Chapter 15 Acids and Bases

Student: _____

1. Which is *not* a characteristic property of acids?

   A. tastes sour
   B. turns litmus from blue to red
   C. reacts with metals to yield CO_2 gas
   D. neutralizes bases
   E. reacts with carbonates to yield CO_2 gas

2. Which is the formula for the hydronium ion?

   A. OH^-
   B. H_2O
   C. H_3O^+
   D. H_3O^-
   E. H_2O^+

3. In the reaction $H_2CO_3 + H_2O \rightleftharpoons HCO_3^- + H_3O^+$, the Brønsted acids are

   A. H_2CO_3 and H_2O.
   B. HCO_3^- and H_2CO_3.
   C. H_2O and H_3O^+.
   D. H_3O^+ and H_2CO_3.
   E. H_2O and HCO_3^-.

4. In the reaction $HSO_4^-(aq) + OH^-(aq) \rightleftharpoons SO_4^{2-}(aq) + H_2O(l)$, the conjugate acid-base pairs are

	pair 1	*pair 2*
Row 1	HSO_4^- and SO_4^{2-};	H_2O and OH^-.
Row 2	HSO_4^- and H_3O^+;	SO_4^{2-} and OH^-.
Row 3	HSO_4^- and OH^-;	SO_4^{2-} and H_2O.
Row 4	HSO_4^- and H_2O;	OH^- and SO_4^{2-}.
Row 5	HSO_4^- and OH^-;	SO_4^{2-} and H_3O^+.

   A. Row 1
   B. Row 2
   C. Row 3
   D. Row 4
   E. Row 5

5. Identify the conjugate base of HPO_4^{2-} in the reaction

$HCO_3^- + HPO_4^{2-} \rightleftharpoons H_2CO_3 + PO_4^{3-}$

A. H_2O
B. HCO_3^-
C. H_2CO_3
D. PO_4^{3-}
E. none of these

6. Identify the conjugate base of HSO_4^- in the reaction

$H_2PO_4^- + HSO_4^- \rightleftharpoons H_3PO_4 + SO_4^{2-}$

A. $H_2PO_4^-$
B. H_2SO_4
C. H_2O
D. H_3PO_4
E. SO_4^{2-}

7. Identify the conjugate base of HCO_3^- in the reaction

$CO_3^{2-} + HSO_4^- \rightleftharpoons HCO_3^- + SO_4^{2-}$

A. HSO_4^-
B. CO_3^{2-}
C. OH^-
D. H_3O^+
E. SO_4^{2-}

8. Identify the conjugate base of CH_3COOH in the reaction

$CH_3COOH + HSO_4^- \rightleftharpoons H_2SO_4 + CH_3COO^-$

A. HSO_4^-
B. SO_4^{2-}
C. CH_3COO^-
D. H_2SO_4
E. OH^-

9. Identify the conjugate base of $HClO_3$ in the reaction

$ClO_3^- + HSO_4^- \rightleftharpoons HClO_3 + SO_4^{2-}$

A. ClO_3^-
B. HSO_4^-
C. OH^-
D. H_3O^+
E. SO_4^{2-}

10. Identify the conjugate acid of SO_4^{2-} in the reaction

$$CO_3^{2-} + HSO_4^- \rightleftharpoons HCO_3^- + SO_4^{2-}$$

A. CO_3^{2-}
B. HSO_4^-
C. OH^-
D. H_3O^+
E. SO_4^{2-}

11. Identify the conjugate acid of HCO_3^- in the reaction

$$HCO_3^- + HPO_4^{2-} \rightleftharpoons H_2CO_3 + PO_4^{3-}$$

A. H_2O
B. HCO_3^-
C. H_2CO_3
D. PO_4^{3-}
E. HPO_4^{2-}

12. Identify the conjugate acid of CO_3^{2-} in the reaction

$$CO_3^{2-} + H_2PO_4^- \rightleftharpoons HCO_3^- + HPO_4^{2-}$$

A. H_2CO_3
B. HCO_3^-
C. H_2O
D. HPO_4^{2-}
E. $H_2PO_4^-$

13. Which one of these statements about strong acids is *true*?

A. All strong acids have H atoms bonded to electronegative oxygen atoms.
B. Strong acids are 100% ionized in water.
C. The conjugate base of a strong acid is itself a strong base.
D. Strong acids are very concentrated acids.
E. Strong acids produce solutions with a higher pH than weak acids.

14. One liter of an aqueous solution contains 6.02×10^{21} H_3O^+ ions. Therefore, its H_3O^+ ion concentration is

A. 0.0100 mole per liter.
B. 0.100 mole per liter.
C. 1.00 mole per liter.
D. 6.02×10^{21} mole per liter.
E. 6.02×10^{23} mole per liter.

15. One liter of an aqueous solution contains 6.02×10^{20} H_3O^+ ions. Therefore, its H_3O^+ ion concentration is

A. 0.0100 mole per liter.
B. 0.00100 mole per liter.
C. 1.00 mole per liter.
D. 6.02×10^{20} mole per liter.
E. 6.02×10^{23} mole per liter.

