Solutions

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- **Solution:** A homogeneous mixture of two or more substances on molecular level.
  - A solution can be physically separated
  - All portions of the solution have the same properties
- **Examples:** **salt water, blood, sugar water, gasoline**

Solutes and Solvents

- **Solute:** a substance that is dissolved to make a solution.
  - **when dissolved it separates into individual particles**
- **Solvent:** is a substance that dissolves a solute.
  - when the solute is dissolved into the solvent it is not possible to identify the solvent and solute as individual parts

- **The solvent is the largest part of the solution and the solute is the smallest part of the solution**

S	O	L	V	E	N	T
S	O	L	U	T	E	

Examples of Solutes and Solvents

- Saltwater

salt=solute

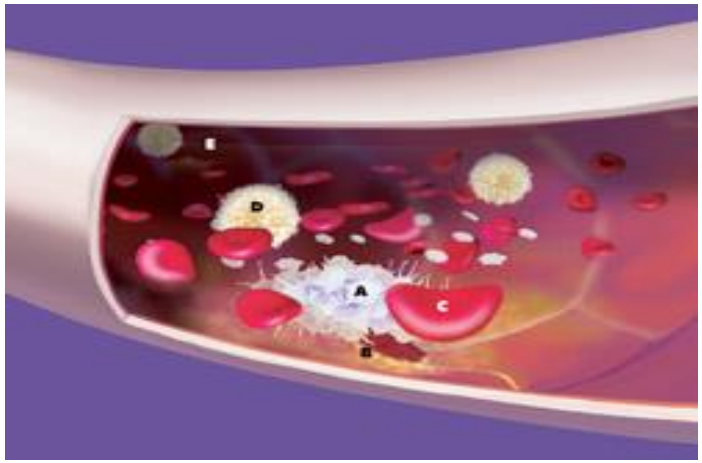
water=solvent

saltwaterfishing365.com

- Blood

calcium ions, sugars=solutes

water =solvent



ucdavismagazine.ucdavis.edu

TYPES AND EXAMPLES OF SOLUTIONS	
TYPES	**Example**
Solid/Solid	**Alloys (brass, etc.)**
Solid/Liquid	**Ocean water**
Solid/Gas	**Sulfur vapor in air**
Liquid/Solid	**Mercury in copper**
Liquid/Liquid	**Alcohol in water**
Liquid/Gas	**Fog**
Gas/Solid	**Hydrogen adhered to platinum**
Gas/Liquid	**Softdrink**
Gas/gas	**Air**

Examples of Solutions

askville.amazon.com

- **Solutions can be made from solids, liquids, and gases**
- **<u>Air:</u> solute=oxygen, solvent=nitrogen (oxygen is dissolved in nitrogen)**
- **Humidity: solute=liquid, solvent=gas (water is dissolved into air)**
- **Stainless steel: solute=chromium metal, solvent=iron (chromium metal is dissolved in iron to form a shiny steel)**

www.germes-online.com

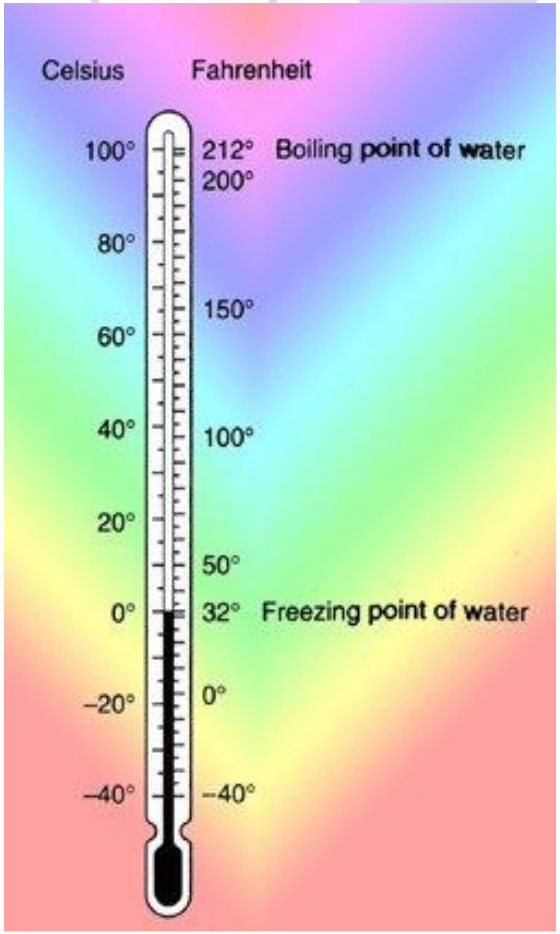
Properties of Solvents change in Solutions

- A solution's physical properties are different from the physical properties of the pure solvent.

