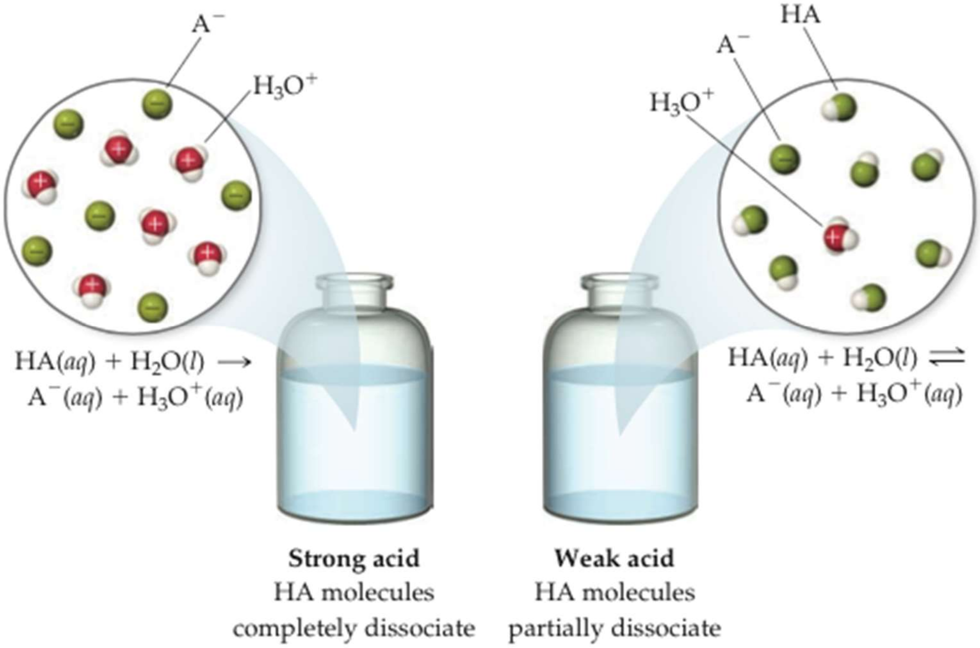
2. STRONG VS. WEAK ACIDS & BASES

CH40S UNIT 4 – ACID BASE EQUILIBRIUM

STRONG VS. WEAK



STRONG ACIDS

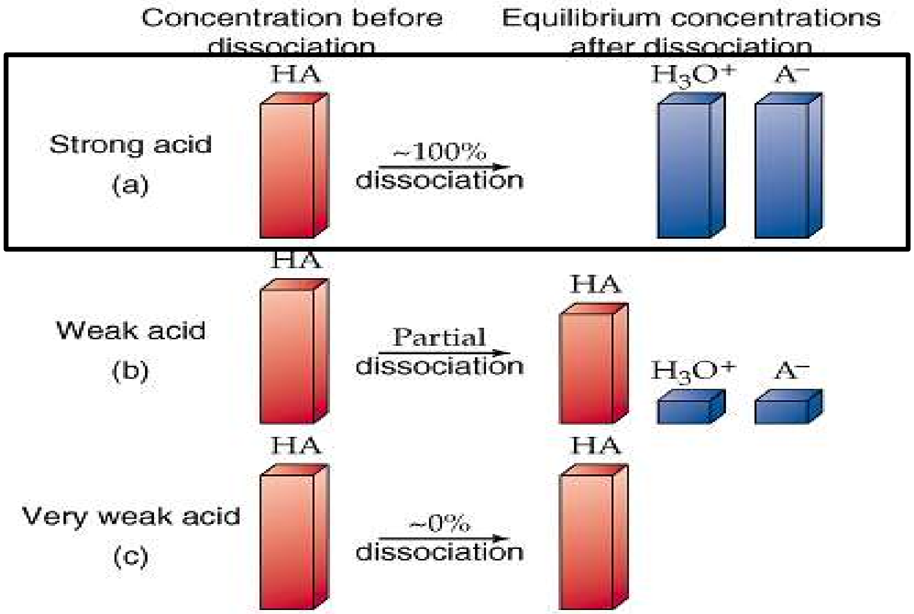
<u>A strong acid is a forceful H⁺ donor</u>. It <u>must</u> give an H^+ to someone! Once a strong acid donates H^+, the H^+ will **<u>never</u>** come back.