16. What is the concentration of H^+ in a 2.5 M HCl solution?

A. 0
B. 1.3 M
C. 2.5 M
D. 5.0 M
E. 10 .M

17. The OH^- concentration in a 1.0×10^{-3} M $Ba(OH)_2$ solution is

A. 0.50×10^{-3} M.
B. 1.0×10^{-3} M.
C. 2.0×10^{-3} M.
D. 1.0×10^{-2} M.
E. 0.020 M.

18. The OH^- concentration in a 7.5×10^{-3} M $Ca(OH)_2$ solution is

A. 7.5×10^{-3} M.
B. 1.5×10^{-2} M.
C. 1.3×10^{-12} M.
D. 1.0×10^{-7} M.
E. 1.0×10^{-14} M.

19. The OH^- concentration in a 2.5×10^{-3} M $Ba(OH)_2$ solution is

A. 4.0×10^{-12} M.
B. 2.5×10^{-3} M.
C. 5.0×10^{-3} M.
D. 1.2×10^{-2} M.
E. 0.025 M.

20. What is the H^+ ion concentration in a 4.8×10^{-2} M KOH solution?

A. 4.8×10^{-2} M
B. 1.0×10^{-7} M
C. 4.8×10^{-11} M
D. 4.8×10^{-12} M
E. 2.1×10^{-13} M

21. Calculate the H^+ ion concentration in a 8.8×10^{-4} M $Ca(OH)_2$ solution.

A. 8.8×10^{-4} M
B. 1.8×10^{-3} M
C. 2.2×10^{-11} M
D. 1.1×10^{-11} M
E. 5.7×10^{-12} M

22. What is the OH^- ion concentration in a 5.2×10^{-4} M HNO_3 solution?

A. 1.9×10^{-11} M
B. 1.0×10^{-7} M
C. 5.2×10^{-4} M
D. zero
E. 1.0×10^{-4} M

23. A 0.10 M HF solution is 8.4% ionized. Calculate the H^+ ion concentration.

A. 0.84 M
B. 0.12 M
C. 0.10 M
D. 0.084 M
E. 8.4×10^{-3} M

24. A 0.14 M HNO_2 solution is 5.7% ionized. Calculate the H^+ ion concentration.

A. 8.0×10^{-3} M
B. 0.057 M
C. 0.13 M
D. 0.14 M
E. 0.80 M

25. Consider the weak acid CH_3COOH (acetic acid). If a 0.048 M CH_3COOH solution is 5.2% ionized, determine the $[H_3O^+]$ concentration at equilibrium.

