AP Acids and Bases 8 -- TITRATIONS

A sample of HA, a weak, monoprotic acid, weighs 1.22 g. It is dissolved in enough water to make 20.0 mL of solution and titrated with 0.100 M KOH solution. After 20.0 mL of titrant was added, the pH of the solution was found to be 5.00. The experimenter found that 40.0 mL of titrant was needed to reach the equivalence point.

a) What is K_a for HA? $\{1.0 \times 10^{-5}\}$

pH = pK_a at ½ equivalence point = 5.00; $K_a = 10^{-pKa} = 10^{-5.00} = 1.0 \times 10^{-5}$

b) How many moles of HA are present in the initial sample? {0.0040 moles}

$$\frac{40.0 \text{ mL}}{} \left| \frac{1 \text{ n } A^-}{1\text{n HA}} \right. = 0.00400 \text{ n KOH}$$

$$\frac{0.00400 \text{ n KOH}}{} \left| \frac{1 \text{ n HX}}{1\text{n KOH}} \right. = 0.00400 \text{ n HX}$$

c) What is the volume of the solution at the equivalence point? {60.0 mL}

20.0 mL + 40.0 mL

d) What is the molarity of A^- at the equivalence point? {0.0667 M}

$$\frac{0.00400 \text{ n HA}}{} \left| \frac{1 \text{ n } A^-}{1\text{n HA}} \right. = 0.00400 \text{ n } A^-$$

$$\frac{0.00400 \text{ n } A^-}{60.0 \text{ mL}} \left| \frac{1000 \text{ mL}}{1\text{L}} \right. = 0.0.0667 \text{ M}$$

e) What is the pH of the solution at the equivalence point? {8.91}

A^-	+	H_2O	⇆	HA	+	OH^-
0.0667				0		0
-X				+X		+X
0.0667				X		X

$$K_b = \frac{K_w}{K_a} = \frac{1 \times 10^{-14}}{1.0 \times 10^{-5}} = 1.0 \times 10^{-9}$$

$$K_b = \frac{[HA][OH^-]}{[A^-]} = 1.0 \times 10^{-9} \qquad K_b = \frac{[x][x]}{[0.0667]} = 1.0 \times 10^{-9}$$

$x = 8.16 \times 10^{-6}$

pOH = $-\log(8.16 \times 10^{-6}) = 5.09$ pH = 14.00 – 5.09 = 8.91

f) What is the molar mass of HA? {305 g/mole}

MW = g/n = 1.22 g / 0.00400 n = 305 g