- Acid chart top six
- Not equilibrium…stoichiometric relationships…No ICE table!
- Use a "→" and not "⇄"

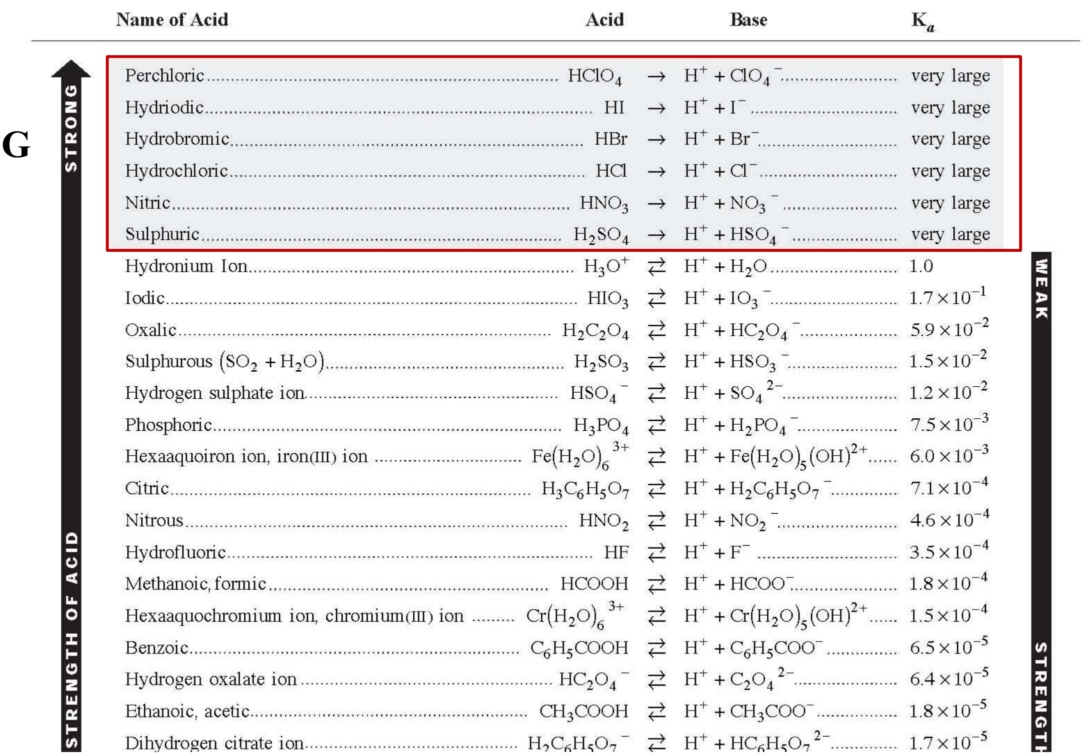
$HCl(aq) + H_2O(l)$

1.0M

RELATIVE ACID STRENGTH



STRONG ACIDS



Name of Acid	Acid		Base	K_a
Perchloric	$HClO_4$	→	$H^+ + ClO_4^-$	very large
Hydriodic	HI	→	$H^+ + I^-$	very large
Hydrobromic	HBr	→	$H^+ + Br^-$	very large
Hydrochloric	HCl	→	$H^+ + Cl^-$	very large
Nitric	HNO_3	→	$H^+ + NO_3^-$	very large
Sulphuric	H_2SO_4	→	$H^+ + HSO_4^-$	very large
Hydronium Ion	H_3O^+	⇄	$H^+ + H_2O$	1.0
Iodic	HIO_3	⇄	$H^+ + IO_3^-$	1.7×10^{-1}
Oxalic	$H_2C_2O_4$	⇄	$H^+ + HC_2O_4^-$	5.9×10^{-2}
Sulphurous $(SO_2 + H_2O)$	H_2SO_3	⇄	$H^+ + HSO_3^-$	1.5×10^{-2}
Hydrogen sulphate ion	HSO_4^-	⇄	$H^+ + SO_4^{2-}$	1.2×10^{-2}
Phosphoric	H_3PO_4	⇄	$H^+ + H_2PO_4^-$	7.5×10^{-3}
