Acid Base Wrap up topics

Lewis acid Bases
Structural indicators of the strength of acids
Non-metal oxides/ metal oxides
Amphoteric substances
Acidic properties of swimming pools

Schweitzer 1-29-05

Lewis Acid/Base

- Lewis acid is a different way to look at some type of acids.
- Lewis Acid/base reactions track the electrons rather then the protons.

- Lewis acids gain electrons
- Lewis bases lose electrons.

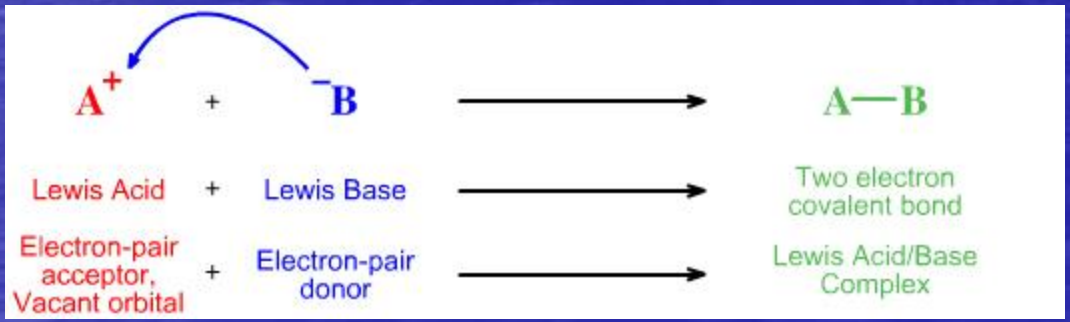
What do Lewis acid/base reactions look like?

- $X^+ + Y^- = XY$

Electron Donator = Lewis base

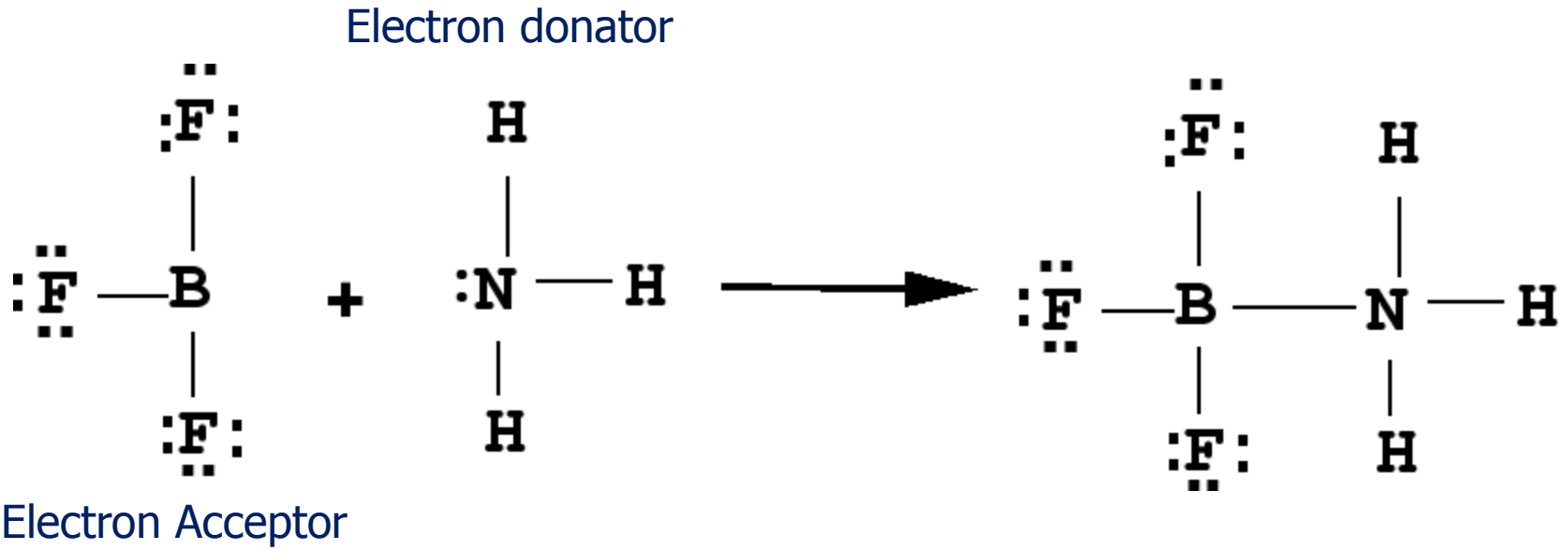
Electron acceptor = Lewis acid

- Lewis acid/base reactions will always look like this. Two substances coming together.



Question

- **Which is the Lewis acid and base?**



AP Question

- $AlCl_3 + Cl^- \Rightarrow AlCl_4^-$
- Which description applies to the reaction above?
- a. amphoterism
- b. anion hydrolysis
- c. Arrhenius neutralization
- d. Lewis acid base reaction
- e. Bronsted Lowery proton transfer

Acid Strength and Bond Strength

Note: Strength of a hydrogen bond is inversely proportional to the strength of acid.

The stronger the bond the weaker the acid.

Or.

The Weaker the bond the stronger the acid.

Strength of acids/bases

- What factors affect the strength of bonds and therefore Acids?

