ACID

PROTON DONOR	H+
Arrhenius Concept	increases H+ in water (ex. H3O+)
Bronsted-Lowry Concept	can donate a proton (H+)
Lewis Concept	electron pair acceptor (covalent bond created)
strong acids	dissociate fully (100% ionized)
weak acids	dissociate partially (<100% ionized)

tart/sour taste

ACID/BASE REACTIONS

can be ions or substances	not limited to (aq) solutions

some react as acid or base depending on other reactant

salt	ionic compound, product of acid base reaction, does **NOT** contain OH-, not metal oxide

ex. HCl (aq) + KOH (aq) ----> KCl (aq) + H2O

AUTOIONIZATION OF WATER

small % of water undergoes ionization to produce ions

Kw = 1 × 10^-14

ex. H2O (l) + H2O (l) --> H3O+ (aq) + OH- (aq)

in pure water.... [H3O+] × [OH-] = 10^{-14} and [H3O+] = [OH-] = 10^{-7}

*the product between the molar concentrations of **hydronium ion** and **hydroxide ion** is a constant*

pH SCALE

ACID	BASE
pH = -log[H3O+] OR [H3O+] = 10^-pH	pOH = -log[OH-] OR [OH-] =10^-pH

pH = -log[H+]
-pH = log[H3O+]
10 10
[H+] = 10^-pH

ACID IONIZATION CONSTANT, Ka

WEAK ACID IONIZATION	equilibria of weak acid
HA (aq) + H2O⇄$H3O^+$(aq) + A-	**Ka = [H+][A-]/[HA]**
pKa = -logKa	
pH = -log [H3O+]	[H3O+] = 10^{-pH}
pOH = -log[OH-]	[OH-] = 10^{-pH}
p = -log	
Degree of Ionization, α	neutral molecule splits into charged ions when exposed in a solution
α of weak acid/base in water = fraction of total concentration that has formed ions	ex. HA(aq) + H2O⇄$H3O^+$(aq) + A- (aq)
% ionization (*weak acid*) =	[A-] eq/[HA] orginally × 100%

the larger the Ka, the stronger the acid

Ka Table

ACID-IONIZATION CONSTANTS AT 25°C*

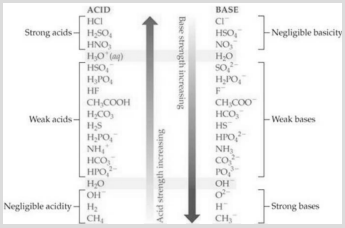
Substance	Formula	Ka
Acetic acid	$HC_2H_3O_2$	1.7×10^{-5}
Benzoic acid	$HC_7H_5O_5$	6.3×10^{-5}
Boric acid	H_3BO_3	$Ka_1 5.9 \times 10^{-10}$
Carbonic acid	H_2CO_3	$Ka_1 = 4.3 \times 10^{-7}$
	HCO_3^-	$Ka_2 = 4.8 \times 10^{-11}$
Cyanic acid	HOCN	3.5×10^{-4}
Formic acid	$HCHO_2$	1.7×10^{-4}
Hydrocyanic acid	HCN	4.9×10^{-10}
Hydrofluoric acid	HF	6.8×10^{-4}
Hydrogen sulfate ion	HSO_4^-	1.1×10^{-2}
Hydrogen sulfide	$H_2S \rightleftharpoons HS^- + H_3O^+$	$Ka_1 = 8.9 \times 10^{-8}$
	$HS^- \rightleftharpoons S^{2-} + H_3O^+$	$Ka_2 = 1.2 \times 10^{-13}$†
Hypochlorous acid	HClO	3.5×10^{-8}
Nitrous acid	HNO_2	4.5×10^{-4}
Oxalic acid	$H_2C_2O_4$	$Ka_1 = 5.6 \times 10^{-2}$
	$HC_2O_4^-$	$Ka_2 = 5.1 \times 10^{-5}$
Phosphoric acid	H_3PO_4	$Ka_1 = 6.9 \times 10^{-3}$
	$H_2PO_4^-$	$Ka_2 = 6.2 \times 10^{-8}$
	HPO_4^{2-}	$Ka_3 = 4.8 \times 10^{-13}$
Phosphorous acid	H_3PO_3	$Ka_1 = 1.6 \times 10^{-2}$
	$H_2PO_3^-$	$Ka_2 = 7 \times 10^{-7}$
Propionoic acid	$HC_3H_5O_2$	1.3×10^{-5}
Pyruvic acid	$HC_3H_3O_3$	1.4×10^{-4}
Sulfurous acid	H_2SO_3	$Ka_1 = 1.3 \times 10^{-2}$
	HSO_3^-	$Ka_2 = 6.3 \times 10^{-8}$

