Lecture 23 Problems

Problem 1

We see that, at equivalence, moles OH^- = moles H^+; by extension

moles NaOH = moles OH^- = moles H^+ = moles HCl

$$\frac{15.4 \text{ ml HCl}}{1} \cdot \frac{1 \text{ L}}{1000 \text{ ml}} \cdot \frac{1 \text{ mole}}{1 \text{ L}} \Rightarrow 0.0154 \text{ moles } H^+$$

Then,

$$\frac{0.0154 \text{ moles } OH^-}{0.05 \text{ L}} \Rightarrow 0.308 \text{ M NaOH in the bottle.}$$

Problem 2

(a) The equivalence point is where moles acid = moles base;

$$\frac{0.1 \text{ Moles NaOH}}{\text{L}} \cdot 450 \text{ mL} = \cancel{\text{X moles A}} \cdot 0.295\text{g} \cdot \frac{\text{X moles}}{1\text{g}}$$

implies a molar weight of 73.759/mol

(b) We see that

$$HA + H_2O \leftrightharpoons A^- + H_3O^+ \; ; \; K_a = X$$

The 30 ml of 0.1 M NaOH provides

$$\frac{0.1 \text{ moles } OH^-}{1\text{L}} \cdot \frac{1\text{L}}{1000 \text{ ml}} \cdot 30\text{ml} = 0.003 \text{ moles } OH^-$$

$$pH = 5.37 = -\log\left(\frac{0.003 \text{ moles } OH^- - y \text{ moles } H_3O^+}{70 \text{ mL}}\right)$$

eventually implies $K_a = 3.28 \cdot 10^{-5}$

Problem 3

(a): Begin by writing the reaction:

$$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$$

Given $K_a = 1.74 \cdot 10^{-5}$ ~~$\Rightarrow K_b = 5.75 \cdot 10^{-10}$~~

$$1.74 \cdot 10^{-5} = \frac{(0.1-x)\ x^2}{(0.1-x)}$$

$$0.174 = x^2 \Rightarrow pH = 2.88$$

(b): By subtracting due to the 0.002 moles of OH^-,

$$pH = 4.68$$

(c): the equivalence volume is 25 ml / 25/2 = 12.5 ml

(d): Similar to (b); pH = 4.76