
1. The K_b of $\text{CH}_3\text{CH}_2\text{NH}_2$ is 5.6×10^{-4} . What is K_a of its conjugate acid?

A. 5.4×10^{-14}

C. 3.25

B. 1.8×10^{-11}

D. 10.75

2. Which of the following salts dissolves in water to give a solution in the indicated pH range?

A. $\text{KC}_2\text{H}_3\text{O}_2$, $\text{pH} > 7$

C. NaClO , $\text{pH} < 7$

B. NH_4F , $\text{pH} = 7$

D. LiBr , $\text{pH} > 7$

3. For which of the following dilute acid solutions can the pH be calculated using only K_{a1} ?

H_2SO_4	$K_{a1} \gg 1$	$K_{a2} = 1.2 \times 10^{-2}$
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H_2CO_3	$K_{a1} = 4.3 \times 10^{-7}$	$K_{a2} = 5.6 \times 10^{-11}$
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$\text{H}_3\text{C}_6\text{H}_5\text{O}_7$	$K_{a1} = 7.4 \times 10^{-4}$	$K_{a2} = 1.7 \times 10^{-5}$	$K_{a3} = 4.0 \times 10^{-7}$
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H_3PO_4	$K_{a1} = 7.5 \times 10^{-3}$	$K_{a2} = 6.2 \times 10^{-8}$	$K_{a3} = 4.2 \times 10^{-13}$
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A. H_2SO_4 , H_2CO_3

C. $\text{H}_3\text{C}_6\text{H}_5\text{O}_7$, H_3PO_4

B. H_2SO_4 , $\text{H}_3\text{C}_6\text{H}_5\text{O}_7$

D. H_2CO_3 , H_3PO_4

4. Which pair has the **weaker** acid listed first?

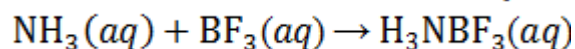
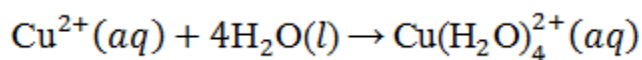
A. HClO, HIO

C. H₂Te, H₂S

B. HBrO, HBrO₄

D. HF, HCl

5. Identify the **Lewis base** in each of the following reactions.



A. Cu²⁺, NH₃

C. H₂O, NH₃

B. Cu²⁺, BF₃

D. H₂O, BF₃

6. The combustion of fossil fuels results in which acids that cause the pH of rain to fall below 5.6?

A. HNO₃, H₂SO₄

C. HNO₃, H₃PO₄

B. H₂CO₃, H₂SO₄

D. H₂CO₃, H₃PO₄

7. Which pair acts as a **buffer** when an equimolar amount of each compound is mixed together in an aqueous solution?

A. HCl and KOH

C. H₂CO₃ and Na₂CO₃

B. H₃PO₄ and NaHSO₄

D. HCHO₂ and KCHO₂

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8. What is true about the base-to-acid ratio in a $\text{HC}_4\text{H}_7\text{O}_2/\text{KC}_4\text{H}_7\text{O}_2$ buffer with a pH of 5.82? The $\text{p}K_a$ of $\text{HC}_4\text{H}_7\text{O}_2$ is 4.82.
- A. $[\text{C}_4\text{H}_7\text{O}_2^-] < [\text{HC}_4\text{H}_7\text{O}_2]$ C. $[\text{C}_4\text{H}_7\text{O}_2^-] > [\text{HC}_4\text{H}_7\text{O}_2]$
B. $[\text{C}_4\text{H}_7\text{O}_2^-] = [\text{HC}_4\text{H}_7\text{O}_2]$ D. $[\text{C}_4\text{H}_7\text{O}_2^-] = 2[\text{HC}_4\text{H}_7\text{O}_2]$
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9. A 1.00 L buffer solution contains 0.125 mol HNO_2 and 0.125 mol NaNO_2 ($\text{p}K_a$ of HNO_2 is 3.34). What is the pH of the solution after 0.025 mol of solid KOH is added? Assume no change in volume.
- A. 2.71 C. 3.52
B. 3.02 D. 4.94
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10. Which of the following is **not** a characteristic of an effective buffer?
- A. Buffers are most effective when $[\text{base}]:[\text{acid}] = 1$.
B. A buffer will be effective as long as the $[\text{base}]:[\text{acid}]$ ratio remains between 0.1 and 10.
C. Buffers are most effective when a weak acid and a weak base are used that differ by more than one H^+ and do not share a common ion.
D. Buffers are most effective when the $[\text{acid}]$ and $[\text{base}]$ are large.
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11. What is the pH of the resulting solution when 5.0 mL of 0.50 M NaOH is added to 50.0 mL of 0.15 M HCl?

A. 13.35

C. 2.75

B. 12.70

D. 1.04

12. A 20.0 mL sample of 0.500 M ethylamine ($\text{C}_2\text{H}_5\text{NH}_2$, $K_b = 5.6 \times 10^{-4}$) is titrated with 1.00 M HCl. What is the pH after adding 4.00 mL of HCl to the $\text{C}_2\text{H}_5\text{NH}_2$ solution?

A. 4.65

C. 10.92

B. 6.74

D. 11.36

13. A handbook lists the following information:

<u>Indicator</u>	<u>pK_{HIn}</u>
Thymol blue	1.65
Chlorophenol red	6.25
Metacresol purple	8.32
Alizarin yellow	11.00

Which indicator would be **best** to use in the titration of 0.100 M $\text{HC}_3\text{H}_3\text{O}_3$ ($K_a = 4.1 \times 10^{-3}$) with 0.100 M NaOH?

