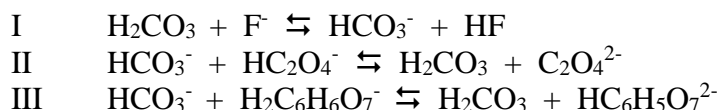


KEY: Acids, Bases, and Salts

Review for Sections 4.1 – 4.15

1. Consider the following:



The HCO_3^- is a base in

- A. I only
B. I and II only
C. II and III only
D. I, II, and III
2. The volume of 0.200 M $\text{Sr}(\text{OH})_2$ needed to neutralize 50.0 mL of 0.200 M HI is

- A. 10.0 mL
B. 25.0 mL
C. 50.0 mL
D. 100.0 mL

3. The pOH of 0.050 M HCl is

- A. 0.050
B. 1.30
C. 12.70
D. 13.70

4. The volume of 0.450 M HCl needed to neutralize 40.0 mL of 0.450 M $\text{Sr}(\text{OH})_2$ is

- A. 18.0 mL
B. 20.0 mL
C. 40.0 mL
D. 80.0 mL

5. Consider the following



Which of the following solutions will have the largest $[\text{H}_3\text{O}^+]$?

- A. I and II only
B. II and III only
C. I, II, and III only
D. II, III, and IV only

6. Which of the following solutions will have the largest $[\text{H}_3\text{O}^+]$?

- A. 1.0 M HNO_2
B. 1.0 M HBO_3
C. 1.0 M $\text{H}_2\text{C}_2\text{O}_4$
D. 1.0 M HCOOH

7. Consider the following: $\text{H}_2\text{O} + 57 \text{ kJ} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^-$

When the temperature of the system is increased, the equilibrium shifts

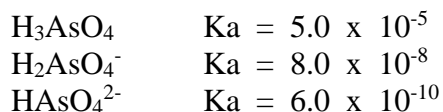
- A. left and the K_w increases
B. left and the K_w decreases
C. right and the K_w increases
D. right and the K_w decreases

8. A 1.0 M solution of sodium dihydrogen phosphate is
- A. acidic and the pH < 7.00**
 - B. acidic and the pH > 7.00
 - C. basic and the pH < 7.00
 - D. basic and the pH > 7.00
9. A Bronsted-Lowry base is defined as a chemical species that
- A. accepts protons**
 - B. neutralizes acids
 - C. donated electrons
 - D. produces hydroxides ions in solution
10. Which of the following solutions will have the greatest electrical conductivity?
- A. 1.0 M HCN
 - B. 1.0 M H₂SO₄**
 - C. 1.0 M H₃PO₄
 - D. 1.0 M CH₃COOH
11. Consider the following equilibrium: $\text{HC}_6\text{H}_5\text{O}_7^{2-} + \text{HIO}_3 \rightleftharpoons \text{H}_2\text{C}_6\text{H}_5\text{O}_7^- + \text{IO}_3^-$
- The order of Bronsted-Lowry acids and bases is
- A. acid, base, acid, base
 - B. acid, base, base, acid
 - C. base, acid, acid, base**
 - D. base, acid, base acid
12. Consider the following: $\text{H}_2\text{O}_{(l)} \rightleftharpoons \text{H}^+ + \text{OH}^-$
- When a small amount of 1.0 M KOH is added to the above system, the equilibrium
- A. shifts left and [H⁺] decreases**
 - B. shifts left and [H⁺] increases
 - C. shifts right and [H⁺] decreases
 - D. shifts right and [H⁺] increases
13. Which of the following has the highest pH?
- A. 1.0 M NaIO₃
 - B. 1.0 M Na₂CO₃
 - C. 1.0 M Na₃PO₄**
 - D. 1.0 M Na₂SO₄
14. In a 100.0 mL sample of 0.0800 M NaOH the [H₃O⁺] is
- A. 1.25 x 10⁻¹³ M**
 - B. 1.25 x 10⁻¹² M
 - C. 8.00 x 10⁻³ M
 - D. 8.00 x 10⁻² M

