5/14/19

Acids + Bases

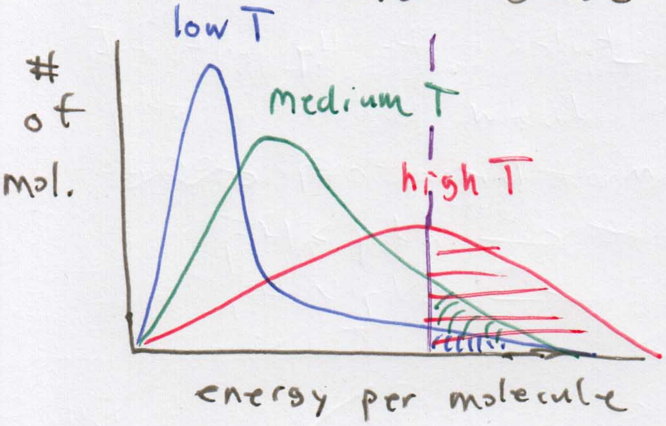
dissociate - to break a bond

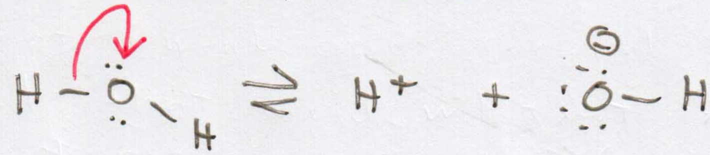
Arrhenius definition

acid - substance that dissociates to produce H^+ (proton)

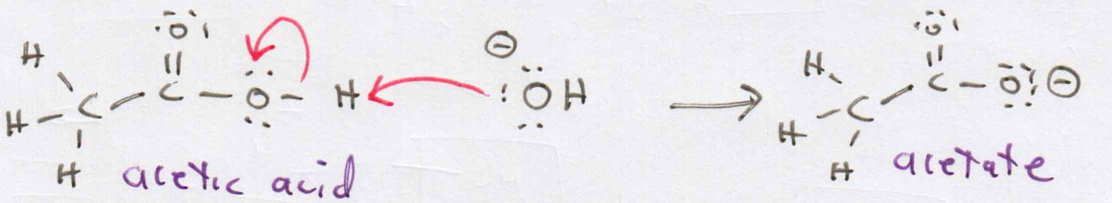
base - substance that dissociates to produce OH^-

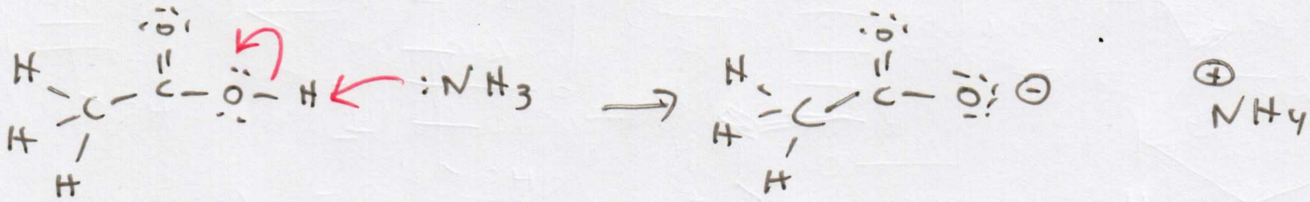
acid + base → water + salt





At any temperature, there is some fraction of water molecules that are able to dissociate due to the amount of energy that they have. This process is known as the auto-ionization of water. This process is why one of the definitions of acids + bases revolves around H^+ + OH^-.



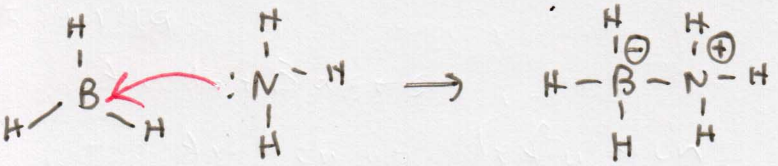


Brønsted-Lowry definition

acid - substance that dissociates to make H^+
proton donor

base - substance that reacts with H^+
proton acceptor

NH_3 is a Brønsted-Lowry base because it does react with H^+, but it is not an Arrhenius base since ammonia does not have OH^- as part of its structure,



Lewis definition -
acid - accepts electron pair
base - donates electron pair

$10^1 = 10$ $10^2 = 100$ $10^3 = 1000$

$\log_{10} 1000 = 3$

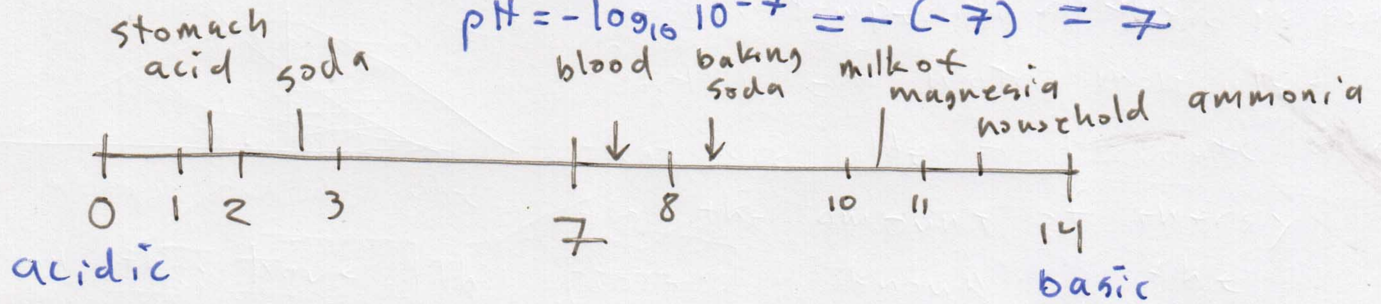
neutral - the concentrations of H^+ and OH^- are equal