Hexaaquoiron ion, iron(III) ion	$Fe(H_2O)_6^{3+}$	⇄	$H^+ + Fe(H_2O)_5(OH)^{2+}$	6.0×10^{-3}
Citric	$H_3C_6H_5O_7$	⇄	$H^+ + H_2C_6H_5O_7^-$	7.1×10^{-4}
Nitrous	HNO_2	⇄	$H^+ + NO_2^-$	4.6×10^{-4}
Hydrofluoric	HF	⇄	$H^+ + F^-$	3.5×10^{-4}
Methanoic, formic	$HCOOH$	⇄	$H^+ + HCOO^-$	1.8×10^{-4}
Hexaaquochromium ion, chromium(III) ion	$Cr(H_2O)_6^{3+}$	⇄	$H^+ + Cr(H_2O)_5(OH)^{2+}$	1.5×10^{-4}
Benzoic	C_6H_5COOH	⇄	$H^+ + C_6H_5COO^-$	6.5×10^{-5}
Hydrogen oxalate ion	$HC_2O_4^-$	⇄	$H^+ + C_2O_4^{2-}$	6.4×10^{-5}
Ethanoic, acetic	CH_3COOH	⇄	$H^+ + CH_3COO^-$	1.8×10^{-5}
Dihydrogen citrate ion	$H_2C_6H_5O_7^-$	⇄	$H^+ + HC_6H_5O_7^{2-}$	1.7×10^{-5}

WEAK ACIDS

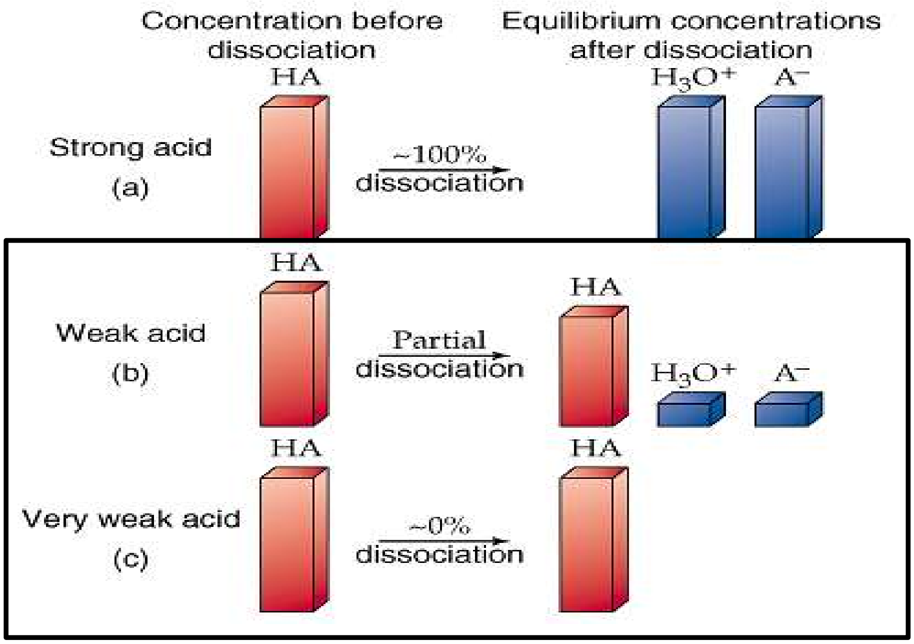
A weak acid is a wishy-washy H^+ donor. It can give away its H^+, but may regain the H^+ a few seconds later. Every acid that is not a strong acid is a weak acid.

