

1. The magnitude of  $K_w$ , the ion-product of water, changes if there is a change in:

- A) pressure                      C) hydrogen ion concentration  
B) temperature                 D) hydroxide ion concentration

Ans: B

2. For a solution at 298 K and 1.00 atm,  $[\text{OH}^-] = 1.00 \times 10^{-6}$ . The **product** of  $[\text{H}_3\text{O}^+]$  and  $[\text{OH}^-]$  for this solution is:

- A)  $1.00 \times 10^{-3}$     B)  $1.00 \times 10^{-6}$     C)  $1.00 \times 10^{-8}$     D)  $1.00 \times 10^{-14}$

Ans: D

3. Molecules that undergo complete dissociation to form  $\text{H}_3\text{O}^+$  in water are called \_\_\_\_\_.

Ans: strong acids

4. Molecules that undergo complete dissociation to form  $\text{OH}^-$  in water are called \_\_\_\_\_.

Ans: strong bases

5. Which of these compounds is not a strong acid?

- A) HCl    B)  $\text{H}_2\text{SO}_4$     C)  $\text{HNO}_3$     D)  $\text{H}_2\text{SO}_3$

Ans: D

6. Which of these compounds is not a strong base?

- A) KOH    B)  $\text{Ca}(\text{OH})_2$     C) NaOH    D)  $\text{Al}(\text{OH})_3$

Ans: D

7. Calculate the molarity of  $\text{H}_3\text{O}^+$  in a solution with  $[\text{OH}^-] = 1.00 \times 10^{-8}$  mol/L. Is the solution acidic, basic, or neutral?

Ans:  $[\text{H}_3\text{O}^+] = 1.00 \times 10^{-6}$  mol/L; the solution is acidic

8. Calculate the molarity of  $\text{OH}^-$  in a solution with  $[\text{H}_3\text{O}^+] = 1.00 \times 10^{-10}$  mol/L. Is the solution acidic, basic, or neutral?

Ans:  $[\text{OH}^-] = 1.00 \times 10^{-2}$  mol/L; the solution is basic

9. To be classified as an acid, a substance must release \_\_\_\_\_ ions.

- A)  $\text{H}^+$  (aq)   B)  $\text{NH}_4^+$  (aq)   C)  $\text{OH}^-$  (aq)   D)  $\text{CO}_3^{2-}$  (aq)

Ans: A

10. Which of these 0.5 M solutions has a pH greater than 7?

- A)  $\text{CH}_3\text{COOH}$    B)  $\text{C}_{12}\text{H}_{22}\text{O}_{11}$    C)  $\text{HCl}$    D)  $\text{KOH}$

Ans: D

11. Determine the molar concentrations of  $\text{H}_3\text{O}^+$  and  $\text{OH}^-$  in a solution with  $\text{pH} = 9.00$ .

Ans:  $[\text{H}_3\text{O}^+] = 1.0 \times 10^{-9} \text{ mol/L}$     $[\text{OH}^-] = 1.0 \times 10^{-5} \text{ mol/L}$

12. Determine the molar concentrations of  $\text{H}_3\text{O}^+$  and  $\text{OH}^-$  in a solution with  $\text{pH} = 3.00$ .

Ans:  $[\text{H}_3\text{O}^+] = 1.0 \times 10^{-3} \text{ mol/L}$     $[\text{OH}^-] = 1.0 \times 10^{-11} \text{ mol/L}$

13. Determine the pH of a solution with  $[\text{OH}^-] = 1.0 \times 10^{-10} \text{ mol/L}$ .

Ans:  $\text{pH} = 4.00$

14. Determine the pH of a solution with  $[\text{H}_3\text{O}^+] = 1.0 \times 10^{-7} \text{ mol/L}$ .

Ans:  $\text{pH} = 7.00$

15. Determine the pH of a solution with  $[\text{OH}^-] = 7.00 \times 10^{-12} \text{ mol/L}$ . Is this solution acidic, basic, or neutral?

Ans:  $\text{pH} = 2.85$ ; the solution is acidic

16. Determine  $[\text{H}_3\text{O}^+]$  and  $[\text{OH}^-]$  in a solution with  $\text{pH} = 12.15$ .

Ans:  $[\text{H}_3\text{O}^+] = 7.1 \times 10^{-13} \text{ mol/L}$     $[\text{OH}^-] = 1.4 \times 10^{-2} \text{ mol/L}$

17. Determine  $[\text{H}_3\text{O}^+]$  and  $[\text{OH}^-]$  in a solution with  $\text{pH} = 3.52$ .

Ans:  $[\text{H}_3\text{O}^+] = 3.0 \times 10^{-4} \text{ mol/L}$     $[\text{OH}^-] = 3.3 \times 10^{-11} \text{ mol/L}$

18. Which solution is the most acidic?

- A) blood B) vinegar C) milk D) detergent

Ans: B

19. Which solution is the most basic?

- A) blood B) vinegar C) milk D) household ammonia

Ans: D

20. What is the pH of an aqueous solution with  $[\text{H}_3\text{O}^+] = 1 \times 10^{-8} \text{ M}$ ? Is the solution acidic, basic, or neutral?

