Acid – Base Nomenclature

- **Binary acids – contain hydrogen and one other atom**

Hydrofluoric acid	HF
Hydrochloric acid	HCl
Hydrobromic acid	HBr
Hydroiodic acid	HI
Hydrosulfuric acid	H_2S
Hydroselenic acid	H_2Se

- **Oxyacids – acids that contain hydrogen, oxygen, and one other element (not carbon)**
  - * **Polyatomic ions are the anions of these acids**
  - **If ion name ends in –ate, then acid ends in –ic** I ate something "icky"
  - **If ion name ends in –ite, then acid ends in –ous** unite ous
  - **Also have per-ate and hypo-ite**
  - **Know your polyatomic ion names and charges!**

ClO_4^- → perchlorate → $HClO_4$ → perchloric acid

* ClO_3^- → chlorate → $HClO_3$ → chloric acid

ClO_2^- → chlorite → $HClO_2$ → chlorous acid

ClO^- → hypochlorite → $HClO$ → hypochlorous acid

Name of Acids Derived from Polyatomic Ions

Polyatomic Ion	Acid Name	Acid Formula
Sulfate SO_4^{2-}	sulfuric acid	H_2SO_4
Sulfite SO_3^{2-}	sulfurous acid	H_2SO_3
Nitrate NO_3^-	nitric acid	HNO_3
Nitrite NO_2^-	nitrous acid	HNO_2
Hypochlorite ClO^-	hypochlorous acid	$HClO$
Chlorite ClO_2^-	chlorous acid	$HClO_2$
Chlorate ClO_3^-	chloric acid	$HClO_3$
Perchlorate ClO_4^-	perchloric acid	$HClO_4$
Permanganate MnO_4^-	permanganic acid	$HMnO_4$
Oxalate $C_2O_4^{2-}$	oxalic acid	$H_2C_2O_4$
Phosphate PO_4^{3-}	phosphoric acid	H_3PO_4
Phosphite PO_3^{3-}	phosphorous acid	$H_3PO_3^-$
Chromate CrO_4^{2-}	chromic acid	H_2CrO_4

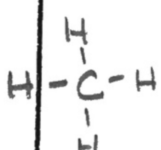
H.W.

functional group

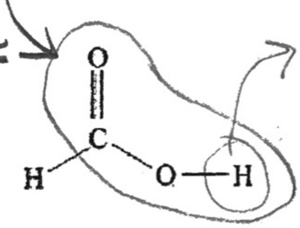
- Organic acids – acids that contain carbon and have a carboxyl group. –COOH

$H_2C_2O_4$

methane



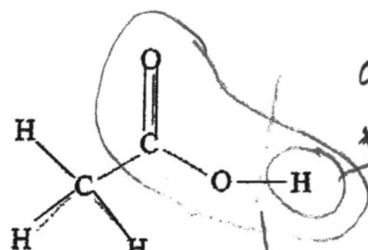
methanoic acid



$\rightarrow H_3O^+$

Formic Acid

ant venom

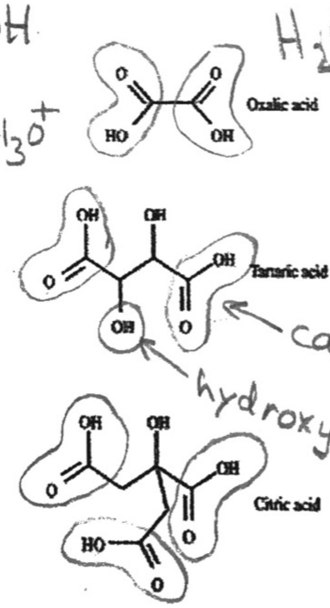


$+H_2O \rightarrow H_3O^+$

Acetic Acid $HC_2H_3O_2$

ethanoic acid

CH_3COOH



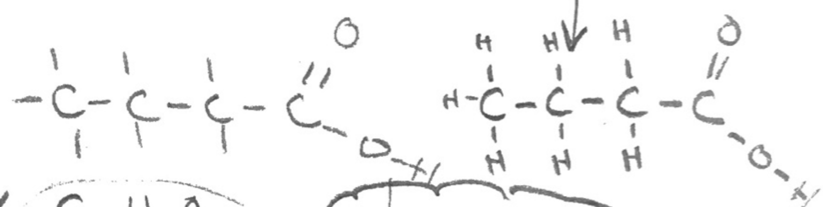
carboxyl group (acids)

hydroxyl group (alcohols)

Figure 2. Structures of organic acids used as electrolytes to deposit the PPy films.

