Lecture 24 problems: Problem 1

(a): 25 ml

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

$$1.74\cdot10^{-5} = \frac{x^2}{(0.010 - x)} \Rightarrow x = 1.16\cdot10^{-6}\ M \Rightarrow 8.7\cdot10^{-8} \text{ moles } H^+$$

$$x = 1.74\cdot10^{-6} \Rightarrow 8.7\cdot10^{-8} \text{ moles } H^+$$

$$x = 0.00131 = 1.31\cdot10^{-3}\ M \Rightarrow 6.55\cdot10^{-5} \text{ moles } H^+$$

Moles OH^- contributed by base:

$$\frac{0.2 \text{ moles}}{1\ L} \cdot 0.025\ L = 5\cdot10^{-3} \text{ moles } OH^-$$

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

$$K_b = \frac{1\cdot10^{-14}}{1.74\cdot10^{-5}}; \quad CH_3COO^- + H_2O \rightleftharpoons OH^- + CH_3COOH$$

How many moles of acetate are present? $\frac{0.1 \text{ moles}}{1000 \text{ ml}} \cdot 50 \text{ ml} = 0.005 \text{ moles}$

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

$$5.75\cdot10^{-10} = \frac{x^2}{(0.067 - x)} \Rightarrow \text{Conc } OH^- = 6.2\cdot10^{-6}\ M$$

$$pH = 8.79$$

(c): We have $\frac{6.2\cdot10^{-6} \text{ moles } OH^-}{1 \text{ liter}} \cdot 75 \text{ ml} + \frac{0.2 \text{ moles } OH^-}{1 \text{ liter}} \cdot 2 \text{ ml} \Rightarrow pH = 11.72$