- A) 6.0, the solution is acidic C) 8.0, the solution is acidic  
B) 6.0, the solution is basic D) 8.0, the solution is basic

Ans: D

21. What is  $[\text{OH}^-]$  in a solution with  $\text{pH} = 8.00$ ?

- A)  $1.0 \times 10^{-6} \text{ M}$  B)  $1.0 \times 10^{-8} \text{ M}$  C)  $1.0 \times 10^{-10} \text{ M}$  D)  $1.0 \times 10^{-12} \text{ M}$

Ans: A

22. What is the pH of a  $1.0 \times 10^{-5} \text{ M}$  HCl solution?

- A) 2.00 B) 4.00 C) 5.00 D) 10.00

Ans: C

23. What is the pH of a  $7.5 \times 10^{-4} \text{ M}$  solution of  $\text{HNO}_3$ ?

- A) 1.00 B) 3.10 C) 5.60 D) 7.40

Ans: B

24. What is the pH of a solution in which the hydronium ion concentration is 0.0026 M?

- A) 1.06 B) 2.59 C) 4.53 D) 6.34

Ans: B

25. In a solution with  $\text{pH} = 7.0$ :

- A)  $[\text{H}_3\text{O}^+] = [\text{OH}^-]$  C)  $[\text{H}_3\text{O}^+] < [\text{OH}^-]$   
B)  $[\text{H}_3\text{O}^+] > [\text{OH}^-]$  D)  $[\text{H}_3\text{O}^+] + [\text{OH}^-] = K_w$

Ans: A

26. If the pH of a 0.10 M solution is 11.00, then  $[\text{H}_3\text{O}^+] =$  \_\_\_\_\_.

- A)  $1.0 \times 10^{-1}$  M   B)  $1.0 \times 10^{-5}$  M   C)  $1.0 \times 10^{-11}$  M   D)  $1.0 \times 10^{-14}$  M

Ans: C

27. What is the pOH of a solution with  $[\text{H}_3\text{O}^+] = 0.001$ ?

- A) -3.0   B) 3.0   C) 5.0   D) 11.0

Ans: D

28. Weak acids and bases differ from strong acids and bases in their degree of \_\_\_\_\_.

Ans: Dissociation

29. The weaker the acid or the base, the \_\_\_\_\_ its acid dissociation constant.

Ans: smaller

30. Which compound is not a weak acid?

- A) HBr   B) HF   C) HCN   D)  $\text{CH}_3\text{COOH}$

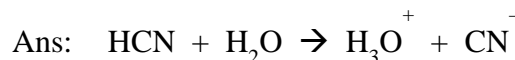
Ans: A

31. Which compound is not a weak base?

- A) methylamine   B)  $\text{NH}_3$    C) LiOH   D) morphine

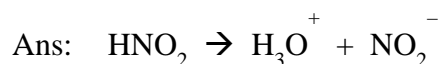
Ans: C

32. Write the dissociation reaction and the acid dissociation expression for HCN.



$$K_a = \frac{[\text{H}_3\text{O}^+][\text{CN}^-]}{[\text{HCN}]}$$

33. Write the dissociation reaction, and the acid dissociation expression, for  $\text{HNO}_2$ .



$$K_a = \frac{[\text{H}_3\text{O}^+][\text{NO}_2^-]}{[\text{HNO}_2]}$$

34. Which of these is a conjugate acid-base pair?

- A)  $\text{H}_3\text{O}^+ / \text{OH}^-$    B)  $\text{H}_2\text{SO}_4 / \text{SO}_4^{2-}$    C)  $\text{H}_3\text{PO}_4 / \text{PO}_4^{3-}$    D)  $\text{CH}_3\text{COOH} / \text{CH}_3\text{COO}^-$

Ans: D

35. Which of these is the weakest acid?

- A)  $\text{NH}_4^+$    B)  $\text{HSO}_4^-$    C)  $\text{H}_2\text{SO}_4$    D)  $\text{HNO}_3$

Ans: A

36. The  $\text{OH}^-$  concentration in a 0.10 M  $\text{NH}_3$  solution is  $1.3 \times 10^{-3}$  M. Calculate  $K_b$  of  $\text{NH}_3$ .

