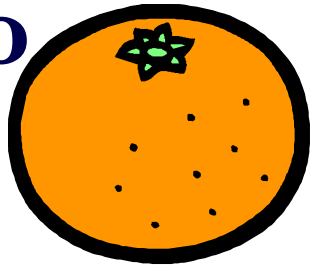
Acids and Bases

Chapters 20 and 21

Acid and Bases

- Have a sour taste. Vinegar is a solution of acetic acid. Citrus fruits contain citric acid.
- React with certain metals to produce hydrogen gas.



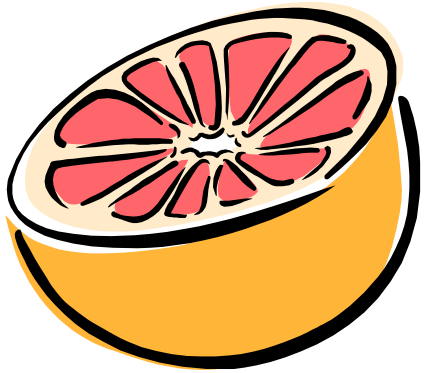
- React with carbonates and bicarbonates to produce carbon dioxide gas.

Bases

- Have a bitter taste.
- Feel slippery. Many soaps contain bases.

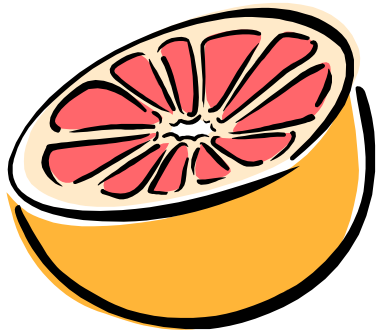
Some Properties of Acids

- Produce H^+ (as H_3O^+) ions in water (the "hydronium" ion is a hydrogen ion attached to a water molecule)
- Taste sour
- Corrode metals



Some Properties of Acids

- Electrolytes
- React with bases to form a salt and water
- pH is less than 7
- Turns blue litmus paper to red