BASE

PROTON RECEPTOR	OH-
Arrhenius Concept	increase [OH-] in water
Bronsted-Lowry Concept	can accept a proton (H+)
Lewis Concept	electron pair donor (covalent bond created)
strong bases	dissociate fully (100% ionized)
weak bases	dissociate partially (>100%)

bitter taste, slippery feeling

BRONSTED ACID/BASE STRENGHT



acid 1 + base 2 <--> (conjugate) base 1 + (conjugate) acid 2

rxn direction favors weaker acid and base

AUTOIONIZATION OF WATER PROBLEMS

1. **hydrogen (hydronium) ion concentration when [OH-] = 2× 10^{-3}M**

$K_w = [H^+][OH^-] = 1 \times 10^{14}$

$[H^+][\ 2\times10^{-3}] = 1 \times 10^{-14}$

$[H^+] = 5.0 \times 10^{-12}$ M

2. **hydroxide ion concentration in 0.002M HCl solution**

$HCl\ (aq) \rightarrow H^+\ (aq) + Cl^-\ (aq)$

HCl is a strong acid, will dissociate 100%

$K_w = [H^+][OH^-] = 1 \times 10^{14}$

$[0.002M][OH^-] = 1 \times 10^{-14}$

$[OH^-] = 5.0 \times 10^{-12}$

CALCULATING pH OF STRONG ACID & BASE

1. **pH of 0.10M Ba(OH)2 solution**	$Ba(OH)_2 + H_2O \rightarrow Ba^{2+} + 2OH^-$
I	0.10M \\\ 0 0
C	-0.10 \\\ +0.10 +2(0.10)
E	0M \\\ 0.10 0.20
pOH = -log[OH-] = -log[0.20M] = 0.6990	pH = 14.00-0.6990 = 13.30

answer: *basic solution*

ACID EQUILLIBRIUM CALCULATIONS (pH from Ka)

calculate pH of 1.0M Acetic acid soln, using approximations.

$K_a=1.8\times10^{-5}$

$HC_2H_3O_2 + H_2O \rightleftarrows H_3O^+ + C_2H_3O_2^-$

I 1.0 M \\ 0M 0M

C -x \\\\ +x +x

E 1-x \\\\ x x

$K_a = [H_3O^+][C_2H_3O_2^-]/[HC_2H_3O_2]$

$K_a = x^2/1.0 - x = 1.8 \times 10^{-5}$

$\sqrt{x^2} = \sqrt{1.8 \times 10^{-5}}$

$x = 4.24 \times 10^{-3}$M

%ionization = $[H_3O^+]eq/[HC_2H_3O_2]org \times 100\%$

$=4.24\times10^{-3}M/1.0M \times100\% =$ **0.424%** *<5% can neglect!*

pH = $-\log[4.24\times10^{-3}] =$**2.30**

calculate pH of 1.0×10^{-5}M Acetic acid soln (*diluted concentration*)

$HC_2H_3O_2 + H_2O \rightleftarrows H_3O^+ + C_2H_3O_2^-$

I 1.0×10^{-5}M \\\\ 0M 0M

C 1.0×10^{-5}M-x \\\ +x +x

E 1.0×10^{-5}M-x \\\\ x x

$K_a = x^2/\ 1.0\times10^{-5}M - x = 1.8\times10^{-5}M$

$\sqrt{x^2} = \sqrt{1.8 \times 10^{-10}}$

$x = 1.34\times 10^{-5}$

%ionization = $[H_3O^+]/[HC_2H_3O_2] \times 100\%$

=**13%** *> 5% can't neglect!*

$x^2/\ 1.0\times10\text{-}5M = 1.8\times10^{-5}M$

$x^2 + 1.8\times10^{-5}x - 1.8\times10^{-10}=0$

$1.8\times10^{-5}\pm\sqrt{(1.8e^{-5})^2 - 4(1)(-1.8\times10^{-10})}/\ 2(1)$

$= 7.15\times10^{-6}M = [H_3O^+]$

pH = $-\log[7.15\times10^{-6}M]=$ **5.14**