A. 0.25 M
B. 9.2×10^{-3} M
C. 0.048 M
D. 0.052 M
E. 2.5×10^{-3} M

26. A 0.10 M NH_3 solution is 1.3% ionized. Calculate the H^+ ion concentration.

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

A. 1.3×10^{-3} M
B. 7.7×10^{-2} M
C. 7.7×10^{-12} M
D. 0.13 M
E. 0.10 M

27. Calculate the pH of a beer in which the hydrogen ion concentration is 6.3×10^{-5} M.

A. 4.2
B. 4.8
C. 5.63
D. 9.8
E. 14.0

28. Determine the pH of a KOH solution made by mixing 0.251 g KOH with enough water to make 1.00×10^2 mL of solution.

A. 1.35
B. 2.35
C. 7.00
D. 11.65
E. 12.65

29. Calculate the H^+ ion concentration in lemon juice having a pH of 2.4.

A. 4.0×10^{-2} M
B. 250 M
C. 0.38 M
D. 4.0×10^{-3} M
E. 12 M

30. Calculate the pH of a 3.5×10^{-3} M HNO_3 solution.

A. -2.46
B. 0.54
C. 2.46
D. 3.00
E. 3.46

31. What is the pH of 10.0 mL of 0.0020 M HCl?

A. 0.70
B. 2.70
C. 3.70
D. 5.70
E. 10.0

32. Calculate the pH of a 0.14 M HNO_2 solution that is 5.7% ionized.

A. 0.85
B. 1.70
C. 2.10
D. 11.90
E. 13.10

33. Calculate the pH of a 0.10 M HCN solution that is 0.0070% ionized.

A. 1.00
B. 0.00070
C. 3.15
D. 5.15
E. 7.00

34. What is the pH of a 0.0055 M HA (weak acid) solution that is 8.2% ionized?

A. 2.26
B. 3.35
C. 4.52
D. 8.21
E. 10.65

35. Calculate the pH of a 6.71×10^{-2} M NaOH solution.

A. 12.83
B. 2.17
C. 11.82
D. 6.71
E. 1.17

36. Calculate the pH of 2.6×10^{-2} M KOH.

A. 12.41
B. 15.59
C. 2.06
D. 7.00
E. 1.59

37. Calculate the pH of a 1.6 M KOH solution.

A. 1.60
B. -0.20
C. 0.20
D. 14.20
E. 13.80

38. What is the pH of a 0.014 M $Ca(OH)_2$ solution?

A. 1.85
B. 1.55
C. 12.15
D. 12.45
E. 15.85

39. What is the pH of a 0.001 M $Ca(OH)_2$ solution?

A. 3.0
B. 11.0
C. 2.7
D. 17.0
E. 11.3

40. Calculate the hydrogen ion concentration in a solution of fruit juice having a pH of 4.25.

A. 1.0×10^{-14} M
B. 5.6×10^{-5} M
C. 4.0×10^{-25} M
D. 2.5×10^{-4} M
E. 5.6×10^{-4} M

41. The pH of tomato juice is about 4.5. Calculate the concentration of hydrogen ions in this juice.

A. $3. \times 10^{-10}$ M
B. $3. \times 10^{-5}$ M
C. $5. \times 10^{-4}$ M
D. 4 .M
E. $3. \times 10^{10}$ M

42. The pH of a certain solution is 2.0. How many $H^+(aq)$ ions are there in 1.0 L of the solution?

A. 0.01 ions
B. 100 ions
C. 2 ions
D. $6. \times 10^{21}$ ions
E. $6. \times 10^{23}$ ions

43. The pH of a certain solution is 3.0. How many $H^+(aq)$ ions are there in 1.0 L of the solution?

A. 0.001 ions
B. 1,000 ions
C. $6. \times 10^{20}$ ions
D. 3 ions
E. $6. \times 10^{26}$ ions

44. Calculate the hydrogen ion concentration in a solution having a pH of 4.60.

A. 4.0×10^{-3} M
B. 4.0×10^{-9} M
C. 4.0×10^{-10} M
D. 2.5×10^{-5} M
E. 2.5×10^{-4} M

45. Calculate the hydrogen ion concentration in a solution of beer having a pH of 4.80.

A. 1.6×10^{-4} M
B. 1.6×10^{-5} M
C. 1.6×10^{-6} M
D. 4.0×10^{-8} M
E. 8.0×10^{-5} M

46. The pH of a $Ba(OH)_2$ solution is 10.00. What is the H^+ ion concentration of this solution?

A. 4.0×10^{-11} M
B. 1.6×10^{-10} M
C. 1.3×10^{-5} M
D. 1.0×10^{-10} M
E. 10 .M

47. Diet cola drinks have a pH of about 3.0, while milk has a pH of about 7.0. How many times greater is the H_3O^+ concentration in diet cola than in milk?

A. 2.3 times higher in diet cola than in milk
B. 400 times higher in diet cola than in milk
C. 0.43 times higher in diet cola than in milk
D. 1,000 times higher in diet cola than in milk
E. 10,000 times higher in diet cola than in milk

48. The pH of coffee is approximately 5.0. How many times greater is the $[H_3O^+]$ in coffee than in tap water having a pH of 8.0?

A. 0.62
B. 1.6
C. 30
D. 1,000
E. 1.0×10^4

49. The pH of coffee is approximately 5.0. How many times greater is the $[H^+]$ in coffee than in neutral water?

A. 200
B. 100
C. 5.0
D. 1.4
E. 0.01

50. If the pH of an acid rain storm is approximately 3.0, how many times greater is the $[H^+]$ in the rain than in a cup of coffee having a pH of 5.0?

A. 1000
B. 100
C. 20
D. 1.7
E. 0.60

51. What is the pH of a solution prepared by mixing 10.0 mL of a strong acid solution with pH = 2.00 and 10.0 mL of a strong acid solution with pH = 6.00?

A. 2.0
B. 2.3
C. 4.0
D. 6.0
E. 8.0

52. The pOH of a solution is 9.60 Calculate the hydrogen ion concentration in this solution.

A. 2.5×10^{-10} M
B. 6.0×10^{-9} M
C. 4.0×10^{-5} M
D. 2.4×10^{-4} M
E. 1.0×10^{-14} M

53. The pOH of a solution is 10.40 Calculate the hydrogen ion concentration in the solution.

A. 4.0×10^{-11} M
B. 3.6 M
C. 4.0×10^{-10} M
D. 2.5×10^{-4} M
E. 1.8×10^{-4} M

54. Which solution will have the lowest pH?

A. 0.10 M HCN
B. 0.10 M HNO_3
C. 0.10 M NaCl
D. 0.10 M H_2CO_3
E. 0.10 M NaOH

55. Which one of these responses is *true* with regard to a 0.1 M solution of a weak acid HA?

A. $[H^+] > [A^-]$
B. pH = 1.0
C. $[H^+] < [A^-]$
D. pH > 1.0
E. $[OH^-] > [H^+]$

56. Acid strength decreases in the series HI > HSO_4^- > HF > HCN. Which of these anions is the *weakest* base?

A. I^-
B. SO_4^{2-}
C. F^-
D. CN^-

57. Acid strength decreases in the series: strongest HSO_4^- > HF > HCN. Which of these species is the *weakest* base?

A. HF
B. SO_4^{2-}
C. F^-
D. CN^-

58. Acid strength increases in the series: HCN < HF < HSO_4^-. Which of these species is the *strongest* base?

A. H_2SO_4
B. SO_4^{2-}
C. F^-
D. CN^-
E. HSO_4^-

59. Acid strength decreases in the series: HCl > HSO_4^- > HCN. Which of these species is the *strongest* base?

A. CN^-
B. SO_4^{2-}
C. HCN
D. Cl^-

60. Acid strength decreases in the series: HNO_3 > HF > CH_3COOH. Which of these species is the *strongest* base?

A. NO_3^-
B. CH_3COO^-
C. F^-
D. CH_3COOH

61. Which of these acids is the *strongest*?

A. H_2SeO_3
B. H_2TeO_3
C. H_2SO_3

62. Arrange the acids HOCl, $HClO_3$, and $HClO_2$ in order of increasing acid strength.

A. HOCl < $HClO_3$ < $HClO_2$
B. HOCl < $HClO_2$ < $HClO_3$
C. $HClO_2$ < HOCl < $HClO_3$
D. $HClO_3$ < HOCl < $HClO_2$
E. $HClO_3$ < $HClO_2$ < HOCl