- Produce small amounts of H^+ / H_3O^+.
- Equilibriums…equilibrium constants (K$_a$’ s)…need ICE tables .
- Use a “⇄” and not “→”

$$HF(aq) + H_2O(l)$$

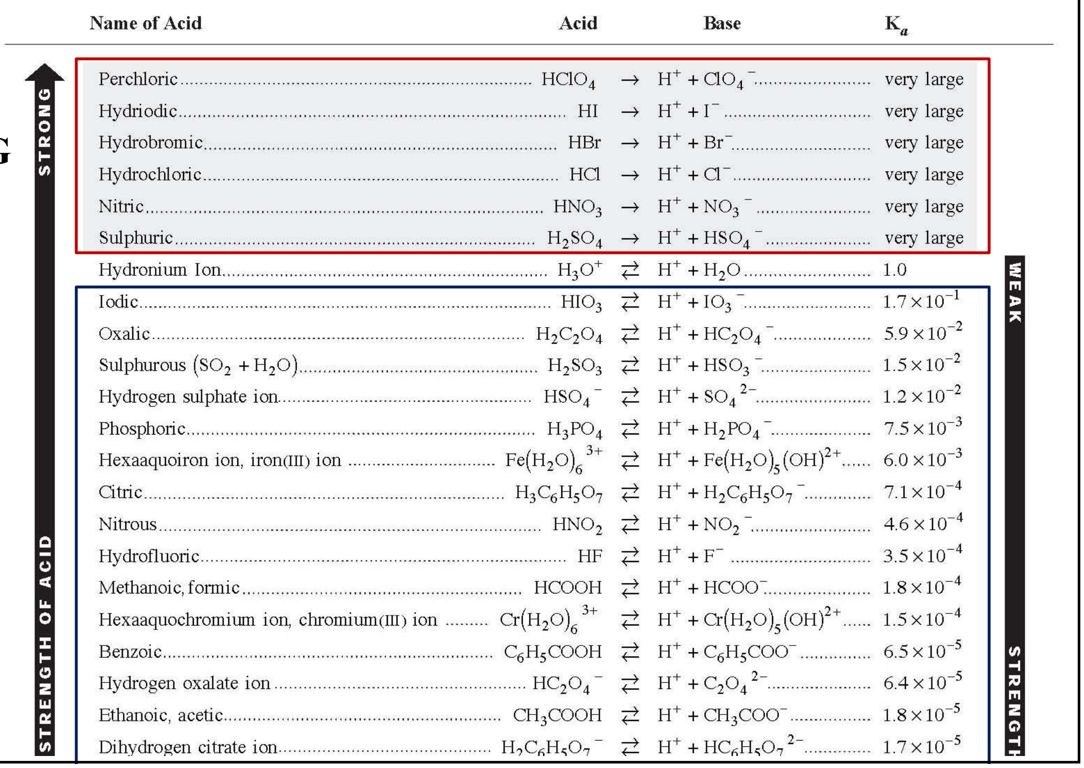
1.0M

RELATIVE ACID STRENGTH



STRONG ACIDS

WEAK ACIDS



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DON'T FORGET LAST LESSON!

- In order to have a reaction, both an acid (H^+ donor) and a base (H^+ acceptor) are required!
- The reaction itself is an **H^+ transfer** (sometimes called a **proton transfer**) from the acid to the base (like tossing a football from quarterback to receiver).
- Many acid-base reactions are reversible, so the H^+ (the "football") may be passed back and forth.

SOME COMMON WEAK ACIDS

Acetic acid, CH_3COOH	$K_a = 1.8 \times 10^{-5}$
Nitrous acid, HNO_2	$K_a = 4.5 \times 10^{-4}$

Write the Bronsted Lowry equation for each acid in water and identify the acids and bases.

