

Questions 1-5 refer to the following information.

A student titrates 20.0 mL of 1.0 M NaOH with 2.0 M formic acid, HCO₂H ($K_a = 1.8 \times 10^{-4}$). Formic acid is a monoprotic acid.

1. How much formic acid is necessary to reach the equivalence point?

- A. 10.0 mL
- B. 20.0 mL
- C. 30.0 mL
- D. 40.0 mL

2. At the equivalence point, is the solution acidic, basic, or neutral? Why?

- A. Acidic; the strong acid dissociates more than the weak base
- B. Basic; the only ion present at equilibrium is the conjugate base
- C. Basic; the higher concentration of the base is the determining factor
- D. Neutral; equal moles of both acid and base are present

3. If the formic acid were replaced with a strong acid such as HCl at the same concentration (2.0 M), how would that change the volume needed to reach the equivalence point?

- A. The change would reduce the amount, as the acid now fully dissociates.
- B. The change would reduce the amount, because the base will be more strongly attracted to the acid.
- C. The change would increase the amount, because the reaction will now go to completion instead of equilibrium.
- D. Changing the strength of the acid will not change the volume needed to reach equivalence.

4. Which of the following would create a good buffer when dissolved in formic acid?

- A. NaCO₂H
- B. HC₂H₃O₂
- C. NH₃
- D. H₂O



The above equation represents the reaction between the base methylamine ($K_b = 4.38 \times 10^{-4}$) and water. Which of the following best represents the concentrations of the various species at equilibrium?

- A. $[\text{OH}^-] > [\text{CH}_3\text{NH}_2] = [\text{CH}_3\text{NH}_3^+]$
- B. $[\text{OH}^-] = [\text{CH}_3\text{NH}_2] = [\text{CH}_3\text{NH}_3^+]$
- C. $[\text{CH}_3\text{NH}_2] > [\text{OH}^-] > [\text{CH}_3\text{NH}_3^+]$
- D. $[\text{CH}_3\text{NH}_2] > [\text{OH}^-] = [\text{CH}_3\text{NH}_3^+]$

Questions 6-10 refer to the following information.

The following reaction is found to be at equilibrium at 25°C:



$$\Delta H = -198 \text{ kJ/mol}$$

6. What is the expression for the equilibrium constant, K_c ?

A.

$$\frac{[\text{SO}_3]^2}{[\text{O}_2][\text{SO}_2]^2}$$

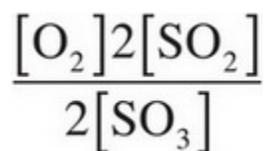
B.

$$\frac{2[\text{SO}_3]}{[\text{O}_2]2[\text{SO}_2]}$$

C.

$$\frac{[\text{O}_2][\text{SO}_2]^2}{[\text{SO}_3]^2}$$

D.



7. Which of the following would cause the reverse reaction to speed up?

- A. Adding more SO₃
- B. Raising the pressure
- C. Lowering the temperature
- D. Removing some SO₂

8. The value for K_c at 25°C is 8.1. What must happen in order for the reaction to reach equilibrium if the initial concentrations of all three species was 2.0 M?

- A. The rate of the forward reaction would increase, and [SO₃] would decrease.
- B. The rate of the reverse reaction would increase, and [SO₂] would decrease.
- C. Both the rate of the forward and reverse reactions would increase, and the value for the equilibrium constant would also increase.
- D. No change would occur in either the rate of reaction or the concentrations of any of the species.

9. Which of the following would cause a reduction in the value for the equilibrium constant?

- A. Increasing the amount of SO₃
- B. Reducing the amount of O₂
- C. Raising the temperature
- D. Lowering the temperature

10. The solubility product, K_{sp} , of AgCl is 1.8×10^{-10} . Which of the following expressions is equal to the solubility of AgCl?

A.

$$(1.8 \times 10^{-10})^2 \text{ molar}$$

B.

$$\frac{1.8 \times 10^{-10}}{2} \text{ molar}$$

C.

$$1.8 \times 10^{-10} \text{ molar}$$

D.

$$\sqrt{1.8 \times 10^{-10}} \text{ molar}$$