63. Arrange the acids HOBr, $HBrO_3$, and $HBrO_2$ in order of increasing acid strength.

A. HOBr < $HBrO_3$ < $HBrO_2$
B. HOBr < $HBrO_2$ < $HBrO_3$
C. $HBrO_2$ < HOBr < $HBrO_3$
D. $HBrO_3$ < HOBr < $HBrO_2$
E. $HBrO_3$ < $HBrO_2$ < HOBr

64. Arrange the acids HBr, H_2Se, and H_3As in order of increasing acid strength.

A. HBr < H_2Se < H_3As
B. HBr < H_3As < H_2Se
C. H_2Se < H_3As < HBr
D. H_3As< H_2Se < HBr
E. H_3As< HBr < H_2Se

65. Arrange the acids H_2Se, H_2Te, and H_2S in order of increasing acid strength.

A. H_2S < H_2Se < H_2Te
B. H_2S < H_2Te < H_2Se
C. H_2Te < H_2S < H_2Se
D. H_2Se< H_2S < H_2Te
E. H_2Se< H_2Te < H_2S

66. When comparing acid strength of binary acids HX, as X varies within a particular group of the periodic table, which *one* of these factors dominates in affecting the acid strength?

A. bond strength
B. electron withdrawing effects
C. percent ionic character of the H-X bond
D. solubility
E. Le Châtelier's principle

67. Which one of these net ionic equations represents the reaction of a *strong acid* with a *weak base*?

A. $H^+(aq) + OH^-(aq) \rightarrow H_2O(aq)$
B. $H^+(aq) + CH_3NH_2(aq) \rightarrow CH_3NH_3^+(aq)$
C. $OH^-(aq) + HCN(aq) \rightarrow H_2O(aq) + CN^-(aq)$
D. $HCN(aq) + CH_3NH_2(aq) \rightarrow CH_3NH_3^+(aq) + CN^-(aq)$

68. Which one of these net ionic equations represents the reaction of a *strong acid* with a *strong base*?

A. $H^+(aq) + OH^-(aq) \rightarrow H_2O(aq)$
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C. $OH^-(aq) + HCN(aq) \rightarrow H_2O(aq) + CN^-(aq)$
D. $HCN(aq) + CH_3NH_2(aq) \rightarrow CH_3NH_3^+(aq) + CN^-(aq)$

69. Which one of these equations represents the reaction of a *weak acid* with a *weak base*?

A. $H^+(aq) + OH^-(aq) \rightarrow H_2O(aq)$
B. $H^+(aq) + CH_3NH_2(aq) \rightarrow CH_3NH_3^+(aq)$
C. $OH^-(aq) + HCN(aq) \rightarrow H_2O(aq) + CN^-(aq)$
D. $HCN(aq) + CH_3NH_2(aq) \rightarrow CH_3NH_3^+(aq) + CN^-(aq)$

70. Which one of these equations represents the reaction of a *weak acid* with a *strong base*?

A. $H^+(aq) + OH^-(aq) \rightarrow H_2O(aq)$
B. $H^+(aq) + CH_3NH_2(aq) \rightarrow CH_3NH_3^+(aq)$
C. $OH^-(aq) + HCN(aq) \rightarrow H_2O(aq) + CN^-(aq)$
D. $HCN(aq) + CH_3NH_2(aq) \rightarrow CH_3NH_3^+(aq) + CN^-(aq)$

71. Predict the direction in which the equilibrium will lie for the reaction

$H_2CO_3 + F^- \rightleftharpoons HCO_3^- + HF.$

$K_{a1}(H_2CO_3) = 4.2 \times 10^{-7}$; $K_a(HF) = 7.1 \times 10^{-4}$

A. to the right
B. to the left
C. in the middle

72. Predict the direction in which the equilibrium will lie for the reaction

$H_3PO_4(aq) + HSO_4^-(aq) \rightleftharpoons H_2PO_4^-(aq) + H_2SO_4(aq).$

$K_{a1}(H_3PO_4) = 7.5 \times 10^{-3}$; $K_a(H_2SO_4)$ = very large

A. to the right
B. to the left
C. in the middle

73. Predict the direction in which the equilibrium will lie for the reaction

$H_2SO_3(aq) + HCO_3^-(aq) \rightleftharpoons HSO_3^-(aq) + H_2CO_3(aq)$.

$K_{a1}(H_2SO_3) = 1 \times 10^{-2}$; $K_{a1}(H_2CO_3) = 4.2 \times 10^{-7}$

A. to the right
B. to the left
C. in the middle

74. Predict the direction in which the equilibrium will lie for the reaction

$C_6H_5COO^- + HF \rightleftharpoons C_6H_5COOH + F^-$.

