Arrhenius Theory of Acids and Bases

1. Acids = aqueous solutions with excess H^{+1} ions
2. Bases = aqueous solutions with excess OH^{-1} ions
3. Acid + Base → Water and a Salt

Ammonia (NH_3) is a base, but it has no hydroxide ions.
An alternate theory (Bronsted-Lowry) explains it.

ammonia accepts H^{+1} water donates H^{+1}

$$NH_3 + H_2O \rightarrow NH_4^{+1} + OH^{-1}$$

ammonia + water → ammonium + hydroxide

NH_3 is a base because it accepts a H^{+1} ion
H_20 is an acid because it donates a H^{+1} ion

4 ways to describe an ACID with chemical symbols

H^{+1} Arrhenius style

p^{+1} a hydrogen ion is really just a proton

any substance able to donate a H^{+1} ion,
according to the alternate theory

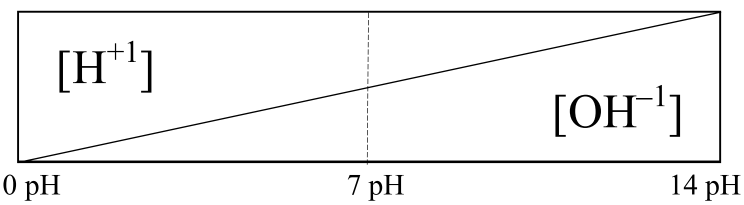
H_3O^{+1} the dreaded, silly, hydronium ion where
the H^{+1} ion "becomes one" with the water!

Acid Base Indicators are (mostly) weak acids in Dynamic Equilibrium. The molecule and the anion are different colors. A LeChatlier Shift caused by the "stress" of adding acid or base shifts forward or reverse.
This example is PHENOLPHTHALIEN.

$$HC_{20}H_{13}O_4 \rightleftharpoons H^{+1} + C_{20}H_{13}O_4^{-1}$$

colorless molecule pink anion

← Add H^{+1}
Add OH^{-1} →



Acids have a low pH, they also have LOTS of H^{+1} ions, and very few OH^{-1} ions.

Bases have a high pH, they also have lots of OH^{-1} ions, and very few H^{+1} ions.

Neutral means the # H^{+1} = # of OH^{-1}

Titration Formula (fixed)

$$(\#H^{+1})(M_AV_A) = (M_BV_B)(\#OH^{-1})$$

which means

$\#H^{+1}$ is the number of hydrogen ions in the acid formula
M_A is the molarity of the acid, V_A is the volume of the acid

M_B is the molarity of the base, V_B is the volume of the base
$\#OH^{-1}$ is the number of hydroxides in the base formula.

Strong Acids dissociate (or ionize) almost completely.

$$HCl + water \rightarrow H^{+1}_{(AQ)} + Cl^{-1}_{(AQ)}$$

In water, weak acids dissociate (ionize) into dynamic equilibrium. All molecules dissolve because they are polar, but most stay "whole".

$$HC_2H_3O_2 \rightleftharpoons H^{+1}_{(AQ)} + C_2H_3O_2^{-1}{}_{(AQ)} + HC_2H_3O_{2(AQ)}$$

pH is the measure of strength of the acid or base.
$[H^{+1}]$ is the molarity of the hydrogen ions.

$$pH = -\log [H^{+1}]$$

High Molarity of H^{+1}

pH 0 means: $[H^{+1}] = 1 \times 10^{0}$ moles H^{+1}/ liter
pH 1 means: $[H^{+1}] = 1 \times 10^{-1}$ moles H^{+1}/ liter
pH 3 means: $[H^{+1}] = 1 \times 10^{-3}$ moles H^{+1}/ liter
pH 7 means: $[H^{+1}] = 1 \times 10^{-7}$ moles H^{+1}/ liter
pH 11 means: $[H^{+1}] = 1 \times 10^{-11}$ moles H^{+1}/ liter
pH 14 means: $[H^{+1}] = 1 \times 10^{-14}$ moles H^{+1}/ liter

↓

Low Molarity of H^{+1}