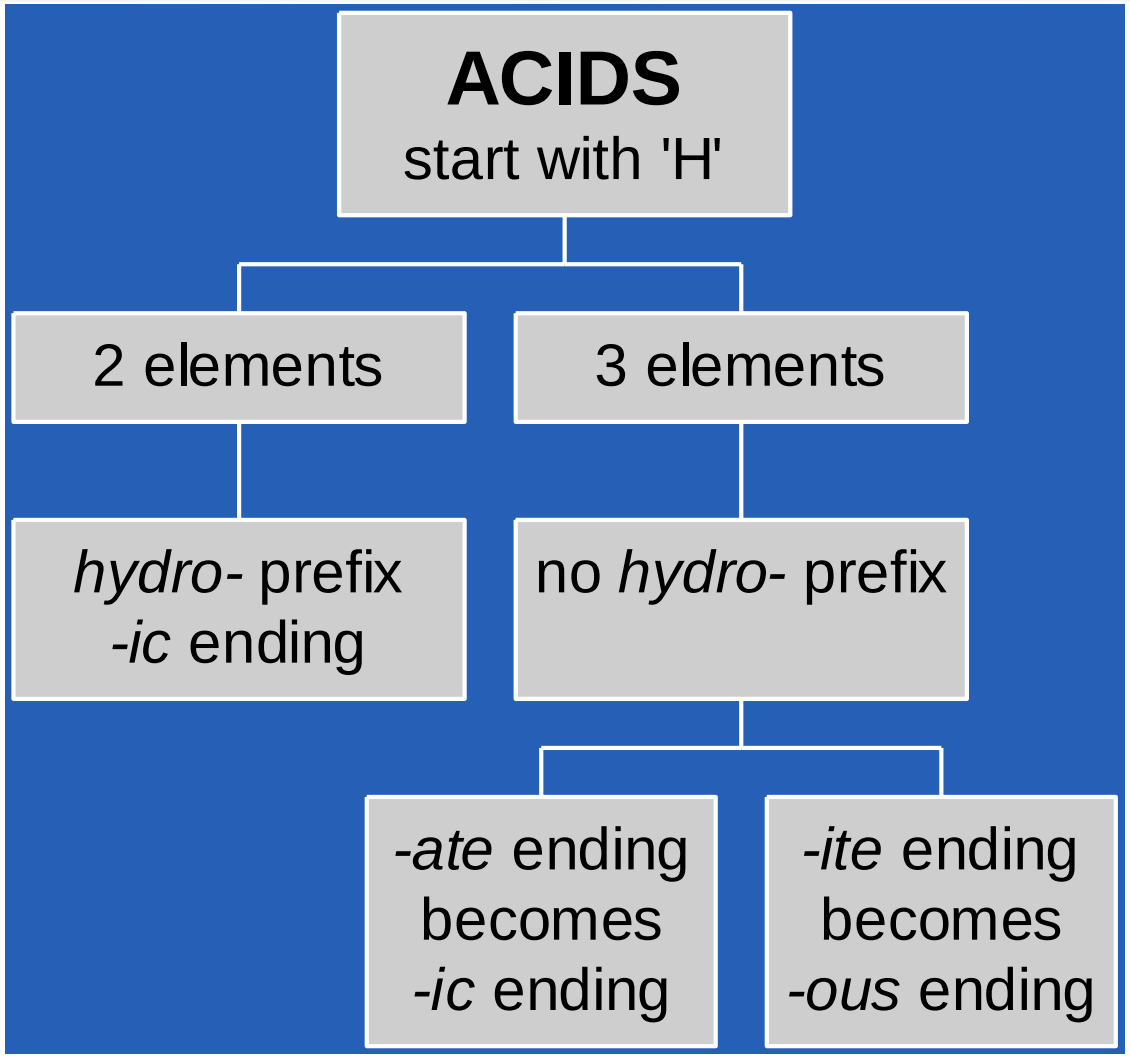
Acid Nomenclature Review

	Anion Ending	Acid Name
Binary →	*-ide*	*hydro*-(stem)-*ic acid*
Ternary	*-ate*	(stem)-*ic acid*
	-ite	(stem)-*ous acid*

An easy way to remember which goes with which…

"In the cafeteria, you ATE something ICky"

Acid Nomenclature Flowchart



Acid Nomenclature Review

$HBr_{(aq)} \rightarrow$ hydrobromic acid

$H_2CO_3 \rightarrow$ carbonic acid

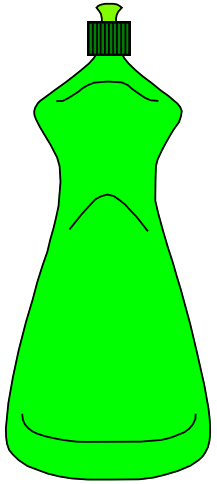
$H_2SO_3 \rightarrow$ sulfurous acid

Polyprotic Acids

- Polyprotic Acid:
  - An acid containing more then one acidic hydrogen
  - Examples:
    - Phosphoric acid: H_3PO_4 – 3 acidic hydrogens
    - Carbonic acid: H_2CO_3 – 2 acidic hydrogens
    - Sulfuric acid: H_2SO_4 – 2 acidic hydrogens

Some Properties of Bases

- Produce OH^- ions in water
- Taste bitter, chalky
- Are electrolytes
- Feel soapy, slippery
- React with acids to form salts and water
- pH greater than 7
- Turns red litmus paper to blue "Basic Blue"



