

Lecture 24 problems: Problem 1

(a): 25 ml

(b): Moles H^+ contributed by acid:

$$1.74 \cdot 10^{-5} = \frac{x^2}{(0.025 - x)} \Rightarrow x = 1.16 \cdot 10^{-6} M \Rightarrow 8.7 \cdot 10^{-8} \text{ moles } H^+$$

$$x = 1.74 \cdot 10^{-6} \Rightarrow 8.7 \cdot 10^{-8} \text{ moles } H^+$$

$$x = 0.00131 = 1.31 \cdot 10^{-3} M \Rightarrow 6.55 \cdot 10^{-5} \text{ moles } H^+$$

Moles OH^- contributed by base:

$$\frac{0.2 \text{ moles}}{1 L} \cdot 0.025 L = 5 \cdot 10^{-3} \text{ moles } OH^-$$

Write the reaction



At the equivalence point, we must only consider the presence of the conjugate base of the acetic acid

$$K_b = \frac{1 \cdot 10^{-14}}{1.74 \cdot 10^{-5}}; CH_3COO^- + H_2O \rightleftharpoons OH^- + CH_3COOH$$

How many moles of acetate are present? $\frac{0.1 \text{ moles}}{1000 \text{ ml}} \cdot 90 \text{ ml} = 0.009 \text{ moles}$

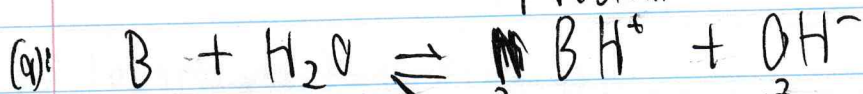
$$\text{Conc. of acetate} = \frac{0.009}{0.075} = 0.06 M, \text{ thus}$$

$$5.75 \cdot 10^{-10} = \frac{x^2}{(0.06 - x)} \Rightarrow \text{Conc } OH^- = 6.2 \cdot 10^{-6} M$$

$$pH = 8.79$$

(c): We have $\frac{6.2 \cdot 10^{-6} \text{ moles } OH^-}{1 \text{ liter}} \cdot 75 \text{ ml} + \frac{0.2 \text{ moles } OH^-}{1 \text{ liter}} \cdot 2 \text{ ml} \Rightarrow pH = 11.72$

Problem 2



$$5.6 \cdot 10^{-4} = \frac{x^2}{0.5 - x} \approx \frac{x^2}{0.5} \Rightarrow x = 0.0167$$

Thus

$$pOH = -\log(0.0167) \Rightarrow pH = 12.22$$

(b) Calculate how many moles ml's to equivalence

$$\frac{0.5 \text{ moles}}{L} \cdot 75 \text{ ml} = \frac{0.205}{L} \cdot x$$

$$x = 182.9 \text{ ml}$$

Thus, half equivalence occurs at $182.9/2 = 91.45 \text{ ml}$ of 0.205 M HCl

Solve for pK_a 's

$$pK_a = -\log(K_a) = -\log\left(\frac{1 \cdot 10^{-14}}{K_b}\right) = 10.75$$

and thus

$$pH = pK_a + \underbrace{\log\left(\frac{[A^-]}{[AH]}\right)}_0 = pK_a = 10.75$$

(c) At the equivalence, we have $0.5 \cdot 0.075 = 0.0375 \text{ moles acid conjugate}$

$$\frac{1 \cdot 10^{-14}}{5.6 \cdot 10^{-4}} = \frac{x^2}{\left(\frac{0.0375}{258} - x\right)} \Rightarrow x = 5.08 \cdot 10^{-8} \text{ and thus } pH = 6.7$$

(d) add 1 ml and $0.205 \cdot 0.001 \text{ moles HCl}$ to get 3.1.