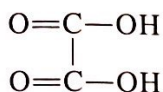


15.5 Identify the acid-base conjugate pairs in each of the following reactions:

- (a) $\text{CH}_3\text{COO}^- + \text{HCN} \rightleftharpoons \text{CH}_3\text{COOH} + \text{CN}^-$
- (b) $\text{HCO}_3^- + \text{HCO}_3^- \rightleftharpoons \text{H}_2\text{CO}_3 + \text{CO}_3^{2-}$
- (c) $\text{H}_2\text{PO}_4^- + \text{NH}_3 \rightleftharpoons \text{HPO}_4^{2-} + \text{NH}_4^+$
- (d) $\text{HClO} + \text{CH}_3\text{NH}_2 \rightleftharpoons \text{CH}_3\text{NH}_3^+ + \text{ClO}^-$
- (e) $\text{CO}_3^{2-} + \text{H}_2\text{O} \rightleftharpoons \text{HCO}_3^- + \text{OH}^-$

15.6 Write the formula for the conjugate acid of each of the following bases: (a) HS^- , (b) HCO_3^- , (c) CO_3^{2-} , (d) H_2PO_4^- , (e) HPO_4^{2-} , (f) PO_4^{3-} , (g) HSO_4^- , (h) SO_4^{2-} , (i) SO_3^{2-} .

15.7 Oxalic acid ($\text{C}_2\text{H}_2\text{O}_4$) has the following structure:



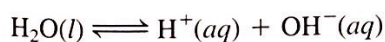
An oxalic acid solution contains the following species in varying concentrations: $\text{C}_2\text{H}_2\text{O}_4$, C_2HO_4^- , $\text{C}_2\text{O}_4^{2-}$, and H^+ . (a) Draw Lewis structures of C_2HO_4^- and $\text{C}_2\text{O}_4^{2-}$. (b) Which of the above four species can act only as acids, which can act only as bases, and which can act as both acids and bases?

15.8 Write the formula for the conjugate base of each of the following acids: (a) CH_2ClCOOH , (b) HIO_4 , (c) H_3PO_4 , (d) H_2PO_4^- , (e) HPO_4^{2-} , (f) H_2SO_4 , (g) HSO_4^- , (h) HIO_3 , (i) HSO_3^- , (j) NH_4^+ , (k) H_2S , (l) HS^- , (m) HClO .

The Acid-Base Properties of Water

Review Questions

- 15.9 What is the ion-product constant for water?
- 15.10 Write an equation relating $[\text{H}^+]$ and $[\text{OH}^-]$ in solution at 25°C .
- 15.11 The ion-product constant for water is 1.0×10^{-14} at 25°C and 3.8×10^{-14} at 40°C . Is the forward process



endothermic or exothermic?

pH—A Measure of Acidity

Review Questions

- 15.12 Define pH. Why do chemists normally choose to discuss the acidity of a solution in terms of pH rather than hydrogen ion concentration, $[\text{H}^+]$?
- 15.13 The pH of a solution is 6.7. From this statement alone, can you conclude that the solution is acidic? If not, what additional information would you need? Can the pH of a solution be zero or negative? If so, give examples to illustrate these values.
- 15.14 Define pOH. Write the equation relating pH and pOH.

Biological: 15.96, 15.107, 15.135, 15.141, 15.145. Conceptual: 15.32, 15.35, 15.36, 15.70, 15.75, 15.76, 15.77, 15.78, 15.81, 15.82, 15.95,

Problems

- 15.15 Calculate the concentration of OH^- ions in a $1.4 \times 10^{-3} \text{ M}$ HCl solution.
- 15.16 Calculate the concentration of H^+ ions in a 0.62 M NaOH solution.
- 15.17 Calculate the pH of each of the following solutions: (a) 0.0010 M HCl, (b) 0.76 M KOH.
- 15.18 Calculate the pH of each of the following solutions: (a) $2.8 \times 10^{-4} \text{ M}$ $\text{Ba}(\text{OH})_2$, (b) $5.2 \times 10^{-4} \text{ M}$ HNO_3 .
- 15.19 Calculate the hydrogen ion concentration in mol/L for solutions with the following pH values: (a) 2.42, (b) 11.21, (c) 6.96, (d) 15.00.
- 15.20 Calculate the hydrogen ion concentration in mol/L for each of the following solutions: (a) a solution whose pH is 5.20, (b) a solution whose pH is 16.00, (c) a solution whose hydroxide concentration is $3.7 \times 10^{-9} \text{ M}$.
- 15.21 Complete the following table for a solution:

pH	$[\text{H}^+]$	Solution is
<7		
	$<1.0 \times 10^{-7} \text{ M}$	
		Neutral

- 15.22 Fill in the word *acidic*, *basic*, or *neutral* for the following solutions:
 - (a) $\text{pOH} > 7$; solution is
 - (b) $\text{pOH} = 7$; solution is
 - (c) $\text{pOH} < 7$; solution is
- 15.23 The pOH of a solution is 9.40. Calculate the hydrogen ion concentration of the solution.
- 15.24 Calculate the number of moles of KOH in 5.50 mL of a 0.360 M KOH solution. What is the pOH of the solution?
- 15.25 How much NaOH (in grams) is needed to prepare 546 mL of solution with a pH of 10.00?
- 15.26 A solution is made by dissolving 18.4 g of HCl in 662 mL of water. Calculate the pH of the solution. (Assume that the volume remains constant.)

Strength of Acids and Bases

Review Questions

- 15.27 Explain what is meant by the strength of an acid.
- 15.28 Without referring to the text, write the formulas of four strong acids and four weak acids.
- 15.29 What are the strongest acid and strongest base that can exist in water?
- 15.30 H_2SO_4 is a strong acid, but HSO_4^- is a weak acid. Account for the difference in strength of these two related species.