Organic Acid Names

Number of Carbons	Sytematic Name	Common Name	Formula
1	Methanioc acid	Formic acid	HCOOH
2	Ethanoic acid	Acetic acid	CH_3COOH
3	Propanoic acid	Propanoic acid	CH_3CH_2COOH
4	Butanoic acid	Butyric acid	$CH_3CH_2CH_2COOH$
5	Pentanoic acid	Valeric acid	$CH_3CH_2CH_2\ CH_2COOH$
6	Benzoic acid	Benzoic acid	$CH_3CH_2CH_2\ CH_2CH_2\ COOH$



do not write this way → X $C_4H_8O_2$

C_3H_7COOH → organic chemist

$HC_4H_7O_2$ – Inorganic Chemist

Strong Acids

* Memorize the six strong acids

- Strong acids dissociate completely into ions when dissolved in water. 100%
- Strong acids are
  - Hydrochloric acid
  - Hydrobromic acid
  - Hydroiodic acid
  - Perchloric acid
  - Nitric acid
  - Sulfuric acid (only the first hydrogen is considered strong)

monoprotic (Hydrochloric, Hydrobromic, Hydroiodic, Perchloric, Nitric acid); diprotic (Sulfuric acid)

$$HCl \xrightarrow{100\%} H^+ + Cl^-$$

$$HCl + H_2O \rightarrow H_3O^+ + Cl^-$$

$$H_2SO_4 \xrightarrow{100\%} H^+ + HSO_4^-$$ strong

$$HSO_4^- \rightleftharpoons H^+ + SO_4^{2-}$$ weak

Weak Acids

- Weak acids only dissociate slightly in water.
- Most weak acids are organic acids.
- The most common weak acids, other than organic acids, are

HF	* H_2CO_3 unstable → $H_2O + CO_2$
$HClO_3$	H_3PO_4
$HClO_2$	H_3AsO_4
HClO	

Relative Strengths of Acids and Bases

- **Binary acids get stronger from left to right across a period. As the EN of the anion increases, it attracts the** electrons **more strongly and the bond with hydrogen becomes weaker. The size of the anion is relatively the same.**

Shielding effect constant (bond widths are similar)

weakest acid b/c strongest bond → $H_3P < H_2S < HCl$ ← greatest EN; strongest acid, weakest bond

- **Binary acids get stronger from the top of a group to the bottom. The size of the anion is the reason. An increase in anion size results in an increase in bond length and the longer the bond, the weaker the bond. In acids, a weaker bond with hydrogen means a stronger acid.**

hard to remember

HF, HCl, HBr, HI: weak acid ↓ strong acid

weak H–F; strong H–Cl; H–Br; > H–I weak bond

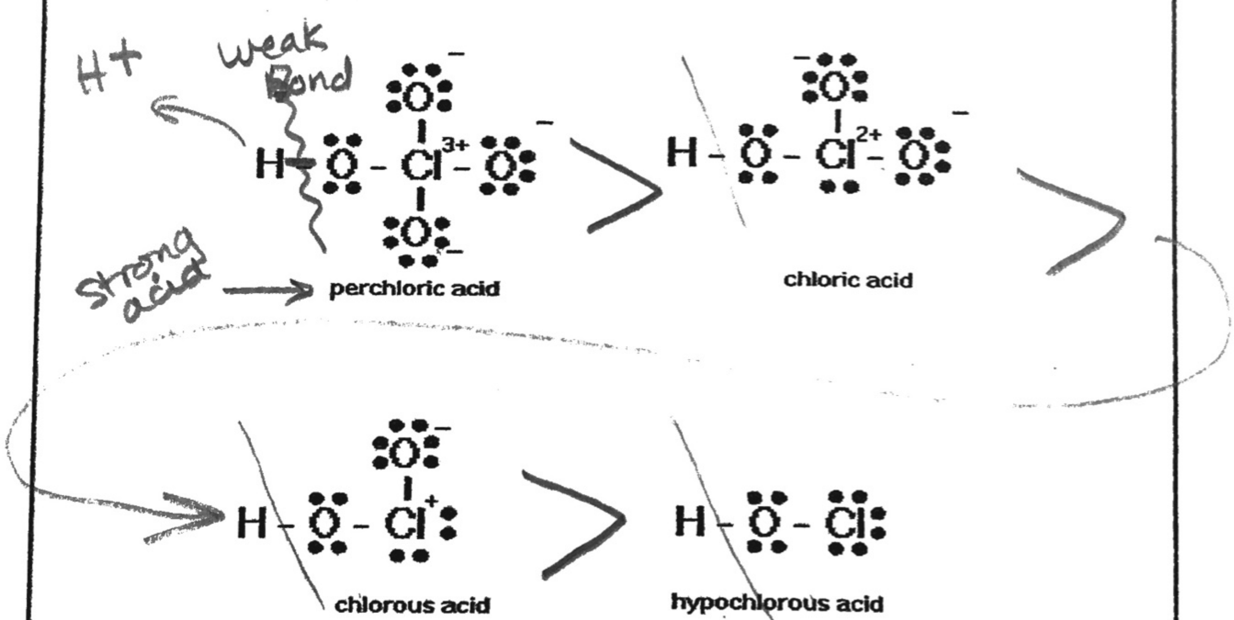
Bond length trumps E.N.

