

Acids and Bases V

3/11/19 ①

In class question: Dissolve $(\text{NH}_4^+) \text{SO}_4$ in water. What is pH?



- NH_4^+ is the conjugate acid of NH_3 , a weak base. Thus, a weak acid.
- SO_4^{2-} is the conjugate base of HSO_4^- , a weak acid. Thus, a weak base.

$K_a > K_b$, so $\text{pH} < 7$

$$K_b \text{ for } \text{NH}_3 = 1.8 \times 10^{-5}$$

$$K_a \cdot K_b = K_w$$

$$K_a \text{ for } \text{NH}_4^+ = \frac{K_w}{K_b} = 5.6 \times 10^{-10}$$

$$K_a \text{ for } \text{HSO}_4^- = 1.01 \times 10^{-2}$$

$$\text{So, } K_b \text{ for } \text{SO}_4^{2-} = 9.9 \times 10^{-13}$$

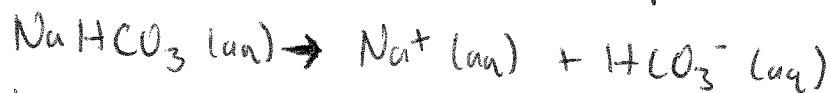
Dissolve Ammonium acetate in water. What is pH?



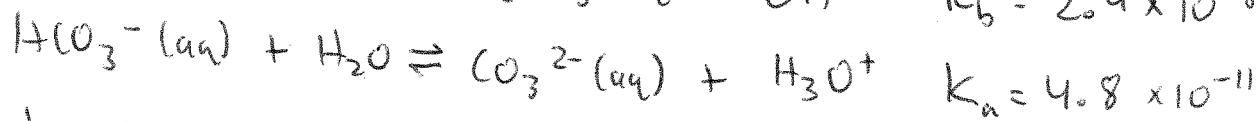
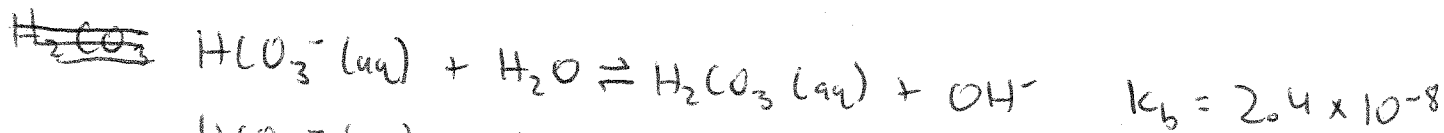
- NH_4^+ is the conjugate acid of NH_3 , a ~~WB~~ ^{WA}. Thus, a WA.
- OAc^- is the conjugate base of acetic acid, a ~~WA~~ ^{WB}. Thus a WB

$K_a = K_b$, so $\text{pH} = 7$

Dissolve NaHCO_3 in water. What is pH?



- Na^+ does not gain or accept H^+
- HCO_3^- is the conjugate base of H_2CO_3 a WA. But it's also an acid. (Polyprotic Acid)



$K_b > K_a$ so, base

Dissolve ferric chloride (FeCl_3) in water. What is pH?

Hydrated Cations

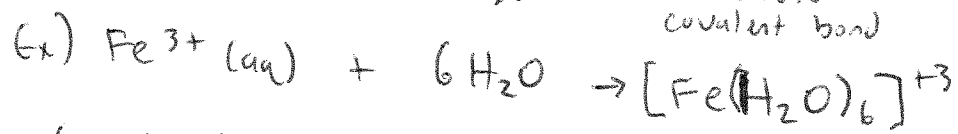
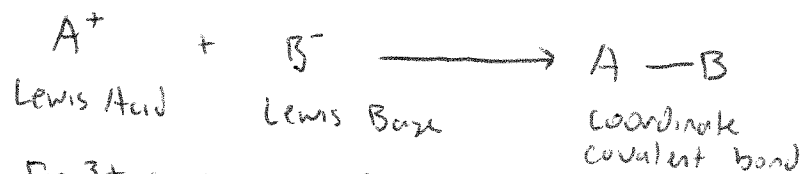
- Transition and post-transition metals form hydrated cations.
- H_2O attached to a metal ion is more acidic than free H_2O , making hydrated metal ions acidic.

Ex) Al^{3+} or Fe^{3+} w/ six H_2O molecules bound

- O-H bonds are weakened by metal binding, leading to release of H^+ . The metal ion stabilizes the resulting negative charge on the OH^- .

Lewis Acid / Base Chemistry

- Metal ions are Lewis Acids
- Lewis acids are electron pair acceptors
- Water is a Lewis Base
 - Lewis bases are electron pair donors.



- Coordination Compound - Lewis acid-base complex of a metal cation (the Lewis Acid) associated with a group of neutral molecules or anions (the Lewis Base aka the "ligand").

Factors that Affect Acid Strength



- ① Polarity: $H-A$ bond must be polarized with δ^+ on H atom and δ^- on the A atom.
- ② Bond strength: Weaker bonds can be broken more easily, making the acid stronger.

Optimal acid has highly polar but weak bonds.

Ex 1) CH_4

Polarity: $C-H$ bond is not polar

Bond strength: $C-H$ bond is strong.

CH_4 is NOT an acid

2) HCl

Polarity: $H-Cl$ bond is very polar

Bond strength: $H-Cl$ bond is pretty strong, but polarity dominates.

HCl is a good acid.

Binary Acids

- Binary acids consist of H and one other element
- Acid strength generally increase down a group
- Acid strength generally increases across a period

Oxyacids

- Oxyacids consist of H , O , and other nonmetal.
- Generally, as the electronegativity of the ~~metal~~ nonmetal increases, the acidity increases for acids with the same structure.

Families of Oxyacids

- If an element can form more than one oxyacid, the oxyacid with more O atoms is more acidic.

Carboxylic Acids

(4)

- Carboxylic acids are organic acids containing -COOH group
- Factors contributing to their acidic behavior:
 - The other oxygen atom draws electron density from the O-H bond, increasing polarity
 - The conjugate base (carboxylic anion) has resonance forms to stabilize the anion.