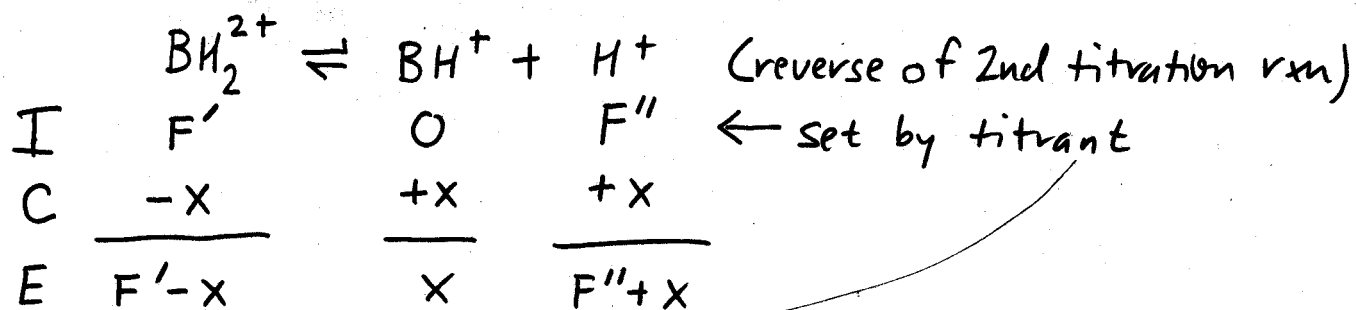


Calculating the pH of a solution of a weak dibasic species + strong acid past V_{e2}

When $B = \text{nicotine}$, BH_2^{2+} is a strong enough acid ($K_1 = 7.08 \times 10^{-4}$) that its hydrolysis significantly affects pH. Quantify as follows:



i.e. the "initial conditions" are setting by assuming the effect of $V_t = 21.0 \text{ mL}$ is 100% stoichiometric:

$$F' = (0.100 \text{ M}) \left(\frac{10.00 \text{ mL}}{(10.00 + 21.00) \text{ mL}} \right) = \underline{0.03226 \text{ M}}$$

and $F'' = \underline{0.00323 \text{ M}}$ (conc. of excess titrant, from previous calc.)

However, not all of the BH_2^{2+} will stay protonated.

Solving for x will tell us how much BH_2^{2+}

"reverts" to BH^+

$$K_1 = \frac{[BH^+][H^+]}{[BH_2^{2+}]} = \frac{x(0.00323 + x)}{0.03226 - x} = 7.08 \times 10^{-4}$$

$$x^2 + 0.00323x = -7.08 \times 10^{-4}x + 2.28 \times 10^{-5}$$

$$x^2 + 0.00394x - 2.28 \times 10^{-5} = 0$$

Using TI-83 Plus Solver,

$$\underline{x = 0.0032 M}$$

∴ at $V_t = 21.0 \text{ mL}$,

$$[H^+] = \frac{0.00323 M}{\uparrow} + \frac{0.0032 M}{\uparrow} = 0.00643 M$$

↑
excess titrant

↑
 BH_2^{2+} that
hydrolyses

⇓
pH = 2.19

(makes sense)

- Only 50% of H^+ from excess titrant!
- Still avoided systematic treatment