Lecture 24 problems: Problem 1

(a): 25 ml

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

$1.74 \cdot 10^{-5} = \frac{x^2}{(0.2 - x)} \Rightarrow x = 1.16 \cdot 10^{-6}\ M \Rightarrow 8.7 \cdot 10^{-8}$ moles H^+

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

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

Moles OH^- contributed by base:

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

Write the reaction

$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H^+ + H_2O$

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? $\frac{0.1 \text{ moles}}{1000 \text{ ml}} \cdot 50 \text{ ml} = 0.005$ moles

Conc. of acetate $= \frac{0.005}{0.075} = 0.06\overline{6}\ M$, thus

$5.75 \cdot 10^{-10} = \frac{x^2}{(0.067 - x)} \Rightarrow$ 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

(a): $B + H_2O \rightleftharpoons BH^+ + OH^-$

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

thus

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

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

$$\frac{0.5 \text{ moles}}{L} \cdot 75 \text{ ml} = \frac{0.2 \text{ os}}{L} \cdot X$$

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

Thus, half equivalence occurs at $182.9/2 = 91.45$ ml of 0.20sM HC

Solve for pK_a:

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

and thus

$$pH = pK_a + \underbrace{\log\left(\frac{[A^-]}{[AH]}\right)}_{0} = pK_a = 10.75$$

(c): At the equivalence, we have $0.5 \cdot 0.075 = 0.0375$ moles acid Conjug

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

(d): add 1 ml and $0.205 \cdot 0.001$ moles ~~of~~ to get 3.1.