aka: oxoacids

Relative Strength of Oxyacids

The strength of an oxyacid depends on the relative strength of the H-O bond. The strength of the H-O bond depends on two things:

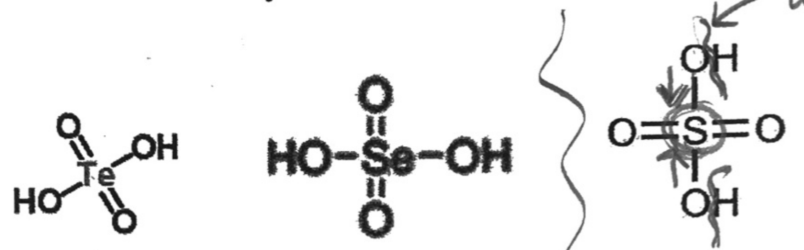
1) the number of O atoms per H atom in the molecule
2) the EN of the central atom



* [Each extra oxygen with draws more electron density from the H-O bond thereby weakening it.] The more oxygen atoms per hydrogen, the stronger the acid.

The strengths of oxyacids that have the same number of hydrogen and oxygen atoms but a different central atom are affected by the EN of the central atom.

weaker bond = stronger acid



telluric acid (weakest) | **selenic acid** | **sulfuric acid (strongest)**

The electronegativity of the central atom increases from tellurium to selenium, weakening the O-H bond and resulting in stronger acids.

Oxyacids that have the same number of oxygen atoms but different numbers of hydrogens can also be compared. In this situation the EN of the central atom increases as the strength of the acid increases.

strong

$$H_3PO_4 < H_2SO_4 < HClO_4$$

* **To repeat: when two acids are compared, the acid with more oxygen atoms per hydrogen atom will be the stronger acid.**

Does not apply to polyprotic acid families.

Polyprotic Acids

SA → $H_2SO_4 \xrightarrow{100\%} H^+ + HSO_4^-$

WA → $HSO_4^- \rightleftharpoons H^+ + SO_4^{2-}$

$H_3PO_4 > H_2PO_4^- > HPO_4^{2-} > PO_4^{3-}$

Relative Strength of Bases

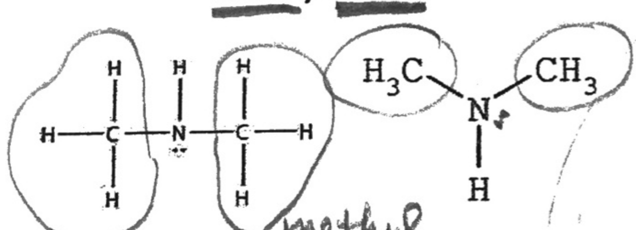
- **Strong bases** In theory
  - **All metal hydroxides are strong bases, however most metal hydroxides are only slightly soluble.**
  - **Only the hydroxides of group 1A metals, strontium and barium, have apprecialble solubility; calcium hydroxide is moderately soluble.**
  - **Soluble hydroxides may cause severe skin burns, while insoluble hydroxides are much less harmful.**

$Al(OH)_3$ is in antacids and used to neutralize excess stomach acid.

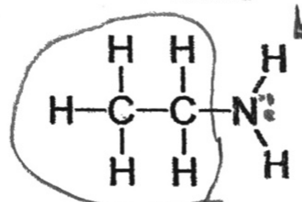
* G1 all
G2 Ca, Sr, Ba → Soluble hydroxides are the only strong bases (in reality)

- **Weak bases** NH_3
  - **All bases related to ammonia are weak bases**
  - **In organic compounds related to ammonia, called <u>amines</u>, carbon-containing groups replace one or more of the hydrogen atoms of ammonia, NH_3**

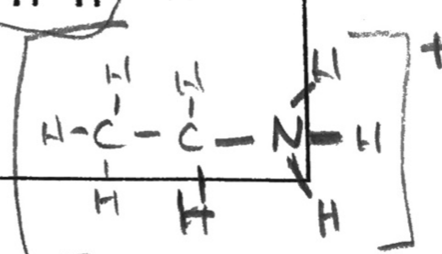
base
Dimethyl amine



base
Ethyl amine



$+ H_2O \rightleftharpoons OH^- +$



conjugate acid