTE** than a saturated solution at the same **TEMPERATURE**. This is an **UNSTABLE** condition that is achieved by **HEATING** and then **COOLING**.

Equilibrium of AgCl

Soluble Salts Applet

Heat of Solution:

- Anytime attractions are **BROKEN**, **ENERGY** is **NEEDED**.
- Anytime attractions are **FORMED**, **ENERGY** is **RELEASED**.

*Remember that for a solute to dissolve...*

1. **SOLUTE** particles must **SEPARATE**
   - attractions are **BROKEN** so energy is **NEEDED**.
   - temperature goes **DOWN** (feels **COLDER**)

2. **SOLVENT** particles must **SEPARATE**
   - attractions are **BROKEN** and energy is **NEEDED**.
   - Temperature goes **DOWN** (feels **COLDER**)

3. **SOLUTE** and **SOLVENT** particles form **NEW ATTRACTIONS**
   - Energy is **RELEASED**
   - Temperature **RISES** (feels **HOTTER**)
Heat of Solution:

In the overall process of SOLUTION FORMATION heat is either ABSORBED or RELEASED.

Whether heat is ABSORBED or RELEASED depends on the two opposing processes. The two opposing processes are the BREAKING of attractions and the FORMING of attractions.

Exothermic
• When a solute dissolves and the overall solution INCREASES in temperature. The solution is WARM/HOT.
• The FORMING of bonds gave off MORE ENERGY than the BREAKING of bonds REQUIRED.

Endothermic
• When a solute dissolves and the overall solution DECREASES in temperature. The solution is COOL/COLD.
• The breaking of bonds REQUIRED more energy than the FORMING of bonds GAVE OFF.
Heat of Solution:

**Example:**

1. If more energy is released when new attractions between the solute particles are formed than when they were broken apart would the solution feel hot or cold?
Heat of Solution

How does a cold pack work?
• Instant cold packs have two sealed bags, one inside the other. The outer bag is made of thick strong plastic and contains a white **POWDER**, usually **AMMONIUM NITRATE**.

• The inner bag is made of a thin weak plastic bag and contains **WATER**.

• When the bag is twisted or squeezed, the **WATER MIXES** with the **POWDER**.

• Since the **DISSOLVING** of **AMMONIUM NITRATE** in **WATER** is **ENDOTHERMIC**, the bag containing the solution gets **COLD**.