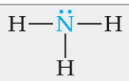
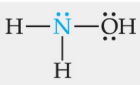
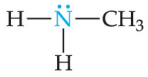
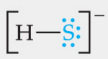
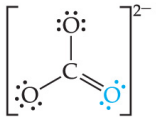
- **Weak Bases**
  - equilibrium constant, **base dissociation constant**, K_b
  - B (weak base) + $H_2O \rightleftharpoons BH^+$ (conjugated acid) + OH^-
  - $K_b = [BH^+][OH^-] / [B]$

Table 16.4 Some Weak Bases in Water at 25 °C

Base	Structural Formula*	Conjugate Acid	K_b
Ammonia (NH_3)		NH_4^+	1.8×10^{-5}
Pyridine (C_5H_5N)		$C_5H_5NH^+$	1.7×10^{-9}
Hydroxylamine ($HONH_2$)		$HONH_3^+$	1.1×10^{-8}
Methylamine (CH_3NH_2)		$CH_3NH_3^+$	4.4×10^{-4}
Hydrosulfide ion (HS^-)		H_2S	1.8×10^{-7}
Carbonate ion (CO_3^{2-})		HCO_3^-	1.8×10^{-4}
Hypochlorite ion (ClO^-)		HClO	3.3×10^{-7}

*The atom that accepts the proton is shown in blue.

- **Calculating pH Using K_b**
  - E.g. 1 What is the pH of 0.15 *M* NH_3 at 25 °C? (PPT 4-6)
  - E.g. 2 The daily therapeutic dose of quinine for malarial prevention is 2100 mg. What is the pH of a gin and tonic that contains one dose of quinine in 100 mL? (PPT 7-8)
  - E.g. 3 A solution of NH_3 has a pH = 11.30. What is its concentration?
    - $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$
      $K_b = [NH_4^+][OH^-] / [NH_3] = 1.8 \times 10^{-5}$
      pOH =14 – pH = 14-11.30 = 2.70
      $[OH^-] = 2.0 * 10^{-3}$

	NH_3	NH_4^+	OH^-
I	y	0	0
C	$-2.0 * 10^{-3}$	$+2.0 * 10^{-3}$	$+2.0 * 10^{-3}$
E	$y-2.0 * 10^{-3}$	$2.0 * 10^{-3}$	$2.0 * 10^{-3}$

$K_b = (2.0 * 10^{-3})^2 / (y-2.0 * 10^{-3}) = 1.8 \times 10^{-5}$
y = 4.5M

- **Relationship between K_a and K_b**
  - For a conjugate acid–base pair, $K_a \times K_b = K_w$
  - *E.g. What is the pH of a 0.015 M solution of procaine? (PPT 10-11)*

- **Acid–Base Properties of Salts**
  - Most salts are strong electrolytes, producing ions in water.
  - Many ions react with H_2O to produce H^+ or OH^-.
  - A systematic analysis of a salt allows prediction of whether an aqueous solution will be acidic, basic, or neutral.
  - The cation can be acidic or neutral.
  - The anion can be acidic, basic, or neutral.
  - In class question 1: You dissolve sodium chloride (NaCl) in water. **What is the pH of the resulting solution?**
    - $NaCl\ (aq) \rightarrow Na^+\ (aq) + Cl^-(aq)$
      Na^+ does not gain or accept H^+, Cl^- does not gain or accept H^+.
      Neither ion has acid-base character; the pH = 7.0.
  - In class question 2: You dissolve ammonium chloride (NH_4Cl) in water. **What is the pH of the resulting solution?**
    - $NH_4Cl\ (aq) \rightarrow NH_4^+\ (aq) + Cl^-(aq)$
      NH_4^+ is the conjugate acid of NH_3, a weak base.
      Cl^- does not gain or accept H^+.
      NH_4^+ is a weak acid, so the pH < 7.0.

- **Acid–Base Properties of Salts**
  - The anion from a monoprotic strong acid does not act as a base.
    - e.g., Cl^-, Br^-, I^-, NO_3^-, ClO_3^-, ClO_4^-.
  - The cation from a strong base does not act as an acid.
    - e.g., Li^+, Na^+, K^+, Ca^{2+}, Sr^{2+}
  - Easy Cases

Cation	Anion	Type of Solution	pH
Weak acid (e.g., NH_4^+, Fe^{3+})	From a strong acid (e.g., Cl^-, NO_3^-, ClO_3^-)	Acidic	< 7.0
From a strong base (e.g., Na^+, Ca^{2+})	Weak base (e.g., F^-, HCO_3^-)	Basic	>7.0
From a strong base (e.g., Na^+, Ca^{2+})	From a strong acid (e.g., Cl^-, NO_3^-, ClO_3^-)	Neutral	=7.0