$K_a(C_6H_5COOH) = 6.5 \times 10^{-5}$; $K_a(HF) = 7.1 \times 10^{-4}$

A. to the right
B. to the left
C. in the middle

75. Predict the direction in which the equilibrium will lie for the reaction

$H_3PO_4 + NO_3^- \rightleftharpoons H_2PO_4^- + HNO_3$.

$K_a(H_3PO_4) = 7.5 \times 10^{-3}$

A. to the right
B. to the left
C. in the middle

76. Which of the following yields a basic solution when dissolved in water?

A. NO_2
B. P_4O_{10}
C. K_2O
D. NaCl
E. SO_2

77. Which of the following yields an acidic solution when dissolved in water?

A. NO_2
B. LiOH
C. K_2O
D. NaCl
E. $Ca(OH)_2$

78. Hard water deposits (calcium carbonate) have built up around your bathroom sink. Which one of these substances would be most effective in dissolving the deposits?

A. ammonia
B. bleach (sodium hypochlorite)
C. lye (sodium hydroxide)
D. vinegar (acetic acid)

79. P_4O_{10} is classified as an acidic oxide because it

A. reacts with acids to produce a salt.
B. is insoluble in water.
C. reacts with water to produce OH^-.
D. gives a solution of phosphoric acid, H_3PO_4, on dissolving in water.
E. can act as a Lewis base by donating electron pairs.

80. In the reaction $CaO(s) + SO_2(g) \rightleftharpoons CaSO_3(s)$,

A. O^{2-} acts as a Lewis base, and SO_2 acts as a Lewis acid.
B. Ca^{2+} acts as a Lewis base, and SO_4^{2-} acts as a Lewis acid.
C. SO_4^{2-} acts as a Lewis base, and SO_2 acts as a Lewis acid.
D. SO_2 acts as a Lewis base, and O^{2-} acts as a Lewis acid.
E. SO_2 acts as a Lewis base, and Ca^{2+} acts as a Lewis acid.

81. Which of these species will act as a Lewis acid?

A. NH_3
B. NH_4^+
C. H_2O
D. BF_3
E. F^-

82. Which of these species is a Lewis acid, but *not* a Brønsted acid?

A. HCN
B. CO_3^{2-}
C. OH^-
D. Cl^-
E. Al^{3+}

83. Find the pH of a 0.135 M aqueous solution of periodic acid (HIO_4), for which $K_a = 2.3 \times 10^{-2}$.

A. 1.25
B. 3.28
C. 1.17
D. 1.34
E. 1.64

84. Find the pH of a 0.183 M aqueous solution of hypobromous acid (HOBr), for which $K_a = 2.06 \times 10^{-9}$.

A. 4.72
B. 8.69
C. 3.97
D. 4.34
E. 9.28

85. Find the pH of a 0.200 M aqueous solution of dichloroacetic acid, for which $K_a = 3.32 \times 10^{-2}$.

A. 0.75
B. 2.71
C. 1.05
D. 2.35
E. 1.18

86. Hydrosulfuric acid is a diprotic acid, for which $K_{a1} = 5.7 \times 10^{-8}$ and $K_{a2} = 1 \times 10^{-19}$. Determine the concentration of sulfide ion in a 0.10 M hydrosulfuric solution.

A. 0.10 M
B. 7.5×10^{-5} M
C. 5.7×10^{-9} M
D. 1×10^{-19} M
E. 1×10^{-20} M

87. Calculate the concentration of oxalate ion ($C_2O_4^{2-}$) in a 0.175 M solution of oxalic acid ($C_2H_2O_4$). [For oxalic acid, $K_{a1} = 6.5 \times 10^{-2}$, $K_{a2} = 6.1 \times 10^{-5}$.]

A. 0.11 M
B. 6.1×10^{-5} M
C. 4.0×10^{-6} M
D. 0.0791 M
E. 0.175 M

88. Calculate the concentration of chromate ion (CrO_4^{2-}) in a 0.450 M solution of chromic acid (H_2CrO_4). [For chromic acid, $K_{a1} = 0.18$, $K_{a2} = 3.2 \times 10^{-7}$.]

A. 3.2×10^{-7} M
B. 1.5×10^{-6} M
C. 0.081 M
D. 1.1×10^{-6} M
E. 0.21 M

89. Calculate the concentration of malonate ion ($C_3H_2O_4^{2-}$) in a 0.200 M solution of malonic acid ($C_3H_4O_4$). [For malonic acid, $K_{a1} = 1.4 \times 10^{-3}$, $K_{a2} = 2.0 \times 10^{-6}$.]

