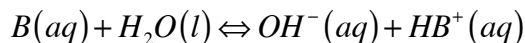
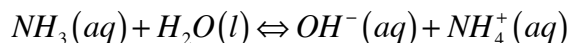


Weak Bases

A weak base is a compound that reacts incompletely with water to form an equilibrium that includes OH^- ions according to the following general equation.



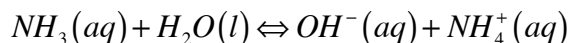
For example, ammonia is a weak base.



Ionization Constants for Weak Bases

Weak bases like ammonia (NH_3) and hydrazine (N_2H_4) form dynamic equilibria in aqueous solutions. As such, the reaction of a weak base with water results in an equilibrium law expression and an equilibrium constant.

The equilibrium constant for a weak base is known as the **base ionization constant** (K_b). Consider the equilibrium reaction of ammonia with water.



The equilibrium law expression for this reaction is written as,

$$K_b = \frac{[OH^-][NH_4^+]}{[NH_3]}$$

The Relationship Between K_a and K_b

It can be shown that, for acids and bases whose chemical formulas differ only by a hydrogen (i.e. conjugate acid-base pairs),

$$K_a \times K_b = K_w$$

where $K_w = 1.0 \times 10^{-14}$ at $25^\circ C$.

This relationship allows us to convert the K_a values of acids into the K_b values of their conjugate bases (and vice versa). Standard acid-base tables typically list only the K_a of the acids. If you need to know the K_b of a base, first look up the K_a of its conjugate acid, then use the above equation to convert it.

Example 1

What is the value of the base ionization constant for the acetate ion (CH_3COO^-) at $25^\circ C$?

The pH of Weak Base Solutions

Just as we used the acid ionization constant to convert between pH and $[H^+]$, we can use the base ionization constant to determine the pH, pOH, $[H^+]$, and $[OH^-]$ of solutions of weak bases.

Example 2

Calculate the pH of a 0.10 mol/L aqueous solution of hydrazine (N_2H_4), a weak base. The K_b for hydrazine is 1.7×10^{-6} .

Worksheet

1. The K_b for hydrazine (N_2H_4), a rocket fuel, is 1.7×10^{-6} . What is the K_a of its conjugate acid ($N_2H_5^+$)?
2. Use information from the Relative Strengths of Brønsted-Lowry Acids and Bases table and K_w to calculate the base ionization constant of the following bases.
 - a) iodate ion (IO_3^-).
 - b) nitrite ion (NO_2^-).
 - c) benzoate ion ($C_6H_5COO^-$).
3. Morphine ($C_{17}H_{19}NO_3$) is a weak base and a powerful painkiller. A solution of morphine has a concentration of 0.01 mol/L . Determine the pH of this solution. The K_b for morphine is 7.5×10^{-7} .
4. Calculate the pH and $[H^+]$ of a 0.30 mol/L solution of butanoic acid ($HC_4H_7O_2$). The K_a of butanoic acid is 1.52×10^{-5} .
5. Strychnine ($C_{21}H_{22}N_2O_2$) is a weak base but a powerful poison. Calculate the pH of a 0.001 mol/L solution of strychnine. The K_b of strychnine is 1.0×10^{-6} .

Answers

1. 5.9×10^{-9}
2. (a) 5.9×10^{-14} (b) 2.2×10^{-11} (c) 1.5×10^{-10}
3. 9.94
4. $[H^+] = 2.1 \times 10^{-3} \text{ mol/L}$, $pH = 2.67$
5. 9.5