15. Consider the following:
- I ammonium nitrate II calcium nitrate III iron III nitrate
- When dissolved in water, which of these salts would form a neutral solution?
- A. II only**
B. III only
C. I and III only
D. I, II, and III
16. Consider the following: $\text{SO}_4^{2-} + \text{HNO}_2 \rightleftharpoons \text{HSO}_4^- + \text{NO}_2^-$
- Equilibrium would favour the
- A. the products since HSO_4^- is a weaker acid than HNO_2
B. the reactants since HSO_4^- is a weaker acid than HNO_2
C. the products since HSO_4^- is a stronger acid than HNO_2
D. the reactants since HSO_4^- is a stronger acid than HNO_2
17. The net ionic equation for the hydrolysis of Na_2CO_3 is
- A. $\text{H}_2\text{O} + \text{Na}^+ \rightleftharpoons \text{NaOH} + \text{H}^+$
B. $\text{H}_2\text{O} + 2\text{Na}^+ \rightleftharpoons \text{Na}_2\text{O} + 2\text{H}^+$
C. $\text{H}_2\text{O} + \text{CO}_3^{2-} \rightleftharpoons \text{H}_2\text{CO}_3 + \text{O}^{2-}$
D. $\text{H}_2\text{O} + \text{CO}_3^{2-} \rightleftharpoons \text{HCO}_3^- + \text{OH}^-$
18. Consider the following equilibrium: $2\text{H}_2\text{O}_{(l)} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^-$
- A few drops of 1.0 M HCl are added to the above system. When equilibrium is re-established, the
- A. $[\text{H}_3\text{O}^+]$ has increased and the $[\text{OH}^-]$ has decreased**
B. $[\text{H}_3\text{O}^+]$ has increased and the $[\text{OH}^-]$ has increased
C. $[\text{H}_3\text{O}^+]$ has decreased and the $[\text{OH}^-]$ has increased
D. $[\text{H}_3\text{O}^+]$ has decreased and the $[\text{OH}^-]$ has decreased
19. A basic solution
- A. tastes sour
B. feels slippery
C. does not conduct electricity
D. reacts with metals to release oxygen gas
20. The balanced formula equation for the neutralization of H_2SO_4 by KOH is
- A. $\text{H}_2\text{SO}_4 + \text{KOH} \rightarrow \text{KSO}_4 + \text{H}_2\text{O}$
B. $\text{H}_2\text{SO}_4 + \text{KOH} \rightarrow \text{K}_2\text{SO}_4 + \text{H}_2\text{O}$
C. $\text{H}_2\text{SO}_4 + 2\text{KOH} \rightarrow \text{K}_2\text{SO}_4 + \text{H}_2\text{O}$
D. $\text{H}_2\text{SO}_4 + 2\text{KOH} \rightarrow \text{K}_2\text{SO}_4 + 2\text{H}_2\text{O}$
21. An Arrhenius base is defined as a substance which
- A. donates protons
B. donates electrons
C. produces H^+ in solution
D. produces OH^- in solution

22. Consider the following equilibrium: $\text{HS}^- + \text{H}_3\text{PO}_4 \rightleftharpoons \text{H}_2\text{S} + \text{H}_2\text{PO}_4^-$
The order of Bronsted-Lowry acids and bases is
- acid, base, acid, base.
 - acid, base, base, acid
 - base, acid, acid, base**
 - base, acid, base, acid
23. The equation representing the reaction of ethanoic acid with water is
- $\text{CH}_3\text{COO}^- + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COOH} + \text{OH}^-$
 - $\text{CH}_3\text{COO}^- + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COO}^{2-} + \text{H}_3\text{O}^+$
 - $\text{CH}_3\text{COOH} + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COO}^- + \text{H}_3\text{O}^+$**
 - $\text{CH}_3\text{COOH} + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COOH}_2^+ + \text{OH}^-$
24. Consider the following equilibrium: $2\text{H}_2\text{O} + 57\text{kJ} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^-$
When the temperature is decreased, the water
- stays neutral and the $[\text{H}_3\text{O}^+]$ increases
 - stays neutral and the $[\text{H}_3\text{O}^+]$ decreases**
 - becomes basic and $[\text{H}_3\text{O}^+]$ decreases
 - becomes acidic and $[\text{H}_3\text{O}^+]$ increases
25. The conjugate acid of $\text{C}_6\text{H}_5\text{O}^-$ is
- $\text{C}_6\text{H}_4\text{O}^-$
 - $\text{C}_6\text{H}_5\text{OH}$**
 - $\text{C}_6\text{H}_4\text{O}^{2-}$
 - $\text{C}_6\text{H}_5\text{OH}^+$
26. Which of the following solutions will have the greatest electrical conductivity?
- 1.0 M HCl**
 - 1.0 M HNO_2
 - 1.0 M H_3BO_3
 - 1.0 M HCOOH
27. A solution of 1.0 M HF has
- a lower pH than a solution of 1.0 M HCl
 - a higher pOH than a solution of 1.0 M HCl
 - a higher $[\text{OH}^-]$ than a solution of 1.0 M HCl**
 - a higher $[\text{H}_3\text{O}^+]$ than a solution of 1.0 M HCl
28. Which of the following is the weakest acid
- HIO_3
 - HCN**
 - HNO_3
 - $\text{C}_6\text{H}_5\text{COOH}$