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

concentration in terms of molarity → $[H^+]$

In neutral water at 25°C,
$[H^+] = 1.0 \times 10^{-7}$

$pH = -\log_{10} 10^{-7} = -(-7) = 7$



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neutralize - to react equal moles of acids + bases
(assuming the acids only dissociate to make one H^+ and bases only react with one H^+)

$HCl_{(aq)} + NaOH_{(aq)} \rightarrow H_2O_{(l)} + NaCl_{(aq)}$
acid   base   water   salt

$CH_3COOH_{(aq)} \rightleftharpoons H^+_{(aq)} + CH_3COO^-_{(aq)}$ ← only around 1% dissociation occurs

↑ reversible reaction arrow

weak acid - a substance that only undergoes minimal dissociation in solution to produce H^+

strong acid - a substance that extensively or completely dissociates in solution to produce H^+

$HCl_{(aq)} \rightleftharpoons H^+_{(aq)} + Cl^-_{(aq)}$

↑ >99.9% dissociation occurs

Strong acids - HCl, HNO_3, H_2SO_4

HCl - hydrochloric acid

HNO_3 - nitric acid

H_2SO_4 - sulfuric acid

NO_3^- - nitrate

ate → ic

ion → acid

$$H_2SO_4(aq) \rightleftharpoons 2H^+(aq) + SO_4^{-2}(aq)$$

weak acids -

CH_3COOH - acetic acid

HF - hydrofluoric acid

HCN - hydrocyanic acid

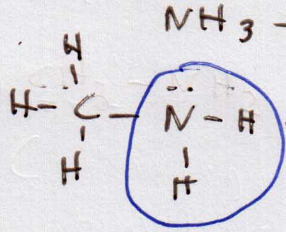
strong bases

$NaOH$ - sodium hydroxide

KOH - potassium hydroxide

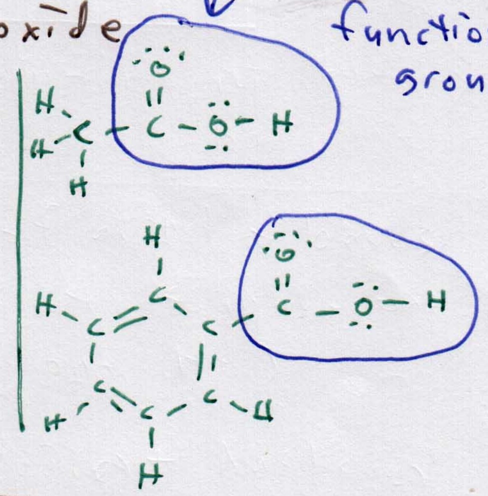
weak bases

NH_3 - ammonia



- an example of an amine (contains $-NH_2$)

carboxylic acid - a type of functional group



$$CO_2 + H_2O \rightleftharpoons H_2CO_3$$

carbonic acid

Indicators - a substance that changes color depending on pH

phenolphthalein - an indicator that turns clear in acidic solutions and pink in basic solutions

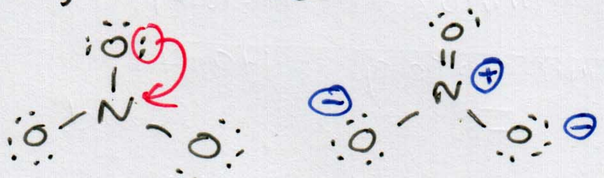
$H_2CO_3(aq) \rightleftharpoons H^+ + HCO_3^-(aq) \rightleftharpoons 2H^+(aq) + CO_3^{-2}$

acid-base conjugate pair – two substances that differ in formula only by an H^+

buffer solution – a solution that contains an acid/base conjugate pair which can resist changes in pH due to the addition of (small quantities of) an acid or a base.

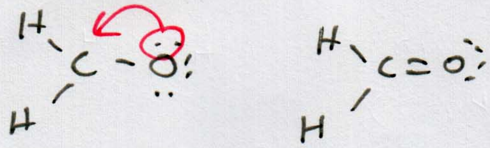
HCO_3^- / CO_3^{-2}

1a) $NO_3^- \rightarrow 24e^-$



b) $HCN \rightarrow 10\ e^-$

c) $H_2CO \rightarrow 12e^-$



2) $C_5H_{12} + 8\ O_2 \rightarrow 5CO_2 + 6\ H_2O$

3) $4\ NH_3(g) + 5\ O_2(g) \rightarrow 4\ NO(g) + 6\ H_2O(g)$

↑ 20.00g

$$\frac{20.00\text{g } NH_3}{1} \times \frac{1\text{ mol } NH_3}{17.04\text{g } NH_3} \times \frac{5\text{ mol } O_2}{4\text{ mol } NH_3} \times \frac{32.00\text{g } O_2}{1\text{ mol } O_2} = 46.95\text{g } O_2$$

5) 3.5 g salt in 97.0 g H_2O

$$\frac{3.5\text{g salt}}{100.5\text{g total}} \times 100\% = 3.48\%$$

$$\frac{3.5\text{g salt}}{100.5\text{g total}} \times 1{,}000{,}000 = 34{,}800\text{ ppm}$$