

$$M_a V_a = M_b V_b \Rightarrow V_b = 50.0 \text{ mL} \text{ needed to reach eq. pt}$$

(0.10)(100.0) = (0.200)V_b 23
2. Consider the titration of 100.0 mL of 0.10 M H₂NNH₂ ($K_b = 3.0 \times 10^{-6}$) by 0.200 M HNO₃. Calculate the pH of the resulting solution after the following volumes of HNO₃ have been added.

a. 0.0 mL Only H₂NNH₂ $\Rightarrow K_b$ problem

$$K_b = \frac{[\text{OH}^-][\text{H}_2\text{NNH}_3^+]}{[\text{H}_2\text{NNH}_2]} = \frac{x^2}{\frac{0.10-x}{x}} \approx \frac{x^2}{0.10}$$

x negligible, $K_b \ll 1$

$$x = \sqrt{(0.10)(3.0 \times 10^{-6})} = 5.5 \times 10^{-4} \text{ M} = [\text{OH}^-]$$

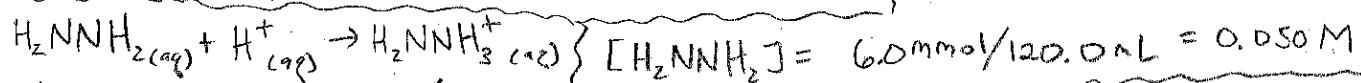
$$\text{pOH} = -\log(5.5 \times 10^{-4}) = 3.26$$

$$\text{pH} = 14 - 3.26 = 10.74$$

b4 eq. pt = buffer! * calculate [HA], [A⁻] first

$$\hookrightarrow \text{b. } 20.0 \text{ mL H}_2\text{NNH}_2 = 100.0 \text{ mL} \times 0.100 \text{ M} = 10.0 \text{ mmol}$$

$$[\text{H}^+] = 20.0 \text{ mL} \times 0.200 \text{ M} = 4.00 \text{ mmol}$$



B	10.0	4.00	\emptyset
C	-4.00	-4.00	+4.00
A	6.0	\emptyset	4.00

$$\text{pH} = \text{pK}_a + \log \frac{[\text{H}_2\text{NNH}_2]}{[\text{H}_2\text{NNH}_3^+]}$$

$$= -\log \left(\frac{10^{-14}}{3.0 \times 10^{-6}} \right) + \log \left(\frac{0.050}{0.0333} \right) = 8.48 + 0.18$$

$$= 8.65$$

$$\text{pH} = \text{pK}_a = -\log \left(\frac{K_w}{K_b} \right) = -\log \left(\frac{10^{-14}}{3.0 \times 10^{-6}} \right) = 8.48$$

→ @ eq. pt! only acidic salt (K_a problem) $K_a = \frac{10^{-14}}{3.0 \times 10^{-6}} = 3.3 \times 10^{-9}$

d. 50.0 mL

$$[\text{H}_2\text{NNH}_3^+] = \frac{(100.0 \text{ mL})(0.100 \text{ M})}{150.0 \text{ mL}} = 0.0667 \text{ M}$$

$$K_a = \frac{x^2}{[\text{H}_2\text{NNH}_3^+] - x} \approx \frac{x^2}{0.0667}$$

x negligible, $K_a \ll 1$

$$x = \sqrt{0.0667 \times 3.3 \times 10^{-9}} = 1.5 \times 10^{-5} \text{ M H}^+$$

$$\text{pH} = -\log(1.5 \times 10^{-5}) = 4.83$$

→ past eq. pt = only strong acid! $\text{H}^+ = 100.0 \text{ mL} \times 0.200 \text{ M} = 20.0 \text{ mmol}$



B	10.0	20.0	\emptyset
C	-10.0	-10.0	+10.0
A	\emptyset	10.0	\emptyset

negligible, weak contribution acid

$$\text{pH} = -\log(0.0500) = 1.301$$