Write the Ka expression for each acid. Which acid is stronger? Why?

STRONG BASES REVISED

<u>**A strong base is a forceful H⁺ grabber**</u>. If an acidic hydrogen is anywhere to be found, the strong base will take it and keep it! There is <u>only 1 strong base</u> that you will see in this class:

- Produce large amounts of OH^-.
- Not equilibrium…stoichiometric relationships…no ICE tables
- Use a "→" and not "⇄"

$$OH^-(aq) + H_2O(l)$$

1.0M

STRONG BASES

<u>Soluble Hydroxides</u>

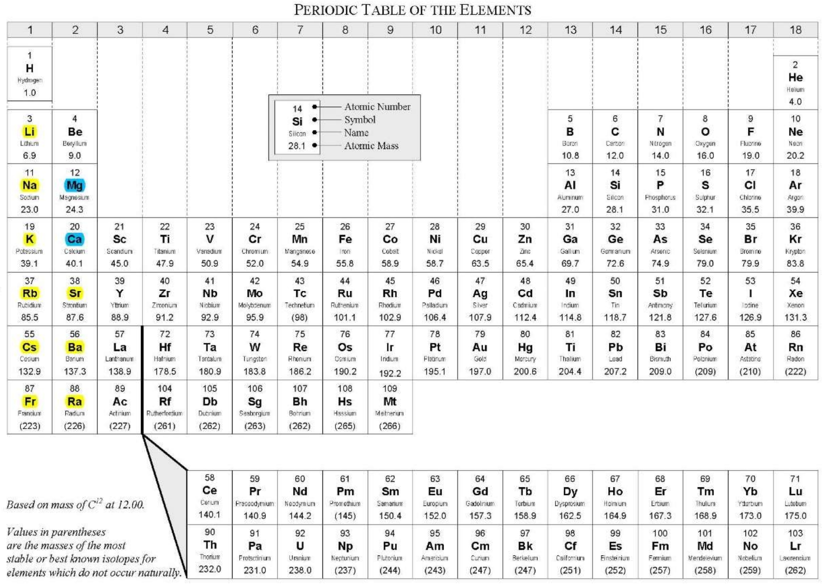
LiOH

NaOH

KOH

$Sr(OH)_2$

$Ba(OH)_2$



PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** Hydrogen 1.0																	2 **He** Helium 4.0
3 **Li** Lithium 6.9	4 **Be** Beryllium 9.0											5 **B** Boron 10.8	6 **C** Carbon 12.0	7 **N** Nitrogen 14.0	8 **O** Oxygen 16.0	9 **F** Fluorine 19.0	10 **Ne** Neon 20.2
11 **Na** Sodium 23.0	12 **Mg** Magnesium 24.3											13 **Al** Aluminum 27.0	14 **Si** Silicon 28.1	15 **P** Phosphorus 31.0	16 **S** Sulphur 32.1	17 **Cl** Chlorine 35.5	18 **Ar** Argon 39.9
19 **K** Potassium 39.1	20 **Ca** Calcium 40.1	21 **Sc** Scandium 45.0	22 **Ti** Titanium 47.9	23 **V** Vanadium 50.9	24 **Cr** Chromium 52.0	25 **Mn** Manganese 54.9	26 **Fe** Iron 55.8	27 **Co** Cobalt 58.9	28 **Ni** Nickel 58.7	29 **Cu** Copper 63.5	30 **Zn** Zinc 65.4	31 **Ga** Gallium 69.7	32 **Ge** Germanium 72.6	33 **As** Arsenic 74.9	34 **Se** Selenium 79.0	35 **Br** Bromine 79.9	36 **Kr** Krypton 83.8
37 **Rb** Rubidium 85.5	38 **Sr** Strontium 87.6	39 **Y** Yttrium 88.9	40 **Zr** Zirconium 91.2	41 **Nb** Niobium 92.9	42 **Mo** Molybdenum 95.9	43 **Tc** Technetium (98)	44 **Ru** Ruthenium 101.1	45 **Rh** Rhodium 102.9	46 **Pd** Palladium 106.4	47 **Ag** Silver 107.9	48 **Cd** Cadmium 112.4	49 **In** Indium 114.8	50 **Sn** Tin 118.7	51 **Sb** Antimony 121.8	52 **Te** Tellurium 127.6	53 **I** Iodine 126.9	54 **Xe** Xenon 131.3
55 **Cs** Cesium 132.9	56 **Ba** Barium 137.3	57 **La** Lanthanum 138.9	72 **Hf** Hafnium 178.5	73 **Ta** Tantalum 180.9	74 **W** Tungsten 183.8	75 **Re** Rhenium 186.2	76 **Os** Osmium 190.2	77 **Ir** Indium 192.2	78 **Pt** Platinum 195.1	79 **Au** Gold 197.0	80 **Hg** Mercury 200.6	81 **Ti** Thalium 204.4	82 **Pb** Lead 207.2	83 **Bi** Bismuth 209.0	84 **Po** Polonium (209)	85 **At** Astatine (210)	86 **Rn** Radon (222)
