

Worksheet 22: Acids and Bases

The Brønsted-Lowry definition of an acid is a substance capable of donating a proton (H^+), and a base is a substance capable of accepting a proton. For example, ammonia and HCl can be described as reacting using the reaction:



In this reaction, HCl is the species losing the proton (H^+), making it the acid. Water is the species accepting the proton, to form the conjugate base, OH^- , making it the base. This H^+ is called the conjugate base of HCl . It can gain a proton in the reverse reaction. Water is the conjugate acid of OH^- because it can lose a proton to the reverse reaction. The conjugate acid and the conjugate base will be used to describe the base, the reaction is conjugate acid

The equilibrium concentrations of these species will be determined by the relative strengths of the acids and bases. The conjugate acid will dominate in the product extent. $HCl(aq)$ is the stronger acid that can exist in an aqueous system. So, the equilibrium in this reaction will favor the products. HCl and H_2O are weaker acid and base. The equilibrium state is determined by an equilibrium constant K_a in the case of acids, and K_b in the case of bases. These can be related by the expression $K_a \times K_b = K_w = 1 \times 10^{-14}$.

1. Classify the following as Brønsted acids, bases or both

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| a) H_2O / $H_2O(aq)$ | b) OH^- / $OH^-(aq)$ | c) H_2O / $H_2O(aq)$ |
| $H_2O(aq) \rightleftharpoons H_3O^+(aq)$ | $OH^-(aq) \rightleftharpoons O^{2-}(aq)$ | $H_2O(aq) \rightleftharpoons H_2O(l)$ |
| $H_2O(aq) \rightleftharpoons H^+(aq)$ | $OH^-(aq) \rightleftharpoons O^{2-}(aq)$ | $H_2O(aq) \rightleftharpoons H_2O(l)$ |
| d) H_2O / $H_2O(aq)$ | e) H_2O / $H_2O(aq)$ | f) OH^- / $OH^-(aq)$ |
| $H_2O(aq) \rightleftharpoons H_3O^+(aq)$ | $H_2O(aq) \rightleftharpoons H_2O(l)$ | $OH^-(aq) \rightleftharpoons O^{2-}(aq)$ |

2. What is the conjugate base of the following acids?

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| a) HCO_2H | b) HNO_2 | c) H_2O | d) HCO_2^- |
| $C_6H_5CO_2H$ | NO_2^- | H_2O^+ | $C_6H_5CO_2^-$ |

3. What is the conjugate acid of the following bases?

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| a) OH^- | b) H_2O | c) H_2O | d) HCO_2^- |
| H_2O | H_2O | H_2O | H_2O |