29. Considering the following data



The K_b value for H_2AsO_4^- is

- A. **2.0×10^{-10}**
- B. 8.0×10^{-8}
- C. 1.2×10^{-7}
- D. 1.7×10^{-5}

30. In a solution at 25°C , the $[\text{H}_3\text{O}^+]$ is $3.5 \times 10^{-6} \text{ M}$. The $[\text{OH}^-]$ is

- A. $3.5 \times 10^{-20} \text{ M}$
- B. **$2.9 \times 10^{-9} \text{ M}$**
- C. $1.0 \times 10^{-7} \text{ M}$
- D. $3.5 \times 10^{-6} \text{ M}$

31. In a solution with a pOH of 4.22, the $[\text{OH}^-]$ is

- A. $1.7 \times 10^{-10} \text{ M}$
- B. **$6.0 \times 10^{-5} \text{ M}$**
- C. $6.3 \times 10^{-1} \text{ M}$
- D. $1.7 \times 10^4 \text{ M}$

32. An aqueous solution of NH_4CN is

- A. **basic because $K_a < K_b$**
- B. basic because $K_a > K_b$
- C. acidic because $K_a < K_b$
- D. acidic because $K_a > K_b$

33. The net ionic equation for the predominant hydrolysis reaction of KHSO_4 is

- A. **$\text{HSO}_4^- + \text{H}_2\text{O} \rightleftharpoons \text{SO}_4^{2-} + \text{H}_3\text{O}^+$**
- B. $\text{HSO}_4^- + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{SO}_4 + \text{OH}^-$
- C. $\text{KHSO}_4 + \text{H}_2\text{O} \rightleftharpoons \text{K}^+ + \text{SO}_4^{2-} + \text{H}_3\text{O}^+$
- D. $\text{KHSO}_4 + \text{H}_2\text{O} \rightleftharpoons \text{K}^+ + \text{H}_2\text{SO}_4 + \text{OH}^-$

34. The $[\text{OH}^-]$ in an aqueous solution always equals

- A. $K_w \times [\text{H}_3\text{O}^+]$
- B. $K_w - [\text{H}_3\text{O}^+]$
- C. **$K_w/[\text{H}_3\text{O}^+]$**
- D. $[\text{H}_3\text{O}^+]/K_w$

35. The $[\text{H}_3\text{O}^+]$ in a solution with pOH of 0.253 is

- A. $5.58 \times 10^{-15} \text{ M}$
- B. **$1.79 \times 10^{-14} \text{ M}$**
- C. $5.58 \times 10^{-1} \text{ M}$
- D. $5.97 \times 10^{-1} \text{ M}$

36. The equilibrium expression for the hydrolysis reaction of 1.0 M K_2HPO_4 is

- A. $\frac{[\text{H}_2\text{PO}_4^{2-}][\text{OH}^-]}{[\text{HPO}_4^-]}$ B. $\frac{[\text{H}_3\text{PO}_4][\text{OH}^-]}{[\text{H}_2\text{PO}_4^-]}$
 C. $\frac{[\text{K}^+][\text{KHPO}_4^-]}{[\text{K}_2\text{HPO}_4]}$ D. $\frac{[\text{K}^+]^2[\text{HPO}_4^{2-}]}{[\text{K}_2\text{HPO}_4]}$

