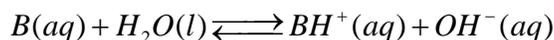


Weak Bases and Ionization Constants

The treatment of the ionization of weak bases is similar to the ionization of weak acids. When a base (B) is dissolved in water, it undergoes equilibrium reaction that is represented by



The equilibrium constant expression for this reaction is given by

$$K = \frac{[BH^+][OH^-]}{[B][H_2O]}$$

We can treat $[H_2O]$ as a constant and combine it with K and rewrite the above equation to yield the base ionization constant K_b , which is *equilibrium constant expression for the ionization reaction of base*.

$$K_b = K[H_2O] = \frac{[BH^+][OH^-]}{[B]}$$

The subscript b in K_b indicates the base to distinguish it from the acid and any other substance.

Strength of Weak Base

At a given temperature, the strength of a base is measured by the magnitude of K_b ; larger the K_b , the stronger the base. The following table lists few weak bases and their K_b values at 25°C in order of decreasing base strength.

Base name	Base formula	K_b
Ethylamine	$C_2H_5NH_2$	5.6×10^{-4}
Methylamine	CH_3NH_2	4.4×10^{-4}
Caffeine	$C_8H_{10}N_4O_2$	4.1×10^{-4}
Ammonia	NH_3	1.8×10^{-5}
Pyridine	C_5H_5N	1.7×10^{-9}
Aniline	$C_6H_5NH_2$	3.8×10^{-10}
Urea	$(NH_2)_2CO$	1.5×10^{-14}

Example

Arrange the following acids in order of decreasing base strength.

- (a) urea ($K_b = 1.53 \times 10^{-14}$)

- (b) ethylamine ($K_b = 5.6 \times 10^{-4}$)
- (c) ammonia ($K_b = 1.8 \times 10^{-5}$)
- (d) aniline ($K_b = 3.8 \times 10^{-10}$)
- (e) caffeine ($K_b = 4.1 \times 10^{-4}$)

Answer

Strength of a base is determined by the magnitude of K_b ; higher the K_b , stronger the base. We arrange the above given bases from high K_b to low K_b for decreasing order. Thus,

ethylamine > caffeine > ammonia > aniline > urea

Example

Ammonia (NH_3) is a weak base, the equilibrium reaction of which with water is given by



Which of the following statements are true for 1.0 M ammonia solution at equilibrium?

- (a) $[\text{NH}_4^+] = 1.0 \text{ M}$
- (b) $[\text{NH}_4^+] < 1.0 \text{ M}$
- (c) $[\text{NH}_4^+] = [\text{OH}^-]$
- (d) $[\text{NH}_3] = [\text{NH}_4^+]$
- (e) $[\text{OH}^-] = 1.0 \text{ M}$

Answer

- (a) not true
 - (b) true
 - (c) true
 - (d) not true
 - (e) not true
-