Quiz Free Response Practice (2009B, #1, 11 points)

A pure 14.85 g sample of the weak base ethylamine, $C_2H_5NH_2$, is dissolved in enough distilled water to make 500. mL of solution.

(a) Calculate the molar concentration of the $C_2H_5NH_2$ in the solution. (2 points)

$$14.85\ g\ C_2H_5NH_2 \times \frac{1\ mol}{45.086\ g} = 0.32937...\ mol\ C_2H_5NH_2$$] 1 pt

$$[C_2H_5NH_2] = \frac{0.032937\ mol}{0.500\ L} = \boxed{0.659\ M}$$ ← 1 pt

(b) Write an equation showing how the aqueous ethylamine reacts with water. (1 point)

$$C_2H_5NH_2(aq) + H_2O(\ell) \rightleftharpoons C_2H_5NH_3^+(aq) + OH^-(aq)$$

(c) Write the equilibrium-constant expression for the reaction between $C_2H_5NH_2$(aq) and water. (1 point)

$$K_b = \frac{[C_2H_5NH_3^+][OH^-]}{[C_2H_5NH_2]}$$

(d) Of $C_2H_5NH_2$(aq) and $C_2H_5NH_3^+$ (aq), which is present in the solution at the higher concentration at equilibrium? Justify your answer. (1 point)

$$[C_2H_5NH_2]_{eq} > [C_2H_5NH_3^+]_{eq}$$

↑ weak base, therefore $K_b < 1$, so $C_2H_5NH_2$ only partially dissociates

⇒ more weak base than conjugate acid at equilibrium

(e) A different solution is made by mixing 500. mL of 0.500 M $C_2H_5NH_2$ with 500. mL of 0.200 M HCl. Assume that volumes are additive. The pH of the resulting solution is found to be 10.93.

a. Calculate the concentration of $OH^-(aq)$ in the solution. (1 point)

$pOH = 14 - pH = 14 - 10.93 = 3.07$

$[OH^-] = 10^{-pOH} = 10^{-3.07} = 8.5 \times 10^{-4}\ M$

b. Write the net-ionic equation that represents the reaction that occurs when the $C_2H_5NH_2$ solution is mixed with the HCl solution. (1 point)

$C_2H_5NH_2(aq) + H^+(aq) \rightarrow C_2H_5NH_3^+(aq) + H_2O(l)$

net ionic!

$C_2H_5NH_2(aq) + HCl(aq) \rightarrow C_2H_5NH_3^+(aq) + H_2O(l)$

weak base; strong acid; full eqt'n (not needed)

c. Calculate the molar concentration of the $C_2H_5NH_3^+$ (aq) that is formed in the reaction. (2 points)

not needed (yet!)
this will be more applicable in Unit 8 (oops!)

d. Calculate the value of K_b for $C_2H_5NH_2$. (2 points)