37. The solution with the highest pH is

- A. 1.0 M NaCl
B. 1.0 M NaCN
 C. 1.0 M NaIO_3
 D. 1.0 M Na_2SO_4

38. The pH of 100.0 mL of 0.0050 M NaOH is

- A. 2.30
 B. 3.30
 C. 10.70
D. 11.70

Written Response Practice

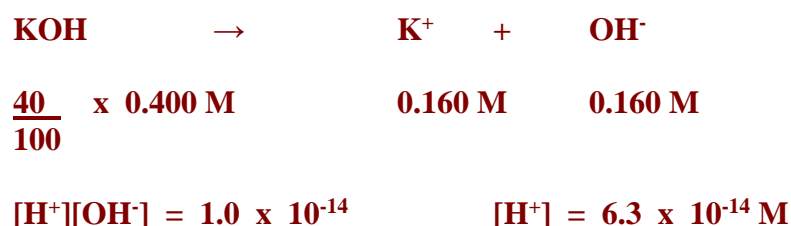
1. a) Write the net ionic equation for the reaction between NaHSO_3 and NaHC_2O_4 .



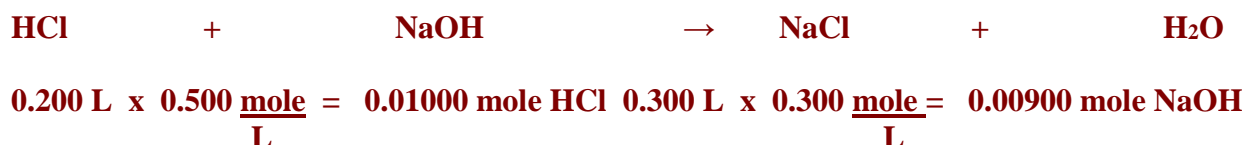
b) Explain why the reactants are favoured in the above reaction.



2. What is the $[\text{H}_3\text{O}^+]$ in a solution formed by adding 60.0 mL of water to 40.0 mL of 0.400 M KOH?



3. Calculate the pH of the solution formed by mixing 20.0 mL of 0.500 M HCl with 30.0 mL of 0.300 M NaOH.



$$\text{Total new volume} = 20.0 \text{ mL} + 30.0 \text{ mL} = 50.0 \text{ mL} = 0.0500 \text{ L}$$

$$[\text{H}^+] = \frac{0.0010 \text{ moles}}{0.0500 \text{ L}} = 0.020 \text{ M}$$

$$\text{pH} = 1.70$$

4. a) Write the balanced equation representing the reaction of HF with H₂O.



- b) Identify the Bronsted-Lowry bases in the above equation.



5. Consider the following data:

Barbituric acid	HC ₄ H ₃ N ₂ O ₃	K _a = 9.8 × 10 ⁻⁵
Sodium propanoate	NaC ₃ H ₅ O ₂	K _b = 7.5 × 10 ⁻¹⁰
Propanoic acid	HC ₃ H ₅ O ₂	K _a = ?

Which is the stronger acid, propanoic acid or barbituric acid? Explain using calculations.

$$K_a(\text{HC}_4\text{H}_3\text{N}_2\text{O}_3) = \frac{K_w}{K_b(\text{C}_3\text{H}_5\text{O}_2^-)} = \frac{1.0 \times 10^{-14}}{7.5 \times 10^{-10}} = 1.3 \times 10^{-5}$$

Barbituric acid is a stronger acid because it has a larger K_a.

6. a) Write equations showing the amphiprotic nature of water as it reacts with HCO₃⁻.



- b) Calculate the K_b for HCO₃⁻.

$$K_b(\text{HCO}_3^-) = \frac{K_w}{K_a(\text{H}_2\text{CO}_3)} = \frac{1.0 \times 10^{-14}}{4.3 \times 10^{-7}} = 2.3 \times 10^{-8}$$