1. Electronegativity
2. Atomic radius

Acid Strength and Electronegativity

- The stronger the electronegativity and weaker the bond the stronger the acid. Especially true with in a period of the periodic table.
- $HF > H_2O > NH_3 > CH_4$
- $HCl > H_2S > PH_3 > SiH_4$

Oxyacid Strength and electronegativity

- Oxygen being one of the big three electronegative atoms (N,O,F) starve for electrons. They can steal electrons several bonds away. Hence the more oxygen atoms the more starved a Hydrogen atom becomes and the easier it is released.
- The relative acid strength of the following
- H_2SO_4 > H_2SO_3
- HNO_3 > HNO_2
- $HClO_4$ > $HClO_3$ > $HClO_2$ > $HClO$

Acid Strength and Size

HI > HBr > HCl > HF

- The larger the base atom the farther away the Hydrogen. Therefore the easier the hydrogen is lost.
- Shielding. The large number of electrons between the electrons and each nuclei lowers attraction as well.
- Generally speaking HI, HBr, HCl are so strong that they are thought of being equal. 100% dissociation.

Acid Base vs. Molecular Structure

- $HClO$ $HClO_2$ $HClO_3$ $HClO_4$
- Why is one acid stronger then another?

Strength of oxyacids

- First… you should realize the trend of strength.
- $HClO_4$ is a strong acid so it must decrease as you go down.
- $HClO$ < $HClO_2$ < $HClO_3$ < $HClO_4$
- Why? Electronegativity of oxygen pulls on the electron of the hydrogen. This lack of electrons causes the bond to weaken and therefore strengthen the acid.

AP Question

As the number of oxygen atoms increases in any series of oxygen acids, such as HXO, HXO_2, HXO_3 Which of the following is generally true?

a. The acid strength varies unpredictably.

b. The acid strength decreases only if X is a nonmetal

c. The acid strength decreases only if X is a metal

d. The acid strength decreases whether X is a nonmetal or a metal.

e. The acid strength increases

Non-metal oxide + water yields acid

- $CO_2 + H_2O \rightarrow H_2CO_3 + H_2O \rightarrow H_3O^+ + HCO_3^-$

hydrolysis

- $SO_2 + H_2O \rightarrow H_2SO_3 + H_2O \rightarrow HSO_3 + H_3O^+$
- $P_2O_5 + H_2O \rightarrow H_3PO_4 + H_2O \rightarrow H_2PO_3^- + H_3O^+$
- *Sulfur is a common element in coal. This is because coal came from dead organisms and Sulfur is essential to life. Therefore when you burn coal the sulfur oxidizes to SO_2 mixes with the water in the air to produce acid rain.*

How I remember….

- Acid breath…CO_2 is acidic.
  - Non-metal oxides are acidic
- Conversely
  - Metal oxides are basic

Metal Oxide + Water yields Base

- $Na + H_2O \rightarrow Na_2O + H_2$ Single displacement
- $Na_2O + H_2O \rightarrow NaOH \rightarrow Na^+ + OH^-$

Amphoteric Substances

- A substance that can act both as an acid and a base.

Ex $H_2PO_4^{-1}$

This substance can both gain and lose hydrogen atoms.

Gain: H_3PO_4

Lose: HPO_4^{-2}

Amphoteric substances

- Aluminum is amphoteric…

Al as a base.

- $Al + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2$
  - Al will neutralize Sulfuric acid

Al as an acid

- $Al + H_2O \rightarrow Al(H_2O)^{+3}_6 \rightarrow Al(H_2O)_5OH^{+2} + H^+$

Note: Dropping an aluminum can does not produce this reaction…. Why?

PH of pools

- What is used to chlorinate a pool.
- NaOCl Sodium Hypochlorite or Bleach
- $HClO(aq) + H_2O \leftrightarrow OCl^- + H_3O^+$
- $OCl^- + H_2O \leftrightarrow HOCl + OH^-$

- OCl^- is a weak base

How does OCl^- kill bacteria

- OCl^- decomposes to Cl_2 gas and OH^-

$$OCl^- + H_2O \leftrightarrow Cl_2 + OH^-$$

Chlorine is extremely reactive reducer meaning it gains electrons.

$$Cl_2 + 2e^- \leftrightarrow 2Cl^-$$

Never mix acids with bleach? Why

- People often think adding an acid which is a great cleaner with bleach which kills bacteria will make an even better cleaner.
- What really happens?

$$OCl^- + H_2O \leftrightarrow Cl_2 + OH^-$$

  - $H^+ + OH^- \rightarrow H_2O$

- Removing OH^- causes the reaction to shift toward products. Causing lots of Cl_2 to be produced.

- One good breath will be your last!!!

Test 1

- Which of the following substances are acidic, basic, or neutral.
- NH_3
- CaO
- $Ca(OH)_2$
- NaF
- $FeCl_2$

Answer 1

- Which of the following substances are acidic, basic, or neutral.
- NH_3 basic. Can gain protons to form NH_4^+
- CaO Metal oxide: basic forms
- $Ca(OH)_2$ basic: has OH^-, strong base even.
- NaF Basic: anion is the conjugate of weak acid
- $FeCl_2$ acidic, cation is conjugate of a weak base

Test 2

- Which of the following pairs is the strongest acid.
- HNO_2 or HNO_3

- H_3PO_4 or H_3PO_3

Answer Test 2

- Which of the following pairs is the strongest acid.
- HNO_2 or HNO_3

- H3PO_4 or H_3PO_3
- Answer: Increasing the number of oxygen increases the pull on electrons which weakens the H- bond.