Some Common Bases

$NaOH \rightarrow$ lye

$KOH \rightarrow$ liquid soap

$Ba(OH)_2 \rightarrow$ used in plastics

$Mg(OH)_2 \rightarrow$ Milk of Magnesia

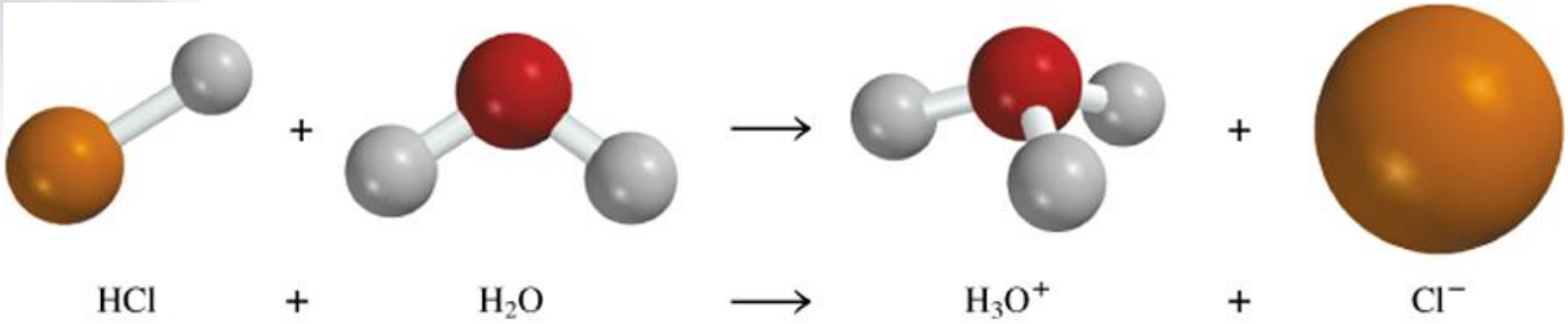
$Al(OH)_3 \rightarrow$ Maalox

Acid/Base definitions

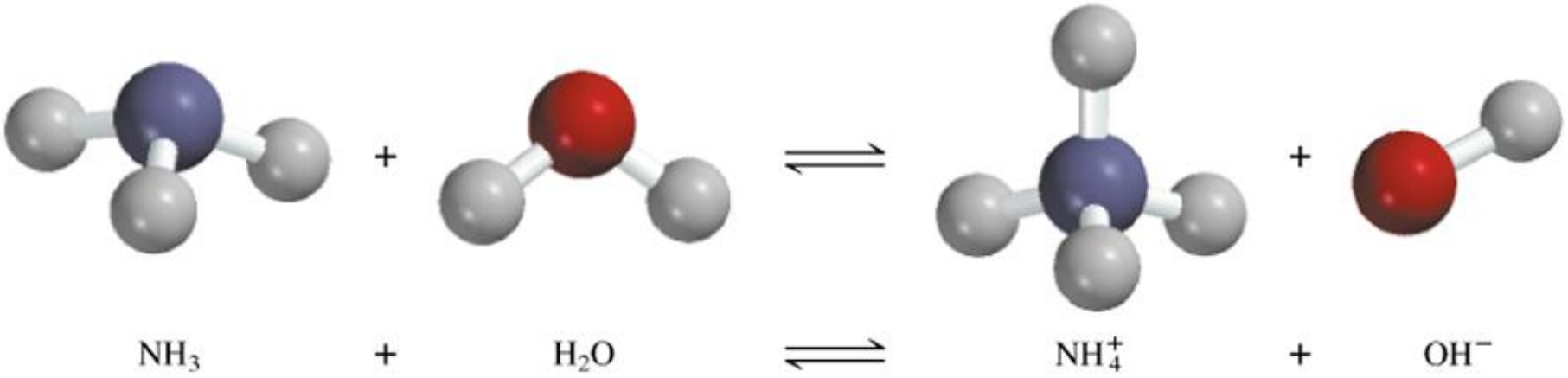
Definition #1: Arrhenius (traditional)

- Acids – produce H^+ ions (or hydronium ions H_3O^+)
- Bases – produce OH^- ions
- Problem: some bases don't have hydroxide ions!