A. 2.8×10^{-4} M
B. 0.016 M
C. 1.8×10^{-4} M
D. 1.4×10^{-3} M
E. 2.0×10^{-6} M

90. For H_3PO_4, $K_{a1} = 7.3 \times 10^{-3}$, $K_{a2} = 6.2 \times 10^{-6}$, and $K_{a3} = 4.8 \times 10^{-13}$. An aqueous solution of NaH_2PO_4 therefore would be

A. neutral.
B. basic.
C. acidic.

91. For H_3PO_4, $K_{a1} = 7.3 \times 10^{-3}$, $K_{a2} = 6.2 \times 10^{-6}$, and $K_{a3} = 4.8 \times 10^{-13}$. An aqueous solution of Na_3PO_4 therefore would be

A. neutral.
B. basic.
C. acidic.

92. An aqueous solution of KCl would be

A. neutral.
B. basic.
C. acidic.

93. Which one of these salts will form a *neutral* solution on dissolving in water?

A. NaCl
B. KNO_2
C. NaCN
D. NH_4NO_3
E. $FeCl_3$

94. Which one of these salts will form a basic solution on dissolving in water?

A. NaCl
B. KCN
C. $NaNO_3$
D. NH_4NO_3
E. $FeCl_3$

95. In 0.10 M KCN, the chemical species with the highest concentration (except H_2O) is

A. Na^+.
B. CN^-.
C. H_3O^+(or H^+).
D. OH^-.
E. K^+.

96. What is the pH of a 0.20 M solution of NH_4Cl? [$K_b(NH_3) = 1.8 \times 10^{-5}$]

A. 3.74
B. 4.98
C. 6.53
D. 9.02
E. 10.25

97. Calculate the pH of a 0.021 M NaCN solution. [$K_a(HCN) = 4.9 \times 10^{-10}$]

A. 1.68
B. 3.18
C. 5.49
D. 7.00
E. 10.82

98. Consider the weak bases below and their K_b values:

C_6H_7O	$K_b = 1.3 \times 10^{-10}$
$C_2H_5NH_2$	$K_b = 5.6 \times 10^{-4}$
C_5H_5N	$K_b = 1.7 \times 10^{-9}$

Arrange the conjugate acids of these weak bases in order of *increasing* acid strength.

A. $C_5H_5NH^+ < C_6H_7OH < C_2H_5NH$
B. $C_6H_7OH < C_5H_5NH^+ < C_2H_5NH$
C. $C_5H_5NH^+ < C_2H_5NH_3^+ < C_6H_7OH$
D. $C_6H_7OH < C_2H_5NH_3^+ < C_5H_5NH^+$
E. $C_2H_5NH_3^+ < C_5H_5NH^+ < C_6H_7OH$

99. Which response gives the products of hydrolysis of NH_4Cl?

A. $NH_4^+ + HCl$
B. $NH_3 + OH^- + HCl$
C. $NH_3 + H^+$
D. $NH_4OH + HCl$
E. No hydrolysis occurs.

100. Which response gives the products of hydrolysis of KF?

A. KOH + HF
B. OH^- + HF
C. KOH + H^+ + F^-
D. KH + F^- + OH^-
E. No hydrolysis occurs.

101. Which one of these salts will form a *basic* solution upon dissolving in water?

A. NaCl
B. $NaNO_2$
C. NH_4NO_3
D. KBr
E. $AlCl_3$

102. Which one of these salts will form a *basic* solution upon dissolving in water?

A. NaI
B. NaF
C. NH_4NO_3
D. LiBr
E. $Cr(NO_3)_3$

103. Which one of these salts will form an *acidic* solution upon dissolving in water?

A. LiBr
B. NaF
C. NH_4Br
D. KOH
E. NaCN

104. Which one of the following salts will form an *acidic* solution on dissolving in water?

A. LiBr
B. NaF
C. KOH
D. $FeCl_3$
E. NaCN

105. What mass of ammonium chloride must be added to 250. mL of water to give a solution with pH = 4.85? [$K_b(NH_3) = 1.8 \times 10^{-5}$]

A. 4.7 g
B. 75 g
C. 2.3×10^{-3} g
D. 19 g
E. 10. g

106. What mass of sodium nitrite must be added to 350. mL of water to give a solution with pH = 8.40? [$K_a(HNO_2) = 5.6 \times 10^{-4}$]

A. 68 g
B. 1.7×10^{-4} g
C. 0.039 g
D. 8.3 g
E. 24 g

107. What mass of potassium hypochlorite must be added to 450. mL of water to give a solution with pH = 10.20? [$K_a(HClO) = 4.0 \times 10^{-8}$]

A. 20. g
B. 0.032 g
C. 4.1 g
D. 2.4 g
E. 9.1 g

108. What is the pH of a solution prepared by mixing 100. mL of 0.0500 M HCl with 300. mL of 0.500 M HF? [$K_a(HF) = 7.1 \times 10^{-4}$]

A. 1.47
B. 1.90
C. 1.30
D. 1.63
E. 2.82

109. What is the pH of a solution prepared by mixing 50.0 mL of 0.300 M HCl with 450.0 mL of 0.400 M HIO_3? [$K_a(HIO_3) = 1.6 \times 10^{-1}$]

A. 1.52
B. 0.80
C. 0.72
D. 0.89
E. 0.66

110. The equilibrium constant for the reaction

$C_6H_5COOH(aq) + CH_3COO^-(aq) \rightleftharpoons C_6H_5COO^-(aq) + CH_3COOH(aq)$

is 3.6 at 25°C. If K_a for CH_3COOH is 1.8×10^{-5}, what is the acid dissociation constant for C_6H_5COOH?

A. 5.0×10^{-6}
B. 6.5×10^{-5}
C. 2.3×10^{-4}
D. 8.3×10^{-5}
E. 5.6×10^{-6}

111. The equilibrium constant for the reaction

$C_7H_{15}COOH(aq) + HCOO^-(aq) \rightleftharpoons C_7H_{15}COO^-(aq) + HCOOH(aq)$

is 7.23×10^{-2} at 25°C. If K_a for formic acid (HCOOH) is 1.77×10^{-4}, what is the acid dissociation constant for $C_7H_{15}COOH$?