- The amount of solute in the solution determines how much the physical properties of the solvent are changed

Lowering the freezing point

- Freezing point: temperature at which a liquid becomes a solid
- The freezing point of a liquid solvent decreases when a solute is dissolved in it.
- Example
  - Water, pure = 0 degrees C.
  - Water + salt = a freezing point lower than 0 degrees C.



coolcosmos.ipac.caltech.edu

Lowering the freezing point

- Making Ice Cream
  - Depends on lowering the freezing point of a solvent
  - Canister hold liquid ice cream ingredients
  - Put in a larger container containing ice and salt
    - Salt lowers the freezing point of the mixture
    - Causes ice to melt (absorbing heat from surroundings)
    - Ice cream mix is chilled when its contents are constantly stirred
    - Tiny ice crystals form all at once instead of gradually
    - Causing the ice cream to be smooth and creamy

Raising the boiling point

- **<u>Boiling point:</u>** temperature when a liquid turns into a gas

www.state.tn.us

- A solution's boiling point can be raised by the amount of solute in the solvent.
- Example:
  - Antifreeze added to cars prevent it from overheating or having the liquid's reach their boiling point

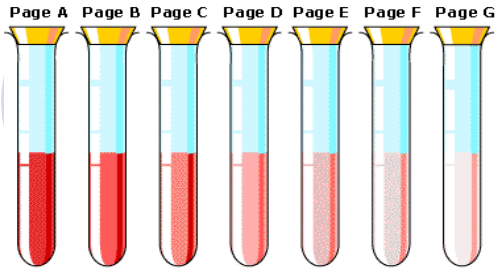
www.classic-car-magazine.co.uk

- **Concentration**: The amount of solute dissolved in a solvent at a given temperature.
- Examples:
  - Hot chocolate…the more powdered mix you add the higher the concentration of chocolate
  - Lemonade…the more frozen lemon concentrate or powdered mix you add the more tart the drink becomes

www.thesunblog.com

Degrees of Concentration

www.seroundtable.com



- **Dilute**: a solution has a low concentration of solute

- **Saturated:** a solution that contains the maximum amount of solute that can be dissolved into the solvent at a given temperature.

- **Supersaturated:** a solution can contain more solute than normal by raising the temperature of the solvent.

Ways to Express Concentrations

- **Mass percentage**
- **Mole fraction**
- **Molarity**
- **Molality**
- **Normality**

Mass Percent

- Solutions can also be represented as percent of solute in a specific mass of solution.
- For a solid dissolved in water, you use percent by mass which is Mass Percent.
- $$\% \text{ by mass} = \frac{\text{mass solute}}{\text{mass of solution}} \times 100$$

**Mass of solution = solute mass + solvent mass

Molarity

- Molarity is the concentration of a solution expressed in moles of solute per Liter of solution.
- Molarity is a conversion factor for calculations

$$\text{Molarity (M)} = \frac{\text{moles of solute}}{\text{Liters of solution}}$$

Molarity

$$M = \frac{\text{mol (solute)}}{\text{L (solution)}}$$

- Example 1: What is the molarity of a solution that has 2.3 moles of sodium chloride in 0.45 liters of solution?

$$\frac{2.3 \text{ moles NaCl}}{0.45 \text{ L}} = 5.1M \text{ NaCl}$$

Molarity

$$M = \frac{\text{mol (solute)}}{\text{L (solution)}}$$

- Example 2: How many grams of NaCl are needed to make 3.0 L of 1.5 M solution?

$$\frac{3.0\ \text{L}}{1} \left| \frac{1.5\ \text{mol NaCl}}{1\ \text{L}} \right| \frac{58.44\ \text{g NaCl}}{1\ \text{mol NaCl}}$$

$$= 260\ \text{g NaCl}$$

Solubility

- **Solubility**: the amount of the substance that will dissolve in a certain amount of solvent at a given temperature.

