Solutions Lesson 6 Answers to Questions 5-11

Sections 8.3–8.4 Questions

Understanding Concepts

1. Distinguish between a strong and weak acid using the concept of reaction with water.
2. What class of substances are strong bases? Explain their properties.
3. What are the properties of a weak base? Explain these properties.
4. Write appropriate chemical equations to explain the acidic or basic properties of each of the following substances added to water.
   (a) hydrogen bromide (acidic) $HBr + H_2O(l) \rightarrow H_3O^+ + Br^-$
   (b) potassium hydroxide (basic) $KOH \rightarrow K^+ + OH^-$
   (c) benzoic acid, $HC_7H_5O_{2(aq)}$ (acidic) $HC_7H_5O_2 + H_2O \rightleftharpoons H_3O^+ + C_7H_5O_2^-$
   (d) sodium sulfide (basic) $S^{2-} + H_2O(l) \rightleftharpoons HS^- + OH^-$
5. Theories in science develop over a period of time. Illustrate this development by writing theoretical definitions of an acid using the following concepts. Begin your answer with, "According to [name of concept], acids are substances that..."
   (a) the Arrhenius concept → produce H^+ ions, produce OH^- ions
   (b) the revised Arrhenius concept → produce H_3O^+ ions, ↑$[OH^-]$
   (c) the Brønsted-Lowry concept → acid is a proton donor, proton acceptor
6. Repeat question 5, defining bases. Refer to both strong and weak bases in your answer.
7. According to the Brønsted-Lowry concept, what happens in an acid–base reaction? acid donates H^+, base accepts H^+
8. Use the Brønsted-Lowry definitions to identify each of the reactants in the following equations as acids or bases.
   (a) $HCO_{3(aq)}^- + S_{(aq)}^{2-} \rightarrow HS_{(aq)}^- + CO_{3(aq)}^{2-}$ (ACID, BASE, ACID, BASE)
   (b) $H_2CO_{3(aq)} + OH_{(aq)}^- \rightarrow HCO_{3(aq)}^- + H_2O_{(l)}$ (ACID, BASE, BASE, ACID)
9. Complete the following chemical equations to predict the acid–base reaction products.
   (a) $HSO_{4(aq)}^- + PO_{4(aq)}^{3-} \rightarrow SO_4^{2-}(aq) + HPO_4^{2-}(aq)$ (ACID, BASE)
   (b) $H_3O_{(aq)}^+ + HPO_{4(aq)}^{2-} \rightarrow H_2O(l) + H_2PO_4(aq)$ (ACID, BASE)
10. Some ions can form more than one conjugate acid–base pair. List the two conjugate acid–base pairs involving a hydrogen carbonate ion. $HCO_3^- + H_2O(l) \rightleftharpoons CO_3^{2-} + H_3O^+$ (ACID, BASE); $HCO_3^- + H_2O(l) \rightleftharpoons H_2CO_3 + OH^-$ (BASE, ACID)
11. Identify the two acid–base conjugate pairs in each of the following reactions.
   (a) $H_3O_{(aq)}^+ + HSO_{3(aq)}^- \rightarrow H_2O_{(l)} + H_2SO_{3(aq)}$ (ACID, BASE, BASE, ACID)
   (b) $OH_{(aq)}^- + HSO_{3(aq)}^- \rightarrow H_2O_{(l)} + SO_{3(aq)}^{2-}$ (BASE, ACID, ACID, BASE)

Applying Inquiry Skills

12. Baking soda is a common chemical but its chemical properties are difficult for chemists to explain and predict. Baking soda is amphiprotic and forms a basic solution. List some of the chemical properties of baking soda and indicate why some of these properties are difficult to explain and predict.
    Follow the links for Nelson Chemistry 11, 8.4.

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Making Connections

13. Common kitchen-variety baking soda has so many uses that it has entire books written about it. Use references to gather a list of uses for baking soda. Identify the uses that involve acid–base reactions.

1. Strong acids completely ionize in water
$HCl + H_2O(l) \rightarrow Cl^-(aq) + H_3O^+$
weak acids form equilibriums.
$HCO_3^- + H_2O(l) \rightleftharpoons CO_3^{2-} + H_3O^+$
2. Soluble metal hydroxides are strong bases because the dissociate in water to produce 100% OH^- ions
$BOH \rightarrow B^+ + OH^-$
3. Weak bases (like weak acids) do not 100% ionize (form equilibriums)
$NH_3 + H_2O(l) \rightleftharpoons NH_4^+ + OH^-$