Arrhenius acid is a substance that produces H^+ (H_3O^+) in water



Arrhenius base is a substance that produces OH^- in water



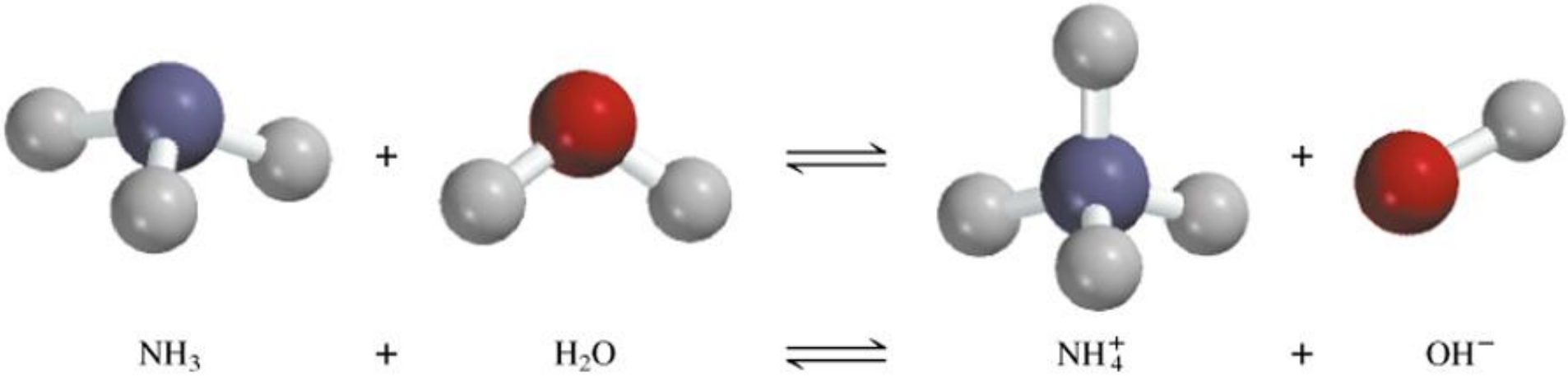
Acid/Base Definitions

Definition #2: Brønsted – Lowry

- Acids – proton donor
- Bases – proton acceptor
- A “proton” is really just a hydrogen atom that has lost it’s electron!

