

Chap 16
#73

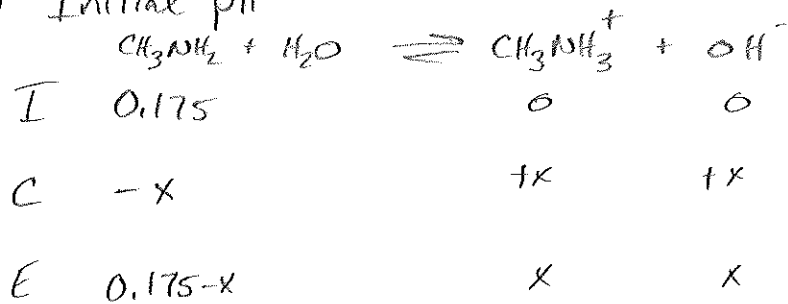
Titration of a weak base
with a strong acid

Chap 16

73

25.0 mL 0.175 M CH_3NH_2 (weak base) $K_b = 4.4 \times 10^{-4}$
 titrate w/ 0.150 M HBr (strong acid)

a) Initial pH



$$K_b = \frac{[\text{CH}_3\text{NH}_3^+][\text{OH}^-]}{[\text{CH}_3\text{NH}_2]} = 4.4 \times 10^{-4} = \frac{[x][x]}{0.175}$$

$$x = 0.0088 \text{ M}$$

$$\text{pOH} = -\log[0.0088] = 2.06$$

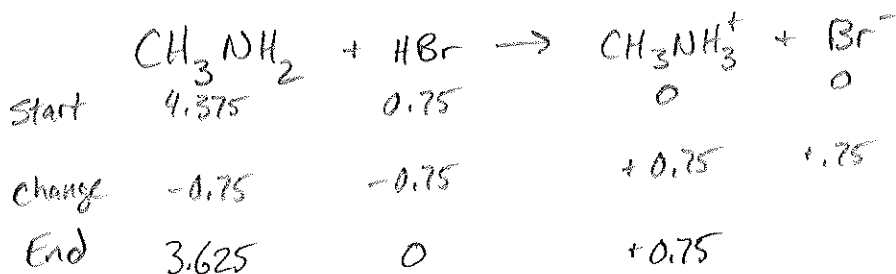
$$\boxed{\text{pH} = 11.94}$$

b) add 5 mL of acid

Stoichiometry

$$\text{Amt of } \text{CH}_3\text{NH}_2 \rightarrow 25.0 \text{ mL} \left(\frac{0.175 \text{ mmol}}{1 \text{ mL}} \right) = 4.375 \text{ mmol } \text{CH}_3\text{NH}_2$$

$$\text{Amt of HBr} \rightarrow 5.0 \text{ mL} \left(\frac{0.150 \text{ mmol}}{1 \text{ mL}} \right) = 0.75 \text{ mmol HBr}$$



$$K_b = 4.4 \times 10^{-4}$$

$$K_w = K_a K_b$$

$$1 \times 10^{-14} = K_a (4.4 \times 10^{-4})$$

$$2.27 \times 10^{-11} = K_a$$

$$10.64 = \text{p}K_a$$

Equil. for the Buffer

H-H

$$\text{pH} = 10.64 + \log$$

$$\text{pH} = 11.33$$

$$\left[\frac{3.625 \text{ mmol}}{30 \text{ mL}} \right]$$

$$\left[\frac{0.75 \text{ mmol}}{30 \text{ mL}} \right]$$

OR \rightarrow

Equil.



$$\left(\frac{3.625 \text{ mmol}}{30 \text{ mL}} \right) \qquad \qquad \left(\frac{0.75 \text{ mmol}}{30 \text{ mL}} \right)$$

I 0.121 M

0.025 M

C -x

+x

+x

E 0.121-x

0.025+x

x

$$4.4 \times 10^{-4} = \frac{[x][0.025]}{[0.121]} \rightarrow x = 0.00213 (= [\text{OH}^-])$$

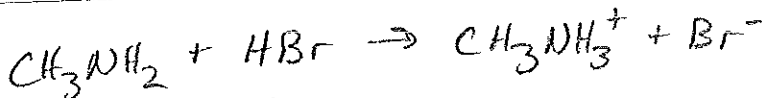
pOH = 2.67

pH = 11.33

c) @ Equivalence pt

will produce

Stoich $4.375 \text{ mmol CH}_3\text{NH}_2 \rightarrow 4.375 \text{ mmol HBr} \left(\frac{1 \text{ mL}}{0.150 \text{ mmol}} \right) = 29.2 \text{ mL HBr}$



start 4.375 mmol 0

add + 4.375 mmol

rxn -4.375 -4.375 + 4.375 + 4.375

End 0 0 + 4.375 mmol

in 25.0 mL — initial
+ 29.2 mL — HBr added

54.2 mL

Equilibrium



I $\left[\frac{4.375 \text{ mmol}}{54.2 \text{ mL}} \right]$

+x

+x

C -x

+x

+x

E 0.0807-x

$K_b = 4.4 \times 10^{-4}$ for CH_3NH_2

$K_a = 2.27 \times 10^{-11}$ for CH_3NH_3^+

↑

$1 \times 10^{-14} = 4.4 \times 10^{-4} K_a$

$$K_a = \frac{[\text{CH}_3\text{NH}_2][\text{H}_3\text{O}^+]}{[\text{CH}_3\text{NH}_3^+]} = \frac{[x][x]}{[0.0807]} = 2.27 \times 10^{-11}$$

$x = 1.35 \times 10^{-6} = [\text{H}_3\text{O}^+]$

5.87 = pH

a bit acidic
pH

d) Add 34.2 mL HBr (5.0 mL over)

$$34.2 \text{ mL} \left(\frac{0.150 \text{ mol/L}}{1 \text{ mL}} \right) = 5.13 \text{ mol}$$

Chap 16
#73

Stoich



start 4.375 mol

add

+ 5.13 mol

rxn - 4.375 mol

- 4.375 → + 4.375

end

0

0.755 mol

4.375 mol

4.375 mol

25.0 mL

34.2 mL

59.2 mL total

Equilibrium



I

$$\left[\frac{4.375 \text{ mol}}{59.2 \text{ mL}} \right]$$

$$\left[\frac{0.755 \text{ mol}}{59.2 \text{ mL}} \right]$$

$$K_a = 2.27 \times 10^{-11} \text{ for } \text{CH}_3\text{NH}_3^+$$

C

-x

+x

+x

E

(0.074 - x)

(0.013 + x)

(x)

$$2.27 \times 10^{-11} = \frac{[0.013][x]}{[0.074]}$$

$$1.3 \times 10^{-10} = x \text{ insignificant}$$

$$\text{pH} = -\log[0.013] = 1.89$$

