

Acid base equilibria 2

The ionization constant for NH_4OH is 1.8×10^{-5} . Calculate the concentration of OH^- ions in a 1.0 molar solution of NH_4OH .

Solution:

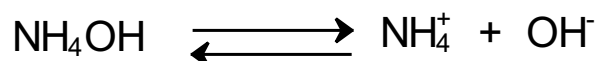
The ionization constant (K_b) is defined as the concentration of OH^- ions times the concentration of the conjugate acid ions of a given base divided by the concentration of an unionized base. For a base (BA),

$$K_b := \frac{(\text{B}^-) \cdot (\text{A}^+)}{(\text{BA})}$$

Where K_b is the ionized constant, (B^-) is the concentration of ionized base ions, (A^+) is the concentration of the conjugate acid, and (BA) is the concentration of the unionized base. The K_b for NH_4OH is stated as

$$K_b = \frac{(\text{NH}_4^+) \cdot (\text{OH}^-)}{\text{NH}_4\text{OH}} = 1.8 \times 10^{-5}$$

When NH_4OH is ionized, one NH_4^+ ion is formed and one OH^- ion is formed,



The concentrations of each ions are equal.

$$(\text{NH}_4^+) = (\text{OH}^-)$$

The concentration of the unionized base is decreased when ionization occurs. The new concentration is equal to the concentration of OH^- subtracted from the concentration of NH_4OH .

$$(\text{NH}_4\text{OH}) = 1.0 - (\text{OH}^-)$$

Since (OH^-) is small relative to 1.0, one may assume that $1.0 - (\text{OH}^-)$ is approximately equal to 1.0.

$$(\text{NH}_4\text{OH}) = 1.0 - (\text{OH}^-) \approx 1.0$$

Using the assumption and the fact that $(\text{OH}^-) = (\text{NH}_4^+)$, K_b can be rewritten as

$$K_b = \frac{(\text{OH}^-) \cdot (\text{OH}^-)}{1.0} = 1.8 \times 10^{-5}$$

Solution for (OH^-) :

$$\frac{(\text{OH}^-) \cdot (\text{OH}^-)}{1.0} = 1.8 \times 10^{-5}$$

$$(\text{OH}^-)^2 = 1.8 \times 10^{-5}$$

$$(\text{OH}^-) = \sqrt[2]{1.8 \times 10^{-5}} = 4.2 \times 10^{-3}$$