- A)  $1.1 \times 10^{-3}$     B)  $1.7 \times 10^{-5}$     C)  $7.6 \times 10^{-4}$     D)  $3.5 \times 10^{-7}$

Ans: B

37. The  $K_a$  of formic acid is  $1.77 \times 10^{-4}$ . What is the pH of a 1.5 M solution?

- A) 1.79    B) 2.34    C) 4.76    D) 6.29

Ans: A

38. According to the Brønsted–Lowry theory, \_\_\_\_\_ are proton acceptors.

- A. Salts  
B. Acids  
C. Bases  
D. electrons

Ans: C

39. According to the Brønsted–Lowry theory, \_\_\_\_\_ are proton donors.

- a. Salts  
b. Acids  
c. Bases  
d. electrons

Ans: B. acids

40. The Brønsted–Lowry bases in this reaction are:  $\text{H}_2\text{O} + \text{HSO}_4^- \rightarrow \text{H}_3\text{O}^+ + \text{SO}_4^{2-}$

- A)  $\text{H}_2\text{O}$  and  $\text{SO}_4^{2-}$     C)  $\text{H}_3\text{O}^+$  and  $\text{HSO}_4^-$   
B)  $\text{H}_2\text{O}$  and  $\text{H}_3\text{O}^+$     D)  $\text{H}_3\text{O}^+$  and  $\text{SO}_4^{2-}$

Ans: A

41. The Brønsted–Lowry acids in this reaction are:  $\text{H}_2\text{O} + \text{CO}_3^{2-} \rightarrow \text{OH}^- + \text{HCO}_3^-$

- A)  $\text{CO}_3^{2-}$  and  $\text{OH}^-$     C)  $\text{H}_2\text{O}$  and  $\text{OH}^-$   
B)  $\text{CO}_3^{2-}$  and  $\text{HCO}_3^-$     D)  $\text{H}_2\text{O}$  and  $\text{HCO}_3^-$

Ans: D

42. According to Brønsted–Lowry theory, an acid is any species that can:

- A) donate an electron    C) accept an electron  
B) donate a proton    D) accept a proton

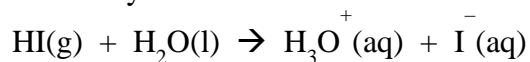
Ans: B

43. The conjugate acid of  $\text{HS}^-$  is:

- A)  $\text{S}^{2-}$  B)  $\text{H}^+$  C)  $\text{H}_2\text{S}$  D)  $\text{H}_2\text{O}$

Ans: C

44. The Brønsted–Lowry base in the forward reaction of this equilibrium is \_\_\_\_\_



- A)  $\text{HI}(\text{g})$  B)  $\text{H}_2\text{O}(\text{l})$  C)  $\text{H}_3\text{O}^+(\text{aq})$  D)  $\text{I}^-(\text{aq})$

Ans: B

45. In the reaction  $\text{HSO}_4^-(\text{aq}) + \text{NH}_3(\text{g}) \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$ ,  $\text{NH}_3(\text{g})$  acts as:

- A) a base, because it is a proton acceptor  
 B) a base, because it is a proton donor  
 C) an acid, because it is a proton acceptor  
 D) an acid, because it is a proton donor

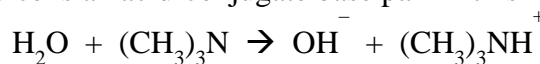
Ans: A

46. Which of these ions is the Brønsted–Lowry base with the strongest conjugate acid?

- A)  $\text{OH}^-$  B)  $\text{F}^-$  C)  $\text{NO}_3^-$  D)  $\text{HS}^-$

Ans: C

47. Which choice is an acid–conjugate base pair in this reaction?



- A)  $\text{H}_2\text{O}/(\text{CH}_3)_3\text{N}$  B)  $(\text{CH}_3)_3\text{NH}^+/\text{OH}^-$  C)  $(\text{CH}_3)_3\text{NH}^+/\text{H}_2\text{O}$  D)  $\text{H}_2\text{O}/\text{OH}^-$

Ans: D

48. Select the strongest acid.

- A) Acid “A”:  $K_a = 4.83 \times 10^{-5}$  C) Acid “C”:  $K_a = 5.65 \times 10^{-3}$   
 B) Acid “B”:  $K_a = 2.56 \times 10^{-3}$  D) Acid “D”:  $K_a = 3.43 \times 10^{-1}$

