Name _____ AP Chemistry

Chapter 15 HW #1: Due 12/1/15 Complete both free response questions. One will be graded. Show all work. Box and clearly label all final answers

$$CH_3NH_2(aq) + H_2O(l) \rightleftharpoons CH_3NH_3^+(aq) + OH^-(aq) \quad K_b = 4.4 \times 10^{-4}$$

Methylamine, CH_3NH_2, is a weak base that reacts with water according to the equation above. A student obtains a 50.0 mL sample of a methylamine solution and determines the pH of the solution to be 11.77.

(a) Write the expression for the equilibrium constant, K_b, for methylamine.

(b) Calculate the molar concentration of OH^- in the 50.0 mL sample of the methylamine solution.

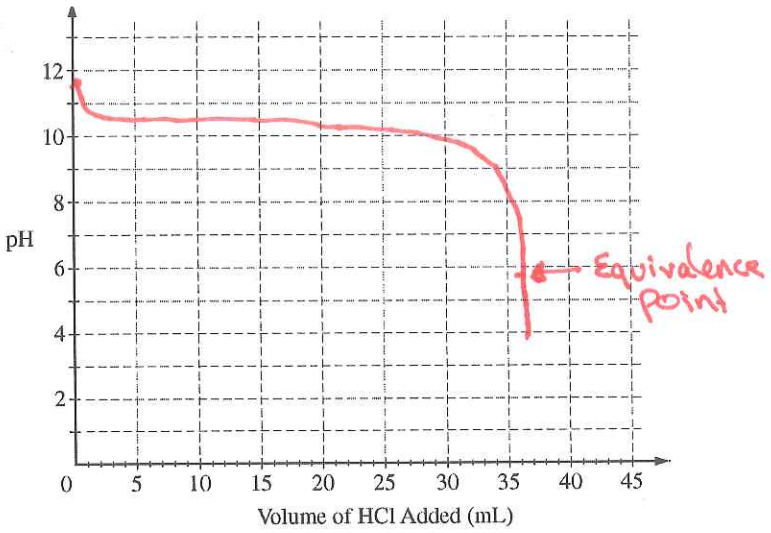
(c) Calculate the initial molar concentration of $CH_3NH_2(aq)$ in the solution before it reacted with water and equilibrium was established.

The 50.0 mL sample of the methylamine solution is titrated with an HCl solution of unknown concentration. The equivalence point of the titration is reached after a volume of 36.0 mL of the HCl solution is added. The pH of the solution at the equivalence point is 5.98.

(d) Write the net-ionic equation that represents the reaction that takes place during the titration.

(e) Calculate the concentration of the HCl solution used to titrate the methylamine.

(f) Using the axes provided, sketch the titration curve that results from the titration described above. On the graph, clearly label the equivalence point of the titration.



a. $K_b = \frac{[CH_3NH_3^+][OH^-]}{[CH_3NH_2]}$

b. $14.0 - 11.77 = 2.23$

$10^{-2.23} = \boxed{0.00589\ M}$

c. $4.4 \times 10^{-4} = \frac{[0.00589]^2}{x}$

$x = 0.0788 + 0.00589 = \boxed{0.0847}$

d. $H^+ + CH_3NH_2 \rightleftharpoons CH_3NH_3^+$

e. $0.085\ M \times 0.050 = 0.00424\ \text{moles } CH_3NH_2 = \text{mol HCl}$

$\frac{0.00424\ \text{mol HCl}}{0.036\ L\ HCl} = \boxed{0.118\ M}$

$C_6H_5NH_2(aq) + H_2O(l) \rightleftharpoons C_6H_5NH_3^+(aq) + OH^-(aq)$

Aniline, a weak base, reacts with water according to the reaction represented above.

(a) Write the equilibrium constant expression, K_b, for the reaction represented above.

(b) A sample of aniline is dissolved in water to produce 25.0 mL of a 0.10 *M* solution. The pH of the solution is 8.82. Calculate the equilibrium constant, K_b, for this reaction.

(c) The solution prepared in part (b) is titrated with 0.10 *M* HCl. Calculate the pH of the solution when 5.0 mL of the acid has been added.

(d) Calculate the pH at the equivalence point of the titration in part (c).

(e) The pK_a values for several indicators are given below. Which of the indicators listed is most suitable for this titration? Justify your answer.

Indicator	p*Ka*
Erythrosine	3
Litmus	7
Thymolphthalein	10

a. $K_b = \frac{[C_6H_5NH_3^+][OH^-]}{[C_6H_5NH_2]}$

b. $14 - 8.82 = 5.18$

$10^{-5.18} = 6.61 \times 10^{-6}$

no ICE table needed b/c $[OH^-]$ is very low

$K_b = \frac{[6.61 \times 10^{-6}]^2}{[0.100]}$

$K_b = 4.37 \times 10^{-10}$

c.

	H^+	$C_6H_5NH_2$	$\rightleftharpoons$	$C_6H_5NH_3^+$	+	OH^-
In	0.10	0.10				
Init	5	25				
Init	.5	2.5				
C	$-x$	$-x$				
Equil	$\emptyset$	2.0		0.50		
Equil		30		30		
Eq		0.0667		0.0167		

$4.37 \times 10^{-10} = \frac{[0.0167][OH^-]}{[0.0667]}$

$[OH^-] = 1.75 \times 10^{-9}$

$pOH = 8.76$

$pH = 5.24$

d.

	H^+	$C_6H_5NH_2$	$\rightleftharpoons$	$C_6H_5NH_3^+$	+	OH^-
In	0.10	0.10				
Init	25	25				
Init	2.5	2.5				
C	$-x$	$-x$				$+x$
Equil	$\emptyset$	$\emptyset$				2.5
Equil						50
Eq						0.050

$C_6H_5NH_3^+ + H_2O \rightleftharpoons C_6H_5NH_2 + H_3O^+$

$K_w = K_a \cdot K_b$

$1 \times 10^{-14} = K_a \cdot 4.37 \times 10^{-10}$

$K_a = 2.29 \times 10^{-5}$

$2.29 \times 10^{-5} = \frac{x^2}{0.050}$

$x = 0.00107$

$pH = 2.97$

e. Erythrosine b/c its pka is closest to the pH at the equivalence point.