Before addition of acid

\[ [\text{H}_2\text{O}^+]^2 + (1.38 \times 10^{-4} + 0.0500) [\text{H}_2\text{O}^+] - 1.38 \times 10^{-4} \times 0.0500 = 0 \]

\[ [\text{H}_2\text{O}^+] = 1.372 \times 10^{-4} \text{ and } \text{pH} = 3.863 \]

After adding acid

\[ c_{\text{HA}} = \frac{(100 \times 0.0500 + 0.500)}{100} = 0.0550 \]

\[ c_{\text{NaA}} = \frac{(100 \times 0.0500 - 0.500)}{100} = 0.0450 \]

\[ [\text{H}_2\text{O}^+]^2 + (1.38 \times 10^{-4} + 0.0450) [\text{H}_2\text{O}^+] - 1.38 \times 10^{-4} \times 0.0550 = 0 \]

\[ [\text{H}_2\text{O}^+] = 1.675 \times 10^{-4} \text{ and } \text{pH} = 3.776 \]

\[ \Delta \text{pH} = 3.776 - 3.863 = -0.087 \]

12-43. \( \text{pH} = 3.50 \text{ and } [\text{H}_2\text{O}^+] = \text{antilog (}-3.50\text{) = } 3.162 \times 10^{-4} \)

\[ [\text{H}_2\text{O}^+] / [\text{HA}] = 1.80 \times 10^{-4} \]

\[ [\text{A}^-] / [\text{HA}] = \frac{1.80 \times 10^{-4}/3.162 \times 10^{-4}} = 0.5693 \]

\[ [\text{HA}] = 1.00 \text{ and } [\text{A}^-] = 0.5693 \times 1.00 = 0.5693 \text{ M} \]

\[ \text{mass HCOONa} = \frac{0.5693 \text{ mmol NaA/mL} \times 400 \text{ mL} \times 0.06801 \text{ g NaA/mmol NaA}} {15.5 \text{ g sodium formate}} \]

12-47. Before the equivalence point (50.00 mL), we calculate the number of mmol NaOH remaining from the original number of mmol NaOH present minus the number of mmol of HCl added. The \([\text{OH}^-]\) is then obtained from the number of mmol of NaOH remaining divided by the total solution volume. The \([\text{OH}^-]\) is then used to obtain \(p\text{OH}\) and from this the \(\text{pH}\). At the equivalence point the \(p\text{OH}\) and \(\text{pH}\) are obtained from \(\sqrt{K_w}\). After the equivalence point, we calculate the excess HCl from the number of mmol of HCl added minus the number of mmol of NaOH originally present. The number of mmol of HCl divided by the total volume gives the \(\text{H}_2\text{O}^+\) concentration and from this the \(\text{pH}\). The spreadsheet shows the resulting \(\text{pH}\) values after each increment of NaOH. The plot is an XY (Scatter) plot of pH (17:116) vs. Vol. HCl (A7:A16).

12-50. (a) 0.00 mL NaOH

\[ c_{\text{HA}} = 0.1000 \text{ M} \]

\[ [\text{H}_2\text{O}^+] = [\text{A}^-] \]

\[ [\text{HA}] = 0.100 - [\text{H}_2\text{O}^+] \]

\[ K_a = 7.1 \times 10^{-4} = \frac{[\text{H}_2\text{O}^+][\text{A}^-]}{[\text{HA}]} = \frac{[\text{H}_2\text{O}^+]^2}{0.1000 - [\text{H}_2\text{O}^+]} \]

\[ [\text{H}_2\text{O}^+]^2 + 7.1 \times 10^{-4}[\text{H}_2\text{O}^+] - 0.1000 \times 7.1 \times 10^{-4} = 0 \]

The result is shown in cell E7 of the spreadsheet for this problem and \(\text{pH} = 2.09\).