Notes #53 Acid Structures, Strength & Hydrolysis

One can often look at the STRUCTURE of acids to determine their strength. It's all about how easy/difficult it is to remove the H^+.

1. The Hydrohalide Acids (HX X = halogen). - As you go down the Halogen group, electronegativity _____. The more electronegative, the _____ the halogen attracts the H and the _____ the H-A bond. The stronger the H-A bond, the harder it is to remove an H^+ and the acid will be _____. - Between what halogen and hydrogen is the bond the STRONGEST? _____.

- Put the Hydrohalide acids in order from WEAKEST to STRONGEST.

2. Oxyacids - acids that contain hydrogen, oxygen and some other nonmetal element, which occupies the central position. EX: H_2CO_3, H_2SO_4, HNO_3, H_3PO_3, H_3PO_4

** LEWIS STRUCTURE, MOLECULAR GEOMETRY REVIEW a. Compare oxoacids with different central atoms from the same family with the same oxidation number.

* The more electronegative the central atom, the STRONGER the acid.

b. Compare oxyacids that have the SAME central atom but different number of attached groups and consequently, different oxidation numbers.

- The greater the oxidation # on the central atom, the STRONGER the acid.

HYDROLYSIS

A. HYDROLYSIS - the reaction of an anion and/or cation of a salt with water. Hydrolysis always affects pH of a solution.

** Not ALL ions hydrolyze. We have to figure out which ones DO and which ones DON'T. And, if they DO hydrolyze, we have to be able to predict whether they will hydrolyze to make an acidic or basic solution.

1. **NEUTRAL IONS** - ions that DO NOT hydrolyze to an appreciable extent and cause little to no pH change. - ALL of the _____ and most of the alkaline earth metals (except for Be and Mg) are neutral ions.

- Conjugate bases of STRONG ACIDS are also neutral. These ions include _____. (Why don't these ions hydrolyze?)

EX: Take a look at the NO_3^- ion in water: NO_3^- + H-OH ** Conjugate bases of STRONG ACIDS have no affinity or desire to accept a proton....

EX 1: List some examples of NEUTRAL salts. _____

2. **BASIC IONS** - ions that hydrolyze in water to produce OH^- and a basic solution.

- Conjugate bases of WEAK ACIDS make basic solutions. Ex's of such ions include_____.

Why? Take a look at the F^- ion in water. F^- + H-OH

** Conjugate bases of WEAK ACIDS do have affinity or desire to accept a proton.

3. **ACIDIC IONS** - ions that hydrolyze in water to produce H_3O^+ (or H^+) and an acidic solution.

- Conjugate acids of WEAK BASES make acidic solutions. NH_4^+ is really the only common example of this. EX: Take a look at NH_4^+ in water. NH_4^+ + H-OH

- ALL metal ions have the ability to hydrolyze and to make acidic solutions although only in **small**, _____ metal cations is the hydrolysis significant enough to produce measurable pH changes.

a. The most common acidic metal ions include: _____

b. How does hydrolysis of metal cations work? First, when metal cations dissolve, they become heavily HYDRATED. The number of H_2O's that will fit around a metal ion center is usually dependent on that metal's charge. (2 H_2Os per charge)

Al^{3+} + ___ $H_2O \rightarrow Al(H_2O)_6^{3+}$ Fe^{3+} + ___ $H_2O \rightarrow$ _____ *3+ charge = 6 H_2O molecules

Cu^{2+} + ___ $H_2O \rightarrow$ _____ Zn^{2+} + ___ $H_2O \rightarrow$ _____ * 2+ charge = 4 H_2O molecules

* The GREATER the ion charge, the _____ water molecules the metal ion attracts and the greater extent of hydrolysis. Compare the pH of a 0.1 M Al^{3+} solution (2.0) to the pH of a 0.1 M Zn^{2+} solution (5.0)

b. Now, let's compare some hydrolysis reactions: $Al(H_2O)_6^{3+}$ (aq) + H_2O (l) ⇌

$Zn(H_2O)_4^{2+}$ (aq) + H_2O (l) ⇌

** The greater the charge density, the stronger the _____ which weakens the O-H bond, allowing an H^+ to be more easily pulled off.....

** Now, explain why metal cations such as Na^+ and K^+ do not hydrolyze in solution?

_____

HYDROLYSIS PRACTICE: 1. Predict which of the following salts will undergo hydrolysis.

a) NaCl b) Li_2S c) $Ca_3(PO_4)_2$ d) CO_2 e) $CuCl_2$ f) NH_4CN

For your "yes" answers above, write an eq. to show hydrolysis and predict whether the solution will be BASIC or ACIDIC.

In a certain experiment, a student finds that the pH's of 0.10 M solutions of three potassium salts KX, KY, and KZ are 7.0, 9.0 and 11.0 respectively. Arrange the acids, HX, HY, and HZ in the order of increasing acid strength.

Calculating the pH of salt solutions that hydrolyze.

EX: What is the pH of a 2.0M solution of KF. (The K_a for HF is 6.9×10^{-4})