

10-17 Given 50.0 mL of 0.0319 M B titrated with 0.0500 M HCl
Calc. pH when $V_a = 12.0$, $\frac{1}{2} V_e$ and V_e .

Note: B = benzylamine \Rightarrow App. G $pK_a(BH^+) = 9.35$
 $K_a(BH^+) = 4.5 \times 10^{-10}$

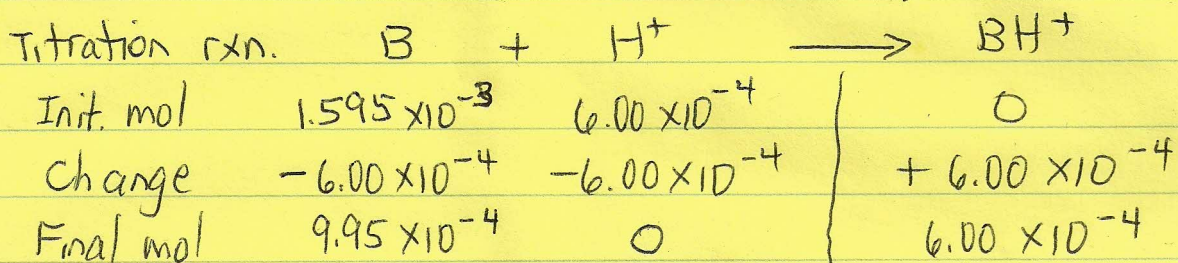
Work: Calc. V_e first

$$V_e = (50.0 \text{ mL})(0.0319 \text{ M}) / 0.0500 \text{ M} = 31.9 \text{ mL}$$

(a) $V_a = 12.0 \text{ mL} < V_e \Rightarrow$ Before the equiv. pt. = BUFFER!

\triangleright Init. mol B = $(0.0500 \text{ L})(0.0319 \text{ mol/L}) = 1.595 \times 10^{-3}$

\triangleright mol H^+ added = $(0.0120 \text{ L})(0.0500 \frac{\text{mol}}{\text{L}}) = 6.00 \times 10^{-4}$



$$pH = pK_a + \log \left(\frac{\text{mol B}}{\text{mol } BH^+} \right) = 9.35 + \log \left(\frac{9.95 \times 10^{-4}}{6.00 \times 10^{-4}} \right)$$

$pH = 9.57$

(b) $V_a = \frac{1}{2} V_e$ } means B is half-neutralized, i.e.
mol B remaining = mol BH^+ formed

$$pH = 9.35 + \log(1) \Rightarrow pH = 9.35$$

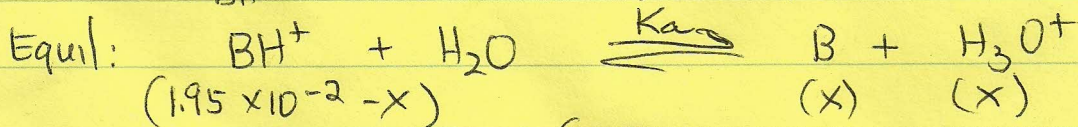
$pH = pK_a$

(c) $V_a = V_e = 31.9 \text{ mL}$ } \Rightarrow Only BH^+ in solution

\triangleright mol BH^+ formed = initial mol B = 1.595×10^{-3}

\triangleright total vol. at $V_e = 50.0 \text{ mL} + 31.9 \text{ mL} = 81.9 \text{ mL} = 0.0819 \text{ L}$

$\triangleright F_{BH^+} = \frac{1.595 \times 10^{-3} \text{ mol}}{0.0819 \text{ L}} = 1.95 \times 10^{-2}$



$$K_a = 4.5 \times 10^{-10} = \left(\frac{x^2}{1.95 \times 10^{-2} - x} \right) \quad \text{Assume } x \ll 1.95 \times 10^{-2}$$

$$x = [H^+] = 2.96 \times 10^{-6}$$

$pH = 5.53$