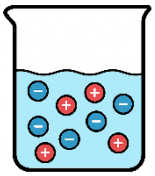
Acids and Bases **Name**_____

Salt Hydrolysis

Read from **Lesson 5: Hydrolysis of Salts** in the **Chemistry Tutorial Section, Chapter 15** of **The Physics Classroom:**
Part a: Predicting and Explaining the Acidity Level of Salts
Part b: K_a and K_b Values of Conjugate Acid-Base Pairs

Part 1: Hydrolysis of Salts

- Salt hydrolysis occurs when ions from a dissolved salt react with water, potentially forming acidic or basic solutions.



How to Predict pH of Salt Solutions

- Identify the cation and anion from the salt.
- Classify each ion as acidic, basic, or neutral.
- Combine classifications to predict the solution's pH.

Ion Classification Chart

Ion Type	Examples	Behavior in Water
Acidic Cations	NH_4^+, Al^{3+}, Fe^{3+}	Donate H^+ → form H_3O^+
Basic Anions	F^-, CN^-, $C_2H_3O_2^-$	Accept H^+ → form OH^-
Neutral Cations	Na^+, K^+, Ca^{2+}	No reaction with water
Neutral Anions	Cl^-, NO_3^-, Br^-	No reaction with water
Amphiprotic Ions	HCO_3^-, $H_2PO_4^-$	Can act as acid or base

pH Prediction Guide

Cation	Anion	Resulting Solution
Acidic	Neutral	Acidic
Basic	Neutral	Basic
Neutral	Neutral	Neutral
Acidic	Basic	Compare Ka vs. Kb

Part 2: K_a and K_b for Conjugate Acid–Base Pairs

- $K_a \times K_b = K_w = 1.0 \times 10^{-14}$
- K_a: strength of a weak acid and K_b: strength of a weak base

Predicting pH When Both Ions React

- $K_a > K_b$ → Acidic solution
- $K_b > K_a$ → Basic solution
- $K_a = K_b$ → Neutral solution

Examples

Salt	K_a vs. K_b	pH Outcome
NH_4F	K_a (NH_4^+) > K_b (F^-)	Acidic
NH_4CN	K_b (CN^-) > K_a (NH_4^+)	Basic
$NH_4C_2H_3O_2$	$K_a \approx K_b$	Neutral

Acids and Bases

Salt Hydrolysis Analysis

For each salt listed below, answer the following:

a. Write the **dissociation equation** showing the ions formed when the salt dissolves in water.
b. Based on hydrolysis, determine whether the **cation** is *acidic* or *neutral*.
c. Based on hydrolysis, determine whether the **anion** is *basic* or *neutral*.
d. Write the **hydrolysis equation** for the ion that reacts with H_2O to form H^+ or OH^-. Write **NR** for no reaction.
e. If both ions undergo hydrolysis, calculate the $\mathbf{K_a}$ and $\mathbf{K_b}$ for each. Show your work clearly, including how you used $\mathbf{K_w = 1.0 \times 10^{-14}}$ to relate $\mathbf{K_a}$ and $\mathbf{K_b}$.
f. Classify the overall salt solution as **acidic**, **basic**, or **neutral**.

Example: KNO_2

a. The **dissociation equation:** $KNO_2\,(s) \rightarrow K^+\,(aq) + NO_2^-\,(aq)$
b. The K^+ is *neutral* - cations of strong bases do not hydrolyze.
c. The NO_2^- is *basic* - it is the conjugate base of a weak acid.
d. Write the **hydrolysis equation:** $NO_2^-\,(aq) + H_2O\,(l) \rightleftarrows HNO_2\,(aq) + OH^-(aq)$
e. Not applicable.
f. This salt solution is **basic**.

Salts to analyze:

1. Sodium acetate
   a.

   b.

   c.

   d.

   e.

   f.

2. Ammonium bromide
   a.

   b.

   c.

   d.

   e.

   f.

Acids and Bases

3. Potassium carbonate
   a.

   b.

   c.

   d.

   e.

   f.

4. Calcium nitrate
   a.

   b.

   c.

   d.

   e.

   f.

5. Lithium perchlorate
   a.

   b.

   c.

   d.

   e.

   f.

Acids and Bases

6. Ammonium hypochlorite
   a.

   b.

   c.

   d.

   e.

   f.

7. Isoquinolinium chloride
   a.

   b.

   c.

   d.

   e.

   f.