A Brønsted-Lowry acid is a proton donor

A Brønsted-Lowry base is a proton acceptor



base

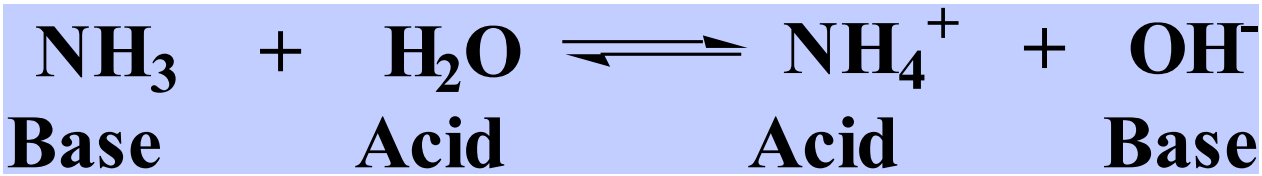
acid

conjugate acid

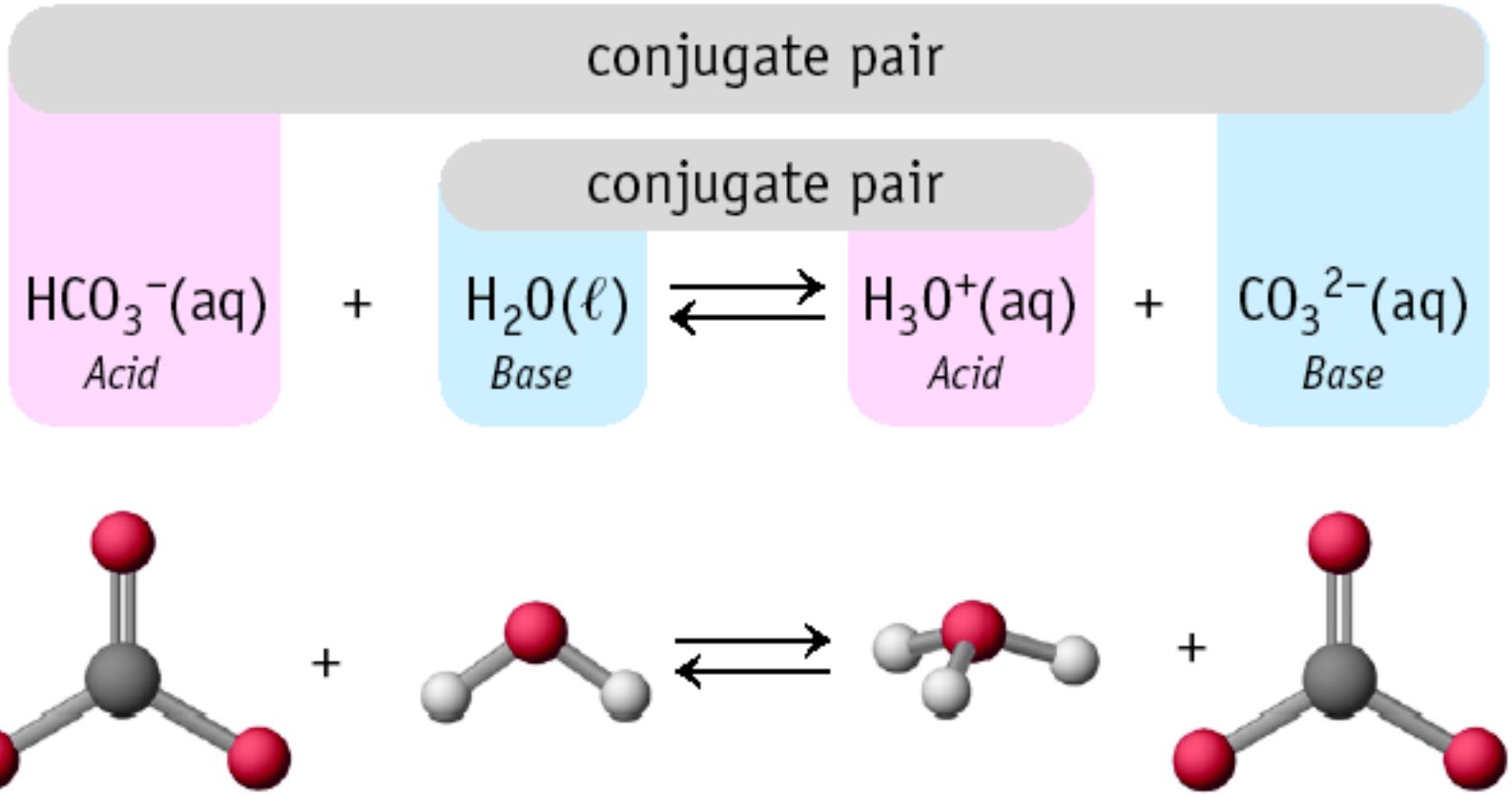
conjugate base

Brønsted-Lowry

The Brønsted definition means NH_3 is a BASE in water — and water is itself an ACID

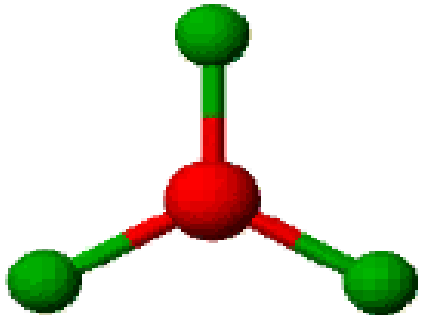


Conjugate Pairs



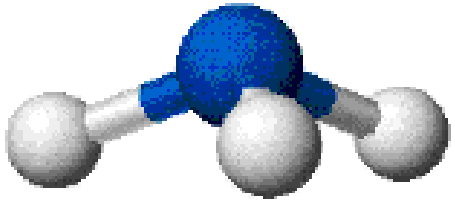
Acids & Base Definitions

Lewis acid - a substance that accepts an electron pair



BF_3, the boron atom is surrounded by only three electron pairs.