87 **Fr** Francium (223)	88 **Ra** Radium (226)	89 **Ac** Actinium (227)	104 **Rf** Rutherfordium (261)	105 **Db** Dubnium (262)	106 **Sg** Seaborgium (263)	107 **Bh** Bohrium (262)	108 **Hs** Hassium (265)	109 **Mt** Meitnerium (266)									
				58 **Ce** Cerium 140.1	59 **Pr** Praseodymium 140.9	60 **Nd** Neodymium 144.2	61 **Pm** Promethium (145)	62 **Sm** Samarium 150.4	63 **Eu** Europium 152.0	64 **Gd** Gadolinium 157.3	65 **Tb** Terbium 158.9	66 **Dy** Dysprosium 162.5	67 **Ho** Holmium 164.9	68 **Er** Erbium 167.3	69 **Tm** Thulium 168.9	70 **Yb** Ytterbium 173.0	71 **Lu** Lutetium 175.0
				90 **Th** Thorium 232.0	91 **Pa** Protactinium 231.0	92 **U** Uranium 238.0	93 **Np** Neptunium (237)	94 **Pu** Plutonium (244)	95 **Am** Americium (243)	96 **Cm** Curium (247)	97 **Bk** Berkelium (247)	98 **Cf** Californium (251)	99 **Es** Einsteinium (252)	100 **Fm** Fermium (257)	101 **Md** Mendelevium (258)	102 **No** Nobelium (259)	103 **Lr** Lawrencium (262)

14 — Atomic Number
Si — Symbol
Silicon — Name
28.1 — Atomic Mass

Based on mass of C^{12} at 12.00.

Values in parentheses are the masses of the most stable or best known isotopes for elements which do not occur naturally.

WEAK BASES REVISED

A weak base is a wishy-washy H^+ acceptor. It can take an H^+, but may relinquish the H^+ a few seconds later. Every base that is NOT hydroxide is a weak base.

- Produce small amounts of OH^-.
- Equilibriums…equilibrium constants (K_b's)…need ICE tables .
- Use a "⇄" and not "→"

$NH_3(aq) + H_2O(l)$

1.0M

SOME COMMON WEAK BASES

Bicarbonate ion, HCO_3^-	$K_b = 2.3 \times 10^{-8}$
Ammonia, NH_3	$K_b = 1.8 \times 10^{-5}$

Write the Bronsted Lowry equations for each base in water and identify the acids and bases.

Write the K_b expression for each acid. Which base is stronger? Why?

INVERSE RELATIONSHIPS

- A strong acid or base has a very weak conjugate.
- A weak acid or base has a weak conjugate.
- A very weak acid or base has a strong conjugate.