A. 2.45×10^{-3}
B. 4.08×10^{-2}
C. 7.81×10^{-4}
D. 1.00×10^{-4}
E. 1.28×10^{-5}

112. For maleic acid, HOOCCH=CHCOOH, $K_{a1} = 1.42 \times 10^{-2}$ and $K_{a2} = 8.57 \times 10^{-7}$. What is the concentration of maleate ion ($^-$OOCCH=CHCOO$^-$) in a 0.150 M aqueous solution of maleic acid?

A. 8.57×10^{-7} M
B. 2.79×10^{-6} M
C. 1.86×10^{-5} M
D. 4.60×10^{-2} M
E. 1.19×10^{-1} M

113. Aspartic acid ($C_4H_7NO_4$), one of the 20 essential amino acids, has two ionizable hydrogens. At 25°C, $K_{a1} = 1.38 \times 10^{-4}$ and $K_{a2} = 1.51 \times 10^{-10}$. What is the concentration of doubly ionized aspartate ions in a 0.125 M aqueous solution of aspartic acid?

A. 3.33×10^{-2} M
B. 4.16×10^{-3} M
C. 4.15×10^{-3} M
D. 1.51×10^{-10} M
E. 2.08×10^{-14} M

114. What mass of sodium cyanide must be added to 250. mL of water at 25°C in order to obtain a solution having a pH of 10.50? (K_a(HCN) = 4.9×10^{-10})

A. 200 g
B. 0.035 g
C. 0.066 g
D. 1.1 g
E. 0.26 g

115. What mass of sodium formate (HCOONa) must be added to 350. mL of water at 25°C in order to obtain a solution having a pH of 8.50? (K_a(HCOOH) = 1.77×10^{-4})

A. 0.23 g
B. 4.3 g
C. 35 g
D. 12 g
E. 130 g

116. A tablet of a common over-the-counter drug contains 200. mg of caffeine ($C_8H_{10}N_4O_2$). What is the pH of the solution resulting from the dissolution of two of these tablets in 225. mL of water at 25°C? (For caffeine, $K_b = 4.1 \times 10^{-4}$.)

A. 2.76
B. 7.67
C. 10.96
D. 6.33
E. 11.24

117. Morphine, $C_{17}H_{19}NO_3$, is often used to control severe post-operative pain. What is the pH of the solution made by dissolving 25.0 mg of morphine in 100. mL of water at 25°C? (For morphine, $K_b = 1.62 \times 10^{-6}$.)

A. 9.57
B. 9.08
C. 3.79
D. 9.87
E. 4.43

118. Which of these lists of molecules is arranged in order of *increasing* acid strength?

A. $H_2S < H_2O < H_2Se$
B. $H_2O < H_2S < H_2Se$
C. $H_2Se < H_2O < H_2S$
D. $H_2S < H_2Se < H_2O$
E. $H_2O < H_2Se < H_2S$

119. Which of these lists of molecules is arranged in order of *increasing* acid strength: HI, H_2Te, H_3Sb.

A. $H_2Te < H_3Sb < HI$
B. $HI < H_2Te < H_3Sb$
C. $HI < H_3Sb < H_2Te$
D. $H_3Sb < H_2Te < HI$
E. $H_3Sb < HI < H_2Te$

120. Identify the conjugate acid-base pairs in the reaction

$HSO_4^- + HF \rightleftharpoons H_2SO_4 + F^-$

One conjugate acid-base pair is _____; the other acid-base pair is _____.

121. Which of these acids is stronger, H_3PO_4 or H_3AsO_4?

122. Which of these acids is stronger, H_3AsO_3 or H_3AsO_4?

123. Which of these acids is stronger, H_2SO_4 or HSO_4^-?

124. In comparing three solutions with pH's of 2.0, 4.8, and 5.2, which is most acidic?

125. $Al(OH)_3$ is an amphoteric hydroxide. Write a balanced ionic equation to show its reaction with HNO_3.

126. $Al(OH)_3$ is an amphoteric hydroxide. Write a balanced ionic equation to show its reaction with KOH.

127. Write the chemical formula for hydrochloric acid.

128. Write the chemical formula for nitric acid.

129. Write the chemical formula for sulfuric acid.

130. Write the chemical formula for phosphoric acid.

131. Write the chemical formula for perchloric acid.

132. Write the formula for the conjugate base of $H_2PO_4^-$.

133. Calculate the pH of a solution containing 0.20 g of NaOH in 2,000. mL of solution.

134. Calculate the pOH of a solution containing 0.25 g of HCl in 800. mL of solution.

135. Calculate the H^+ ion concentration in a solution with a pH of 3.85.

136. If the pH of stomach acid is 1.0, what is the hydroxide ion concentration in this solution?

137. If the pH of liquid bleach is 12.0, what is the hydroxide ion concentration in this solution?

138. If the pH of pure water is 7.0, what is the hydroxide ion concentration in pure water?

139. If the pH of tomato juice is 4.0, what is the hydroxide ion concentration in this solution?

140. If the pH of seawater is 8.0, what is the hydroxide ion concentration in seawater?

141. The pH of a sample of river water is 6.0. A sample of effluent from a food processing plant has a pH of 4.0. What is the ratio of hydronium ion concentration in the effluent to the ion concentration in the river?