Lewis base - a substance that donates an electron pair



NH_3, the N atom has three bond pairs and one lone pair of electrons.

Definitions of Acids & Bases

	Acid	Base
Arrhenius	H^+ donor	OH^- donor
Bronsted-Lowry	p^+ donor	p^+ acceptor
Lewis	e^- pair acceptor	e^- pair donor

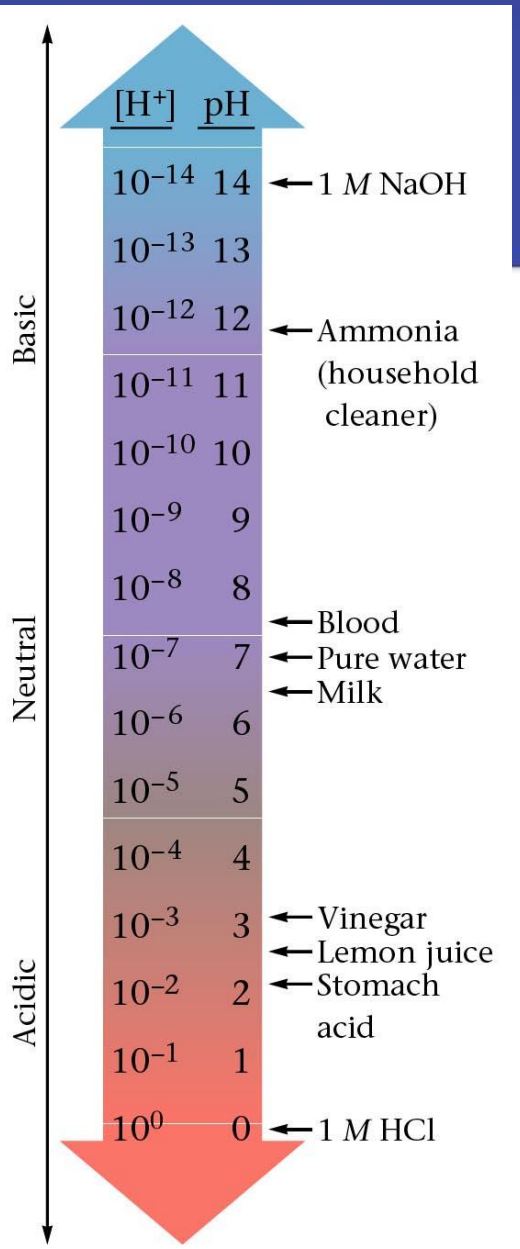
The pH scale

The pH scale is a way of expressing the strength of acids and bases. Instead of using very small numbers, we just use the NEGATIVE power of 10 on the Molarity of the H^+ (or OH^-) ion.

Under 7 = acid

7 = neutral

Over 7 = base



The pH scale

- pH is a logarithmic scale, similar to the Richter scale used to measure earthquakes.
- An acid with a pH of 2 is ten times stronger than a pH 3 solution.
- An acid with a pH of 1 is ten times stronger than a pH 2 solution.

