1. Calculate the pH of a solution that contains 150 mL of 0.25 M HF and 225 mL of 0.30 M NaF. (3 pts)

\[ K_a = 3.5 \times 10^{-4} \]

Total Volume = 225 mL + 150 mL = 375 mL or 0.375 L

\[ pK_a = -\log(3.5 \times 10^{-4}) = 3.46 \]

\[
[HF] = \frac{0.25 \text{ mol/L} \times 0.150 \text{ L}}{0.375 \text{ L}} = 0.10 \text{ M} \\
[F^-] = \frac{0.30 \text{ mol/L} \times 0.225 \text{ L}}{0.375 \text{ L}} = 0.18 \text{ M}
\]

Use the Henderson-Hasselbach Equation:

\[ pH = pK_a + \log \left( \frac{[A^-]}{[HA]} \right) = 3.46 + \log \frac{0.18}{0.10} = 3.46 + 0.26 = 3.71 \]

2. Calculate the percent ionization for a 0.20 M solution of Hydrazoic Acid, HN₃. (3 pts)

\[ K_a = 2.5 \times 10^{-5} \]

\[
\begin{array}{ccc}
\text{HN}_3 & \rightleftharpoons & \text{H}^+ + \text{N}_3^- \\
\text{I} & 0.20 & 0 & 0 \\
\text{C} & -x & x & x \\
\text{E} & 0.20-x & x & x
\end{array}
\]

\[ K_a = 2.27 \times 10^{-5} = \frac{x^2}{0.20 - x} \approx \frac{x^2}{0.20} \quad ; \quad x = 2.24 \times 10^{-3} \text{ M} = [H^+] \]

Percent Ionization = \frac{2.24 \times 10^{-3}}{0.20} \times 100 = 1.12 \%

3. Calculate the ratio of conjugate base over acid for the following solutions and clearly state if the solution is a buffer. (4 pts) Buffer ratio range: 0.1 – 10

a) 75.0 mL of 0.10 M HF; 55.0 mL of 0.15 M NaF

moles HF = 0.075 L x 0.10 M = 0.0075 moles ; moles of F⁻ = 0.055 L x 0.15 M = 0.00825 moles

\[
\frac{[F^-]}{[HF]} = \frac{8.25 \times 10^{-3}}{7.50 \times 10^{-3}} = 1.1 \quad \text{Yes, this is a buffer.}
\]

b) 50.0 mL of 0.15 M HF; 35 mL of 0.15 M NaOH

moles of HF = 0.05L x 0.15 M = 0.0075 moles ; moles of OH⁻ = 0.035 L x 0.15 M = 0.00525 moles OH⁻

Must subtract the weak acid and strong base: 0.0075 HF – 0.00525 OH⁻ = 0.00225 moles HF left over

\[
\frac{[F^-]}{[HF]} = \frac{5.25 \times 10^{-3}}{2.25 \times 10^{-3}} = 2.3 \quad \text{Yes, this is a buffer}
\]