1. Calculate the pH of a solution that contains 25.0 mL of 0.23 M Cyanic Acid (HCNO) and 13.0 mL of 0.15 M Sodium Cyanate (NaCNO). (4 pts)

\[ K_a = 2 \times 10^{-4} \]

moles HCNO = 0.025 L x 0.23 mol/L = 0.00575 mol of acid [HA]

moles CNO\(^-\) = 0.013 L x 0.15 mol/L = 0.00195 mol of conjugate base [A\(^-\)]

**Henderson-Hasselbach Equation**

\[
\text{pH} = pK_a + \log \frac{[A^-]}{[HA]} = -\log(2.0 \times 10^{-4}) + \log \frac{0.00195}{0.00575}
\]

\[
\text{pH} = 3.70 - 0.47 = 3.23
\]

2. Calculate the initial concentration of an Acetylsalicylic Acid (HC\(_9\)H\(_7\)O\(_4\)) solution at pH 4.38 if the percent ionization is 2.78%. Acetylsalicylic acid is a mono-protic acid. (3 pts)

\[ K_a = 3.3 \times 10^{-4} \]

\[ x = [H^+] = 10^{4.38} = 4.17 \times 10^{-5} \]

\[
\text{percent ionization} = \left( \frac{4.17 \times 10^{-5}}{[HA]_i} \right) \times 100 = 2.78\%
\]

Re-arrange and solve for the initial concentration:

\[
[HA]_i = \frac{4.17 \times 10^{-5}}{2.78\%} \times 100 = 1.50 \times 10^{-3} M
\]

3. Calculate the conjugate base, [A\(^-\)], to acid, [HA], ratio for a solution of pyruvic acid at pH 5.2. Clearly state if this solution is within the buffer zone of pyruvic acid (HC\(_3\)H\(_3\)O\(_3\))? (3 pts)

\[ K_a = 4.1 \times 10^{-3} \]

\[
5.2 = -\log(4.1 \times 10^{-3}) + \log \frac{[A^-]}{[HA]}
\]

\[
5.2 = 2.4 + \log \frac{[A^-]}{[HA]} \quad \text{or} \quad 2.8 = \log \frac{[A^-]}{[HA]}
\]

Inverse log of both sides:

\[
10^{2.8} = \frac{[A^-]}{[HA]} \approx 631
\]

The conjugate base to acid ratio must be between 0.1 and 10 to be within the buffer zone, therefore this ratio is not appropriate for a pyruvic acid/pyruvate buffer.