pH of Common Substances

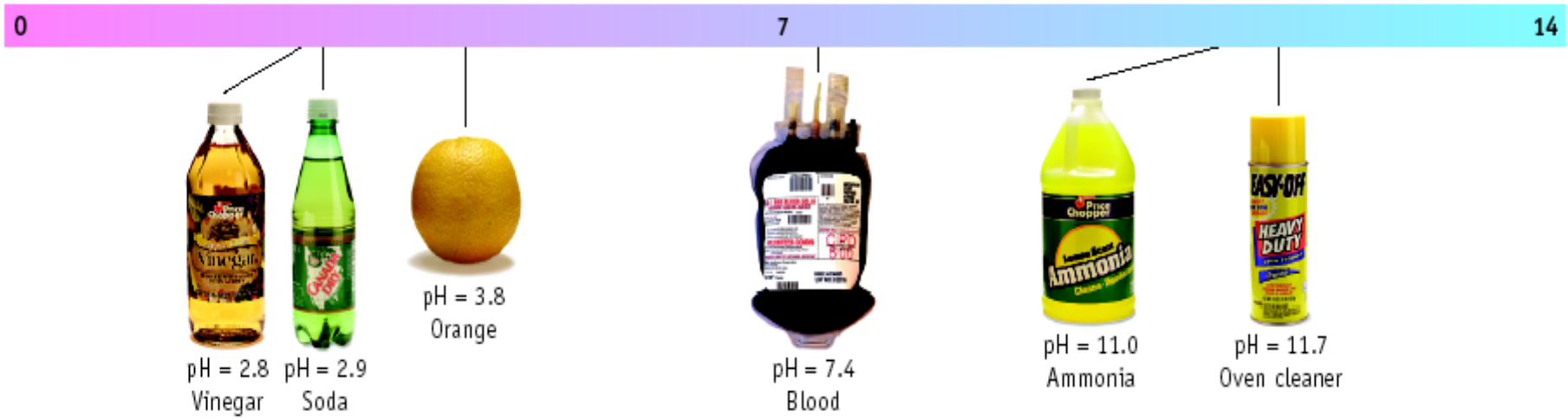


Figure 5.17 **pH values of some common substances.** Here the "bar" is colored red at one end and blue at the other. These are the colors of litmus paper, commonly used in the laboratory to decide if a solution is acidic (litmus is red) or basic (litmus is blue). *(Charles D. Winters)*

Self-Ionization

- Water is neutral when the $[H_3O^+] = [OH^-]$
- <u>Water dissociation constant</u> (K_w) – constant rate at which water dissociates
  - Different at each temperature
- $K_w = [H_3O^+][OH^-]$

  $= [1 \times 10^{-7}\ M][1 \times 10^{-7}\ M]$

  $\mathbf{= 1 \times 10^{-14}\ M^2}$

Calculating the pH

$$pH = - \log [H+]$$

Example: If $[H^+] = 1 \times 10^{-10}$

$pH = - \log 1 \times 10^{-10}$

$pH = - (- 10)$

$pH = 10$

Example: If $[H^+] = 1.0 \times 10^{-5}$

$pH = - \log 1.0 \times 10^{-5}$

$pH = - (-5.0)$

$pH = 5.0$

pH and pOH

- The pH and pOH total is equal to 14.00

$$pH + pOH = 14.00$$

- This relationship allows us to determine the pH if the pOH is known
- pH = 14.00 – pOH = 14.00 – 2.00

= 12.00

Concentrations from pOH

- If you can calculate the pOH from your $[OH^-]$, can you do the reverse? Yes!
- How? Rearrange your parent equation!

$$pOH = - \log [OH^-]$$

$$-pOH = \log [OH^-]$$

$$\text{Inverse log } (-pOH) = [OH^-]$$

$$\mathbf{10^{-pOH}} = [OH^-]$$

Neutralization

- Acids & Bases react to form water and a salt (ionic compound).
- When combined in the correct amounts, all the OH^- and H^+ ions combine to form water molecules.
- The resulting solution is neutral.

Acid-Base Titrations

- **Titration**:
  - The process of determining the concentration of one substance in a solution by reacting it with a solution of another substance that has a known concentration.
  - Add the known substance until the reaction between the two substances is complete: **equivalence point**
  - Shown by an **indicator**: changes color due to sensitivities of acids and bases
  - **End point**: the point at which the indicator changes color