**Buffers Formative Quiz – Answer Key**

1. Determine the number of grams of sodium fluoride, NaF, that must be added to 100. mL of 1.0 M hydrofluoric acid, HF, to create a buffered solution with a pH of 3.05? Assume that the volume does not change. (\(K_a = 7.2 \times 10^{-4}\)).

Using Henderson-Hasselbalch Equation:
\[
pK_a = -\log (7.2 \times 10^{-4}) = 3.14
\]
\[
3.05 = 3.14 + \log \left( \frac{[F^-]}{1.0} \right) \Rightarrow -0.09 = \log \left( \frac{[F^-]}{1.0} \right)
\]
\[
0.81 = \frac{[F^-]}{1.0} \Rightarrow [F^-] = 0.81 M
\]
\[
0.100 L \times 0.83 \frac{mol}{L} = 0.081 M \text{ F} = 0.0813 mol \text{ NaF} \times \frac{41.99 g \text{ NaF}}{1 \text{ mol NaF}} = 3.4 g \text{ NaF}
\]

2. Determine the number of grams potassium hypochlorite, KOCl, that must be added to 250. mL of 0.50 M hypochlorous acid, HOCl, to create a buffered solution with a pH of 8.00? Assume that the volume does not change. (\(K_a = 3.5 \times 10^{-8}\)).

Using Henderson-Hasselbalch Equation:
\[
pK_a = -\log (3.5 \times 10^{-8}) = 7.46
\]
\[
8.00 = 7.46 + \log \left( \frac{[OCl^-]}{[0.50]} \right) \Rightarrow 0.54 = \log \left( \frac{[OCl^-]}{[0.50]} \right)
\]
\[
3.5 = \frac{[OCl^-]}{[0.50]} \Rightarrow [OCl^-] = 1.8 M
\]
\[
0.250 L \times 1.8 \frac{mol}{L} \times 0.45 \text{ mol OCl} = 0.45 \text{ mol KOCl} \times \frac{90.55 g \text{ KOCl}}{1 \text{ mol KOCl}} = 40. \text{ g KOCl}
\]

3. Determine the volume, in milliliters, of 1.0 M NaOH that would need to be added to 75.0 mL of 0.50 M benzoic acid, C₆H₅COOH to produce a buffered solution with a pH of 4.25. (\(K_a = 6.5 \times 10^{-5}\)).

Using Henderson-Hasselbalch Equation:
\[
pK_a = -\log (6.5 \times 10^{-5}) = 4.19
\]
*moles of base and acid can be used since volumes are additive
\[
4.25 = 4.19 + \log \left( \frac{A^-}{[HA]} \right)* \Rightarrow 0.06 = \log \left( \frac{A^-}{[HA]} \right)*
\]
\[
1.2 = \frac{A^-}{(0.038 - A^-)} \Rightarrow 0.046 = 1. A^- = 0.021 \text{ mol C}_6\text{H}_5\text{COO}^-
\]
Moles C₆H₅COO⁻ = moles OH⁻ from balanced equation C₆H₅COOH + OH⁻ → C₆H₅COO⁻ + H₂O
\[
0.021 \text{ mol NaOH} \times \frac{1 L}{1.0 \text{ mol NaOH}} = 0.021 L = 21 \text{ mL}
\]

4. Determine the volume, in milliliters, of 0.50 M HCl that would need to be added to 100. mL of 0.50 M NH₃ to produce a buffered solution with a pH of 9.50. (\(K_b = 1.8 \times 10^{-5}\)).

\[
K_a = K_a \times K_b = 1.0 \times 10^{-14} = K_a \times 1.8 \times 10^{-5}
\]
\[
K_a = 5.56 \times 10^{-10} \Rightarrow pK_a = 9.25
\]
Using Henderson-Hasselbalch Equation:
*moles of base and acid can be used since volumes are additive
\[
9.50 = 9.25 + \log \left( \frac{B}{HB^+} \right)* \Rightarrow 0.25 = \log \left( \frac{B}{HB^+} \right)*
\]
\[
1.8 = \frac{0.050 - HB^+}{HB^+} \Rightarrow 2. HB^+ = 0.050 \Rightarrow HB^+ = 0.018 \text{ mol NH}_4^+
\]
Moles NH₄⁺ = moles HCl from balanced equation NH₃ + H⁺ → NH₄⁺
\[
0.018 \text{ mol HCl} \times \frac{1 L}{0.50 \text{ mol HCl}} = 0.036 L = 36 \text{ mL}
\]