

Problem Set 7: Acids and Bases Answers

10. Problem Level 2

a.

Write down conditions for HNO_2 and HNO_3 in the solution: $\text{HNO}_2 \rightleftharpoons \text{H}^+ + \text{NO}_2^-$, $K_a = 4.5 \times 10^{-4}$, corresponding to $\text{pH} = 3.35$.

b.

The equilibrium is:



For HNO_2 , $K_a = 4.5 \times 10^{-4}$ and for H_2O , $K_a = 1.0 \times 10^{-14}$, so:

$$\frac{[\text{H}_3\text{O}^+][\text{NO}_2^-]}{[\text{HNO}_2]} = 4.5 \times 10^{-4}$$

The initial concentrations of the acid and conjugate base are respectively: $[\text{HNO}_2] = 0.1000 \text{ M}$ and $[\text{NO}_2^-] = 0.1000 \text{ M}$. The water dissociation constant is:

$$[\text{H}_3\text{O}^+][\text{OH}^-] = 1.0 \times 10^{-14} \text{ and } [\text{H}_3\text{O}^+] = [\text{OH}^-]$$

and the mass balance is given by:

$$[\text{HNO}_2] + [\text{NO}_2^-] + [\text{H}_2\text{O}] = [\text{HNO}_2] + [\text{NO}_2^-]$$

and for the electroneutrality there is: $[\text{H}_3\text{O}^+] = [\text{NO}_2^-] + [\text{OH}^-]$. The equilibrium concentrations of the species are then:

$$[\text{HNO}_2] = 0.1000 - x \text{ and } [\text{NO}_2^-] = 0.1000 + x$$

Substituting $[\text{H}_3\text{O}^+] = [\text{NO}_2^-] + [\text{OH}^-]$ into the equilibrium constant for the acid, we obtain:

$$\frac{(0.1000 + x)(x)}{0.1000 - x} = 4.5 \times 10^{-4}$$

Since $x \ll 0.1000$, we have $[\text{H}_3\text{O}^+] = 4.5 \times 10^{-4} \text{ M}$ and $\text{pH} = 3.35$.

Answers To Problem Set 2

**James N. Thompson, Jr, Jenna J.
Hellack, Gerald Braver, David S. Durica**

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