NMSI Super Problem: Buffers and Titrations

$$NH_3(aq) + H_2O(\ell) \rightleftharpoons NH_4^+(aq) + OH^-(aq) \qquad K_b = 1.80 \times 10^{-5}$$

Ammonia reacts with water as indicated in the reaction above.

a. Write the equilibrium constant expression for the reaction represented above.

b. Calculate the pH of a 0.150 *M* solution of NH_3

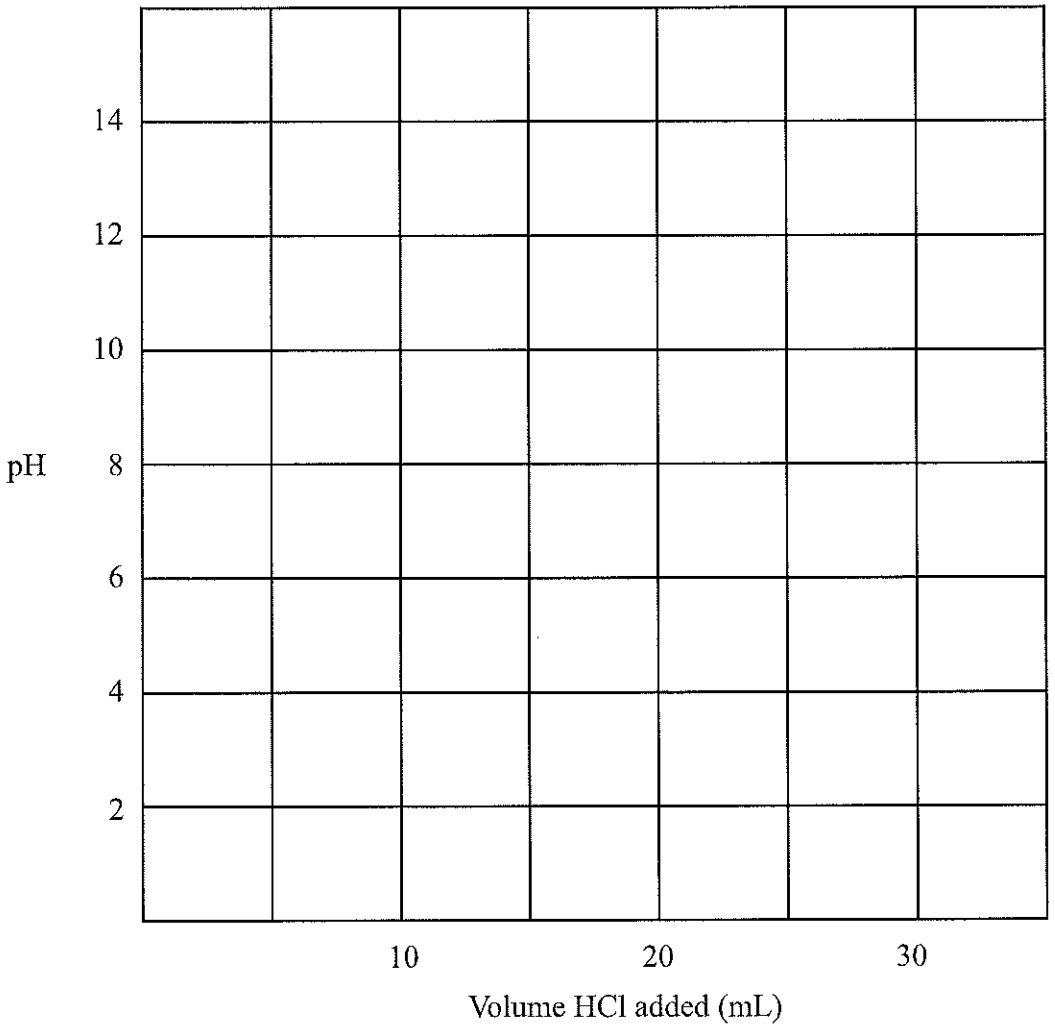
A 20 mL sample of the 0.150 *M* solution of NH_3 is titrated with 0.100 *M* HCl

c. Determine the volume of HCl required to reach the equivalence point.

d. Calculate the pH of the solution after the addition of 15 mL of HCl.

e. Calculate the pH of the solution at the equivalence point of the titration.

f. Using the axes provided below, sketch the titration curve that would result if the student had used 0.200 *M* HCl instead of the 0.100 *M* used above, to perform the titration. The equivalence point must be clearly marked.



When ammonia is reacted with methanol with a specific catalyst, the colorless gas methylamine (along with dimethyamine and trimethlyamine) can be produced. While trimethylamine is the favored product, adjusting the reactant ratios can help alter the amount of the three 'amines' produced. The process is complex but is used to industrially produce methylamine – which is listed as a controlled substance by the US Drug Enforcement Agency, because of its uses in the production of methamphetamine.

$$CH_3OH + NH_3 \rightarrow CH_3NH_2 + H_2O$$

When methylamine is isolated and dissolved in water it acts as a weak base according to the reaction below.

$$CH_3NH_2 + H_2O \rightleftharpoons CH_3NH_3^+ + OH^- \qquad K_b = 4.40 \times 10^{-4}$$

The methylamine above was dissolved in 150 mL of water, resulting in a solution had a methylamine concentration of 0.150 *M*.

g. Calculate the pH of the methylamine solution

h. To the above solution of methylamine, 0.120 mole of methylammonium chloride was added. Calculate the pH of the solution after the addition of the methylammonium chloride, CH_3NH_3Cl.