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, HCO_2H ($K_a = 1.8 \times 10^{-4}$). 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 equivalance.

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

- A. $NaCO_2H$
- B. $HC_2H_3O_2$
- C. NH_3
- D. H_2O

5. $CH_3NH_2(aq) + H_2O(l) \leftrightarrow OH^-(aq) + CH_3NH_3^+(aq)$

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. $[OH^-] > [CH_3NH_2] = [CH_3NH_3^+]$
- B. $[OH^-] = [CH_3NH_2] = [CH_3NH_3^+]$
- C. $[CH_3NH_2] > [OH^-] > [CH_3NH_3^+]$
- D. $[CH_3NH_2] > [OH^-] = [CH_3NH_3^+]$

Questions 6-10 refer to the following information.

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

$2SO_3(g) \leftrightarrow O_2(g) + 2SO_2(g)$

$\Delta H = -198$ kJ/mol

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

- A. $\dfrac{[SO_3]^2}{[O_2][SO_2]^2}$

$[O_2]2[SO_2]$

C. $\frac{[O_2][SO_2]^2}{[SO_3]^2}$

D. $\frac{[O_2]2[SO_2]}{2[SO_3]}$

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

A. Adding more SO_3

B. Raising the pressure

C. Lowering the temperature

D. Removing some SO_2

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 $[SO_3]$ would decrease.

B. The rate of the reverse reaction would increase, and $[SO_2]$ 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 SO_3

B. Reducing the amount of O_2

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

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

C. 1.8×10^{-10} molar

D. $\sqrt{1.8 \times 10^{-10}}$ molar

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