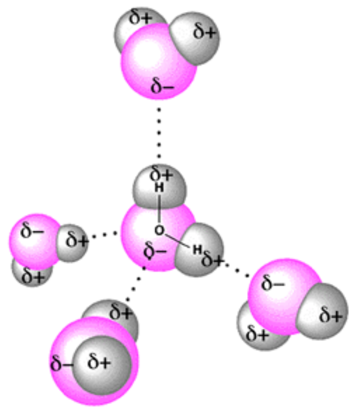
# Solutions

**Homogeneous** (uniform) **Mixture**
of two or more non-reacting substances

**Solvent** - component in greater amount
**Solute(s)** - lesser component(s)

**Dilute** - small amount of solute
**Concentrated** - large amount of solute

**Water** - universal solvent
dissolves so many
other substances
**Polar Molecule**
electronegativity
H 2.1
O 3.5
Where are the electrons?




**RULE:** Like dissolves like.
oil (non-polar) does not dissolve in water

**Solutions are not just liquids!** See Table 17-7.

**Adding solute to pure solvent:**
RAISES boiling point
LOWERS freezing point (salt in snow)

**Depending of the SIZE of particles in the solute, we can have:**

| SOLUTION | COLLOID | SUSPENSION |
|---|---|---|
| ← 10 Å → | ← 1000 Å → | |
| molecules | groups of molecules<br>small particles<br>Blood - Milk | particles |
| clear | ------------- scatter light | -------------- |
| | particles visible in<br>high power microscope | particles visible |
| | **remain suspended** | **eventually settle** |

**Dispersed Phase** - particles or solute
**Dispersing Medium** - solvent

See Tables 17-8 and 17-9.

## Acids and Bases

**ACID** - Robert Boyle
compound that in water solution will
taste sour ("acidus" ⇒ "sour")
turn litmus dye from blue ⇒ red
neutralizes bases
react with some metals producing $H_2$

**Arrhenius Theory:**
**ACID** - substance in water solution that
increases concentration of hydrogen (hydronium) ions

$HA \Leftrightarrow H^+ + A^-$ where $A$ = anything
molecules ions

**Acid dissociation constant**

$$K_a = \frac{[H^+][A^-]}{[HA]}$$

determines strength of the acid:

| acid | Formula | % | strength |
|---|---|---|---|
| acetic | $HC_2H_3O_2$ | 1.3 | weak |
| nitrous | $HNO_4$ | 1.5 | |
| sulfurous | $H_2SO_3$ | 20 | moderate |
| phosphoric | $H_3PO_4$ | 27 | |
| sulfuric | $H_2SO_4$ | 61 | strong |
| hydrochloric | HCl | 92 | |

**BASE** - compound that in water solution will
taste bitter
have a soapy feel
turn litmus dye from red ⇒ blue
neutralizes acids
increase hydroxide ion concentration

$B + H_2O \Leftrightarrow BH^+ + OH^-$

**Water Dissociates:** $H_2O \Leftrightarrow H^+ + OH^-$

with **Ionization Constant:**

$$K_I = \frac{[H^+][OH^-]}{[H_2O]}$$

in pure water and dilute solutions

$[H_2O]$ = concentration of $H_2O$ in water = constant, so

$$K_I[H_2O] = K_w = [H^+][OH^-] = 10^{-14}\ \text{mole}^2/\text{liter}^2$$

in **Neutral** solution $[H^+] = [OH^-] = 10^{-7}$ mole/liter (M)

**Acidic** solution $[H^+] > [OH^-]$, $[H^+] > 10^{-7}$ M

**Basic** solution $[H^+] < [OH^-]$, $[H^+] < 10^{-7}$ M

| $[H^+]$ | $10^{-14}$ | $10^{-7}$ | $10^0=1$ |
|---|---|---|---|
| | BASE | NEUTRAL | ACID |
| pH | 14 | 7 | 0 |

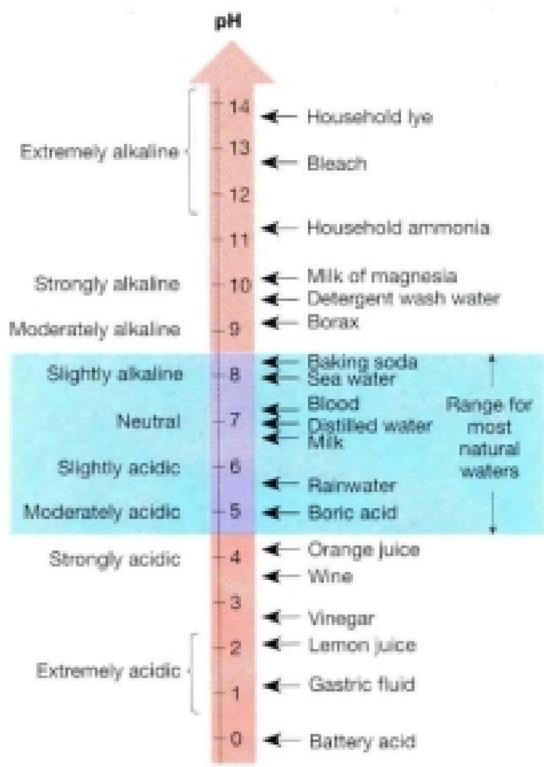
**pH Scale**

Sven Sörensen (1868-1939)

$$pH = -\log_{10}[H^+]$$

- > 7 Basic
- = 7 Neutral
- < 7 Acidic

Extremely important for many biological processes




17-19

Agriculture soil pH ~ 6

Seawater pH ~ 8

many marine organisms die if pH < 7.5

Blood 7.3 < pH < 7.5

death if pH < 7 or pH > 7.8

Rain water normal pH ~ 5.7

passed through polluted air pH ⇒ 3

acid rain