Free Response Practice

(1980)1) Methylamine, CH_3NH_2, is a weak base that ionizes in solution as shown by the following equation.

$$CH_3NH_2 + H_2O <===> CH_3NH_3^+ + OH^-$$

(a) At 25 °C, the percentage ionization in a 0.160-molar solution of CH_3NH_2 is 4.7%. Calculate $[OH^-]$, $[CH_3NH_3^+]$, $[CH_3NH_2]$, $[H_3O^+]$, and the pH of a 0.160-molar solution of CH_3NH_2 at 25 °C.

(b) Calculate the value for K_b, the ionization constant for CH_3NH_2, at 25 °C.

(1982) 1) A buffer solution contains 0.40 mole of formic acid, HCOOH, and 0.60 mole of sodium formate, HCOONa, in 1.00 liter of solution. The ionization constant, K_a, of formic acid is 1.8×10^{-4}

(a) Calculate the pH of this solution.

(b) If 100. milliliters of this buffer solution is diluted to a volume of 1.00 liter with pure water, the pH does not change. Discuss why the pH remains constant on dilution.

(c) A 5.00-milliliter sample of 1.00-molar HCl is added to 100. milliliters of the original buffer solution. Calculate the $[H_3O^+]$ of the resulting solution.

(d) A 800-milliliter sample of 2.00-molar formic acid is mixed with 200. milliliters of 4.80-molar NaOH. Calculate the $[H_3O^+]$ of the resulting solution.

(1986) 2) In water, hydrazoic acid, HN_3, is a weak acid that has an equilibrium constant, K_a, equal to 2.8×10^{-5} at 25 °C. A 0.300-liter sample of a 0.050-molar solution of the acid is prepared.

(a) Write the expression for the equilibrium constant, K_a, for hydrazoic acid.

(b) Calculate the pH of this solution at 25 °C.

(c) To 0.150 liter of this solution, 0.80 gram of sodium azide, NaN_3, is added. The salt dissolves completely. Calculate the pH of the resulting solution at 25 °C if the volume of the solution remains unchanged.

(d) To the remaining 0.150 liter of the original solution, 0.075 liter of 0.100-molar NaOH solution is added. Calculate the $[OH^-]$ for the resulting solution at 25 °C.

(1991)1) The acid ionization constant, K_a, for propanoic acid, C_2H_5COOH, is 1.3×10^{-5}.

(a) Calculate the hydrogen ion concentration, $[H^+]$, in a 0.20-molar solution of propanoic acid.

(b) Calculate the percentage of propanoic acid molecules that are ionized in the solution in (a).

(c) What is the ratio of the concentration of propanoate ion, $C_2H_5COO^-$, to that of propanoic acid in a buffer solution with a pH of 5.20 ?

(d) In a 100-milliliter sample of a different buffer solution, the propanoic acid concentration is 0.50-molar and the sodium propanoate concentration is 0.50-molar. To this buffer solution, 0.0040 mole of solid NaOH is added. Calculate the pH of the resulting solution.