- The solubility of a solute can be changed
  - by raising the temperature
  - If solute is a gas…then you can change the pressure…higher pressure of gas in a liquid increases the amount of gas that can be dissolved

Solubility and Temperature

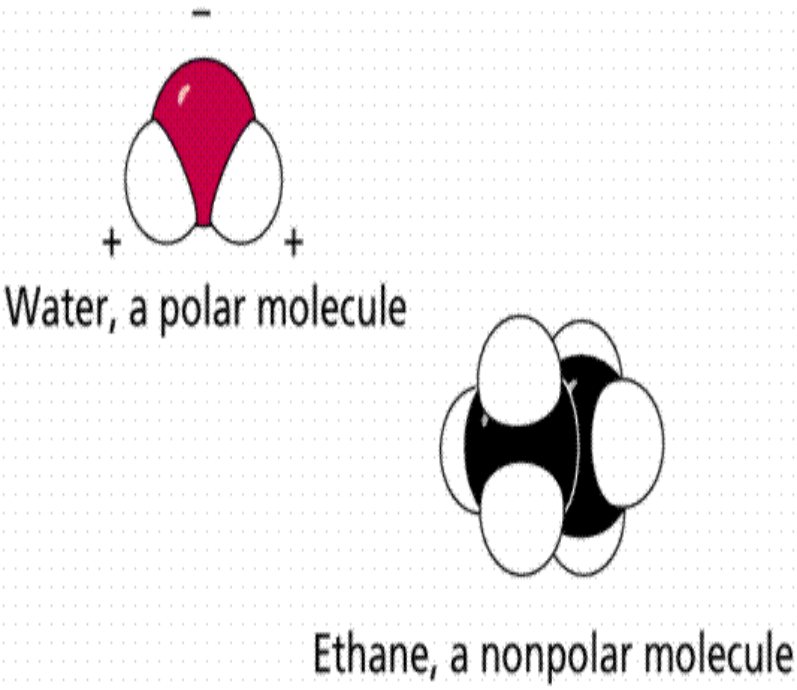
Solute	Increased Temperature	Decreased Temperature
Solid	Increase in solubility	Decrease in solubility
Gas	Decrease in solubility	Increase in solubility

Solubility and Pressure

Solute	Increased Pressure	Decreased Pressure
Solid	No effect on solubility	No effect on solubility
Gas	Increase in solubility	Decrease in solubility

Solubility depends on Molecular Structure

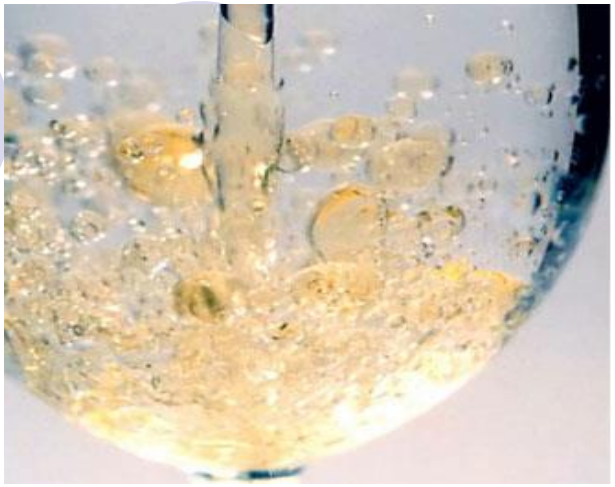
- When a substance dissolves, its molecules (covalent bonds) or ions (ionic bonds) separate from one another and become evenly mixed with molecules of the solvent



www.emc.maricopa.edu

- Water contains polar covalent bonds.
  - Negative region (O)
  - Positive region (H)

Polar and Nonpolar



www.historyforkids.org

- Water and oil do not mix
  - Water is polar…negative and positive regions
  - Oil is nonpolar...no charge
  - Molecules are not attracted to each other (opposite charges attract each other) so they do not mix
- Water and sugar or salt mix
  - Water is polar
  - Salt and sugar are also polar
  - Opposite charged molecules are attracted to each other

Solutions can be acidic, basic, or neutral

Acid	Base
Donate H^+ ion (proton…atomic number is 1=1 proton)	Can accept a H^+ ion...usually release an OH^- ion than can accept a H^+ ion.
Taste sour	Taste bitter
Produce burning or prickling sensation on skin	Feel slippery
React with most metals	

Common Household Acids & Bases

Acids

Bases

www.mhhe.com

pH scale

- pH scale: potential of Hydrogen
- Higher H^+ lower number (Acid)
- Lower H^+ higher number (Base)
- Range is 0-14, 7 is neutral
- Common Acids and Bases
  - Base: Soap pH 10
  - Acid: lemon juice pH 2
- Acids and Bases neutralize each other

Metal alloys are solid mixtures

- **Alloy:** a mixture of one or more metals and one or more other elements…made from melting and mixing

www.kengem.com

- Examples:
  - Brass: zinc and copper
  - Bronze: tin and copper
  - Stainless steel: chromium and iron

art-foundry.com

Liquid-Liquid Solutions

1. Phenol-water
2. Methanol-cyclohexane
3. Carbondisulphide-methanol
4. Hexane aniline

Azeotropic Mixture

Distribution Law