Ans: D

49. Select the acid with the strongest conjugate base.

- A) Acid “A”:  $K_a = 4.83 \times 10^{-5}$  C) Acid “C”:  $K_a = 5.65 \times 10^{-3}$   
 B) Acid “B”:  $K_a = 2.56 \times 10^{-3}$  D) Acid “D”:  $K_a = 3.43 \times 10^{-1}$

Ans: A

50. Acids with multiple dissociable protons are called \_\_\_\_\_ acids.

- A) diprotic B) amphoteric C) polyprotic D) weak

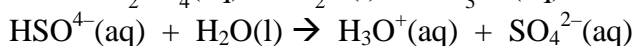
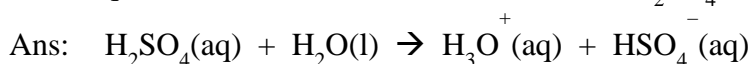
Ans: C

51. A substance that can act as an acid or a base is called:

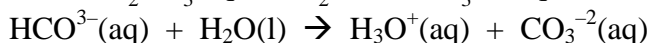
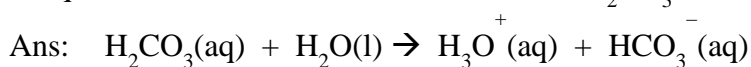
- A) diprotic B) amphoteric C) polyprotic D) a weak acid

Ans: B

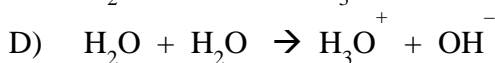
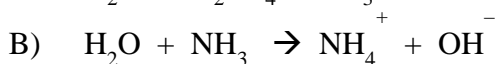
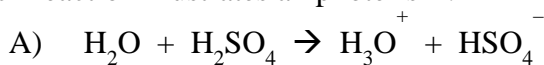
52. Write the equations for the dissociation reactions of  $\text{H}_2\text{SO}_4$ .



53. Write equations for the dissociation reactions of  $\text{H}_2\text{CO}_3$ .



54. Which reaction illustrates amphoterism?



Ans: D

55. Which substance is amphoteric?

- A) HI B)  $\text{H}_2\text{S}$  C)  $\text{H}_2\text{PO}_4^-$  D)  $\text{NO}_3^-$

Ans: C

56. KCl is a salt derived from which acid–base combination?

- A) weak acid and weak base C) strong acid and weak base  
B) weak acid and strong base D) strong acid and strong base

Ans: D

57. When  $\text{CuSO}_4$  hydrolyzes, the solution will be:

- A) acidic, with  $\text{pH} < 7$  C) basic, with  $\text{pH} < 7$   
B) acidic, with  $\text{pH} > 7$  D) basic, with  $\text{pH} > 7$

Ans: A

58. Which of these compounds is a salt?

- A)  $\text{CH}_3\text{OH}$  B)  $\text{C}_6\text{H}_{12}\text{O}_6$  C)  $\text{C}_6\text{H}_6\text{O}_{12}$  D)  $\text{KC}_2\text{H}_3\text{O}_2$

Ans: D

59. Which salt gives an aqueous solution with  $\text{pH} = 7.0$ ?

- A)  $\text{FeSO}_4$  B)  $\text{NaNO}_3$  C)  $\text{Na}_2\text{CO}_3$  D)  $\text{Na}_3\text{PO}_4$

Ans: B

60. In which of these solutions will red litmus turn blue?

- A)  $\text{NaOH}$  B)  $\text{CH}_3\text{OH}$  C)  $\text{CH}_3\text{COOH}$  D)  $\text{HCl}$

Ans: A

61. The net ionic equation for a neutralization reaction is:

- A)  $\text{H}^+ + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+$  C)  $2\text{H}^+ + 2\text{O}^{2-} \rightarrow 2\text{OH}^-$   
B)  $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$  D)  $\text{H}^+ + \text{NH}_3 \rightarrow \text{NH}_4^+$

Ans: B

62. When  $\text{HCl}$  is exactly neutralized by  $\text{NaOH}$  in aqueous solution, the hydrogen ion concentration in the resulting mixture is:

- A) less than the hydroxide ion concentration  
B) greater than the hydroxide ion concentration  
C) equal to the hydroxide ion concentration  
D) sometimes greater and sometimes less than the hydroxide ion concentration, depending on the salt that forms

Ans: C

63. The reaction  $\text{KOH} + \text{HNO}_3 \rightarrow \text{KNO}_3 + \text{H}_2\text{O}$  is an example of:

- A) a neutralization reaction C) an hydrolysis reaction  
B) an oxidation-reduction reaction D) a substitution reaction

Ans: A

**END OF SECTION**