

Activity 34: Chemical Equilibrium, Le Châtelier's Principle, and Weak Acids

Learning Objectives

- Part 1 *Provide an equilibrium expression for an equilibrium equation*
Distinguish between endothermic and exothermic reactions
Predict the progress of a reaction given a value for K
- Part 2 *Predict the direction that an equilibrium reaction will shift if products, reactants, or heat are added or removed from the reaction*
Predict the effect of a catalyst on an equilibrium reaction
- Part 3 *Recognize conjugate acid–base pairs*
Identify the conjugate acid given a weak base and a conjugate base given a weak acid
-

Estimated Completion Time 60 Minutes

Instructor Information

Equilibrium is introduced along with the terms *endothermic* and *exothermic*. The focus here should be on the definition of K as $[\text{products}]/[\text{reactants}]$ as opposed to writing equilibrium expressions. K and Le Châtelier's principle will become important in the next activity when K_a s and buffers are introduced. The relationship between weak acids and their conjugates is emphasized in Part 3.

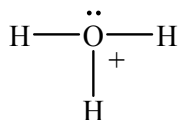
ANSWERS TO QUESTIONS

Part 1. Chemical Equilibrium

1.

	No. of Nitrogen Atoms	No. of Hydrogen Atoms
Reactants	2	6
Products	2	6

2. Exothermic. The reverse is endothermic.
3. More reactants (N_2 and H_2).
- 4.



5. $K = [\text{OH}^-][\text{H}_3\text{O}^+]$ Note that the activity states that H_2O does not appear in equilibrium expressions as a solvent.
6. H_2O molecules

Part 2. LeChâtelier's Principle

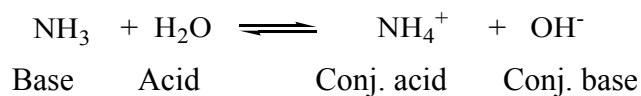
1. a. Exothermic
 - b. $K = \frac{[\text{CH}_3\text{OH}]}{[\text{CO}][\text{H}_2]^2}$
 - c. Shift right
 - d. Shift left
 - e. Shift right
 - f. No. A catalyst does not affect the equilibrium; it just speeds up a chemical reaction.

Activity 34: Skill Development - LeChâtelier's Principle

1. a. Reaction A is endothermic, and Reaction B is exothermic.
 - b. Shift right
 - c. Shift right
 - d. Reaction A would shift right, and Reaction B would shift left if heat were added.

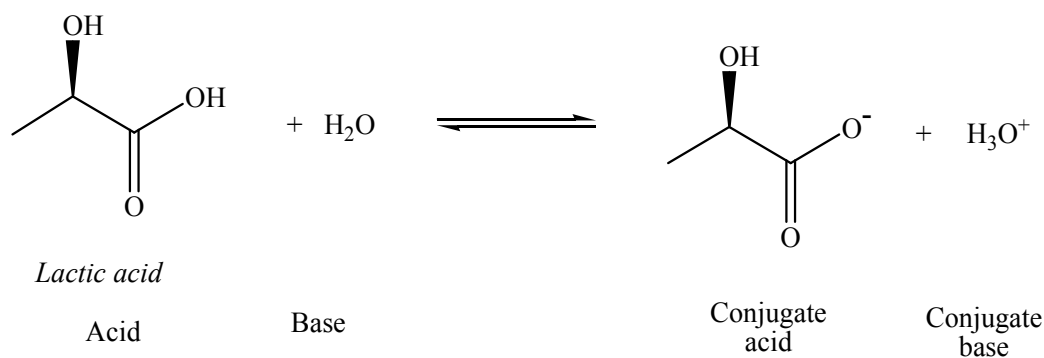
Part 3. Weak Acids

1. It donates or loses a proton.
2. It accepts or picks up a proton.
- 3.



4. An acid and a base that differ by one proton (H^+).

5.



6. a. HS^- b. H_2O c. H_2PO_4^- d. CO_3^{2-}

Activity 34: Skill Development—Weak Acids

1. a. $\text{H}_3\text{PO}_4 (aq) + \text{H}_2\text{O} (l) \rightleftharpoons \text{H}_3\text{O}^+ (aq) + \text{H}_2\text{PO}_4^- (aq)$
A B CA CB
 - b. $\text{CO}_3^{2-} (aq) + \text{H}_2\text{O} (l) \rightleftharpoons \text{OH}^- (aq) + \text{HCO}_3^- (aq)$
B A CB CA
 - c. $\text{H}_3\text{PO}_4 (aq) + \text{NH}_3 (aq) \rightleftharpoons \text{NH}_4^+ (aq) + \text{H}_2\text{PO}_4^- (aq)$
A B CA CB
2. a. CO_3^{2-} b. H_2O c. PO_4^{3-} d. NO_2^-

3. a. HSO_4^- b. HCN c. H_2O d. HClO_2

4.