142. What concentration of potassium hydroxide will result from the reaction of 0.170 g of potassium with 100. ml of water?

143. What volume of hydrogen, at STP, will be formed by the reaction of 0.170 g of potassium with 100. ml of water?

144. Lime is used in farming to reduce the acidity of the soil. The chemical name for lime is calcium oxide. When water in the soil reacts with lime, what base is formed?

145. The compound CH_3NH_2 reacts with water to form $CH_3NH_3^+$ and OH^-. What role does CH_3NH_2 play in this reaction?

146. HCN is classified as a weak acid in water. What does this classification mean?

147. A sample of rainwater has a pH of 3.5. The concentration of what ion is approximately 3×10^{-4} M in this rain sample?

148. The pH of rain collected on a remote island in the Pacific is assumed to be unaffected by human pollution. The pH of the rainwater on this island will be _____ .

149. An unknown substance was added to a solution and the pH decreases. What type of substance was added?

150. The pH of a 0.02 M solution of an unknown weak base is 8.1. What is the pK_b of the unknown base?

151. A solution containing $NH_3(aq)$ and $NH_4Cl(aq)$ has a pH of 9.5. What is the $[NH_3]/[NH_4^+]$ ratio in this solution? (For ammonia, $K_b = 1.8 \times 10^{-5}$.)

152. When 2.0×10^{-2} mole of nicotinic acid (a monoprotic acid) is dissolved in 350. mL of water, the pH is 3.05. What is the K_a of nicotinic acid?

153. A 8.0 M solution of formic acid (HCOOH) is 0.47% ionized. What is the K_a of formic acid?

154. The pH of a 0.6 M solution of a weak acid is 4.0. What percent of the acid has ionized?

155. A solution with a pH of 8 has a hydrogen ion concentration [H^+] that is 30 times greater than that of a solution of pH 11.

True False

156. A solution of HNO_3 would change the color of litmus from red to blue.

True False

157. In the reaction $HNO_3 + NH_3 \rightleftharpoons NH_4^+ + NO_3^-$, NH_4^+ and NH_3 are a conjugate acid-base pair.

True False

158. Of the two acids HBr and H_2Se, H_2Se is the stronger acid.

True False

159. In the reaction $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$, Ag^+ acts as a Lewis acid.

True False

160. In aqueous solutions at 25°C, the sum of the ion concentrations ([H^+] + [OH^-]) equals 1×10^{-14}.

True False

Chapter 15 Acids and Bases Key

1.C

2.C

3.D

4.A

5.D

6.E

7.B

8.C

9.A

10.B

11.C

12.B

13.B

14.A

15.B

16.C

17.C

18.B

19.C

20.E

21.E

22.A

23.E

24.A

25.E

26.C

27.A

28.E

29.D

30.C

31.B

32.C

33.D

34.B

35.A

36.A

37.D

38.D

39.E

40.B

41.B

42.D

43.C

44.D

45.B

46.D

47.E

48.D

49.B

50.B

51.B

52.C

53.D

54.B

55.D

56.A

57.B

58.D

59.A

60.B

61.C

62.B

63.B

64.D

65.A

66.A

67.B

68.A

69.D

70.C

71.B

72.B

73.A

74.A

75.B

76.C

77.A

78.D

79.D

80.A

81.D

82.E

83.D

84.A

85.E

86.D

87.B

88.A

89.E

90.C

91.B

92.A

93.A

94.B

95.E

96.B

97.E

98.E

99.C

100.B

101.B

102.B

103.C

104.D

105.A

106.D

107.C

108.D

109.D

110.B

111.E

112.A

113.D

114.C

115.B

116.E

117.A

118.B

119.D

120. HF-F^-; H_2SO_4-HSO_4^-

121.H_3PO_4

122.H_3AsO_4

123.H_2SO_4

124.The solution with pH = 2.0

125.$Al(OH)_3 + 3HNO_3 \rightarrow Al(NO_3)_3 + 3H_2O$

126.$Al(OH)_3 + KOH \rightarrow K[Al(OH)_4]$

127.HCl

128.HNO_3

129.H_2SO_4

130.H_3PO_4

131.$HClO_4$

132.HPO_4^{2-}

133.11.40

134.11.93

135.1.4×10^{-4} M

136.1×10^{-13} M

137.1×10^{-2} M

138.1×10^{-7} M

139.1×10^{-10} M

140.1×10^{-6} M

141.The hydronium ion concentration in the effluent is 100 times greater than the hydronium ion concentration in the river.

142.4.35×10^{-2} M

143.4.87×10^{-2} L

144.$Ca(OH)_2$

145.CH_3NH_2 acts as a base.

146.A relatively small fraction of the acid undergoes ionization.

147.H_3O^+

148.less than 7

149.an acid

150.10.1

151.1.8

152.1.4×10^{-5}

153.1.77×10^{-4}

154.0.02 %

155.FALSE

156.FALSE

157.TRUE

158.FALSE

159.TRUE

160.FALSE