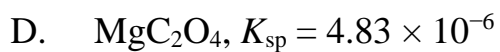
A. Alizarin yellow

C. Chlorophenol red

B. Thymol blue

D. Metacresol purple

14. Which one of the following salts is the least soluble in water?



15. Calculate the molar solubility of $\text{Al}(\text{OH})_3$ in pure water. K_{sp} of $\text{Al}(\text{OH})_3$ is 1.3×10^{-33} .

A. $9.3 \times 10^{-6} \text{ M}$

C. $7.6 \times 10^{-20} \text{ M}$

B. $2.6 \times 10^{-9} \text{ M}$

D. $5.9 \times 10^{-2} \text{ M}$

16. What is the solubility of CuBr in 0.30 M KBr ? K_{sp} of CuBr is 6.3×10^{-9} .

A. $9.2 \times 10^{-20} \text{ M}$

C. $2.1 \times 10^{-8} \text{ M}$

B. $6.0 \times 10^{-4} \text{ M}$

D. $1.3 \times 10^{-12} \text{ M}$

17. Which of the following solutions will see a **decrease** in solubility with an **increase** in pH?

A. KBr

C. AgCl

B. $\text{Pb}(\text{NO}_3)_2$

D. $\text{Cd}(\text{OH})_2$

18. Two solutions are mixed together such that $[\text{Ni}^{2+}]$ is 5.0×10^{-9} M and $[\text{S}^{2-}]$ is 4.0×10^{-14} M. The K_{sp} of NiS is 3.0×10^{-20} . Will a precipitate form?

A. A precipitate will not form because $Q < K_{\text{sp}}$.

B. A precipitate will not form because $Q > K_{\text{sp}}$.

C. A precipitate will form because $Q < K_{\text{sp}}$.

D. A precipitate will form because $Q > K_{\text{sp}}$.

19. A solution is 0.018 M in Pb^{2+} and 0.011 M in Ba^{2+} . If Na_2SO_4 is used to selectively precipitate one of the cations from solution, which cation will precipitate first? What minimum concentration of Na_2SO_4 will trigger the precipitation of the cation that precipitates first? K_{sp} of PbSO_4 is 1.8×10^{-8} and K_{sp} of BaSO_4 is 1.1×10^{-10} .

A. Pb^{2+} , 1.0×10^{-6} M Na_2SO_4

C. Ba^{2+} , 1.0×10^{-6} M Na_2SO_4

B. Pb^{2+} , 1.0×10^{-8} M Na_2SO_4

D. Ba^{2+} , 1.0×10^{-8} M Na_2SO_4

20. Which one of the following statements is **true**?

- A. A thermodynamically spontaneous reaction must be kinetically fast at a given temperature.
- B. A thermodynamically spontaneous reaction may be kinetically slow at a given temperature.
- C. A nonspontaneous process is impossible.
- D. A nonspontaneous process can be made spontaneous by the use of a catalyst.

21. Which of the following statements is **false**?

- A. When ice is added to water, heat flows from the ice to the water in a spontaneous process.
- B. Water evaporates spontaneously, increasing the entropy of the system.
- C. A gas under constant temperature and pressure will spontaneously expand to fill the entire volume of the container.
- D. NaCl dissolving in water is spontaneous because the process increases the entropy of the system.

22. Which of the following processes has a **decrease** in entropy?

- A. $\text{CO}_2(s) \rightarrow \text{CO}_2(g)$
 - B. $\text{SO}_2\text{Cl}_2(g) \rightarrow \text{SO}_2(g) + \text{Cl}_2(g)$
 - C. $\text{CO}(g) + 2 \text{H}_2(g) \rightarrow \text{CH}_3\text{OH}(l)$
 - D. $\text{Ag}_2\text{SO}_4(s) \rightarrow 2 \text{Ag}^+(aq) + \text{SO}_4^{2-}(aq)$
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23. For a spontaneous process with $\Delta S_{\text{sys}} = -50 \text{ J}$, what is true about the value of ΔS_{surr} ?
- A. $\Delta S_{\text{surr}} < 50 \text{ J}$ C. $\Delta S_{\text{surr}} = 50 \text{ J}$
B. $\Delta S_{\text{surr}} > 50 \text{ J}$ D. There is no connection between ΔS_{surr} and ΔS_{sys} .

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24. What is the change in the entropy of the surroundings at 350 K for a reaction whose enthalpy change is -735 kJ/mol ?
- A. $2.1 \text{ kJ/mol}\cdot\text{K}$ C. $-3.3 \text{ kJ/mol}\cdot\text{K}$
B. $0.14 \text{ kJ/mol}\cdot\text{K}$ D. $-4.5 \text{ kJ/mol}\cdot\text{K}$

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25. If ΔH and ΔS are both positive, what is true about ΔG and the spontaneity of the reaction?
- A. ΔG will be positive for all temperatures and the reaction will be spontaneous in the forward direction.
B. At high temperatures, ΔG will be negative and the reaction will be spontaneous in the forward direction
C. At low temperatures, ΔG will be positive and the reaction will be spontaneous in the forward direction.
D. ΔG will be negative for all temperatures and the reaction will be nonspontaneous in the forward direction.
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Answer Key:

1. B
2. A
3. D
4. B
5. C
6. A
7. D
8. C
9. C
10. C
11. D
12. C
13. D
14. A
15. B
16. C
17. D
18. A
19. D
20. B
21. A
22. C
23. B
24. A
25. B