YOU MAY USE YOUR CALCULATOR FOR PART A.

CLEARLY SHOW THE METHOD USED AND THE STEPS INVOLVED IN ARRIVING AT YOUR ANSWERS. It is to your advantage to do this, since you may obtain partial credit if you do and you will receive little or no credit if you do not. Attention should be paid to significant figures. Be sure to write all your answers to the questions on the lined pages following each question in this booklet.

Answer Questions 1, 2, and 3. The Section II score weighting for each question is 20 percent.

1. A 1.22 g sample of a pure monoprotic acid, HA, was dissolved in distilled water. The HA solution was then titrated with 0.250 *M* NaOH. The pH was measured throughout the titration, and the equivalence point was reached when 40.0 mL of the NaOH solution had been added. The data from the titration are recorded in the table below.

Volume of 0.250 *M* NaOH Added (mL)	pH of Titrated Solution
0.00	?
10.0	3.72
20.0	4.20
30.0	?
40.0	8.62
50.0	12.40

(a) Explain how the data in the table above provide evidence that HA is a weak acid rather than a strong acid.

(b) Write the balanced net-ionic equation for the reaction that occurs when the solution of NaOH is added to the solution of HA.

(c) Calculate the number of moles of HA that were titrated.

(d) Calculate the molar mass of HA.

The equation for the dissociation reaction of HA in water is shown below.

$$HA(aq) + H_2O(l) \rightleftarrows H_3O^+(aq) + A^-(aq) \qquad K_a = 6.3 \times 10^{-5}$$

(e) Assume that the initial concentration of the HA solution (before any NaOH solution was added) is 0.200 *M*. Determine the pH of the initial HA solution.

(f) Calculate the value of $[H_3O^+]$ in the solution after 30.0 mL of NaOH solution is added and the total volume of the solution is 80.0 mL.

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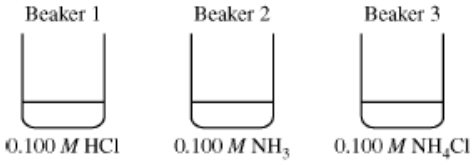

1. Each of three beakers contains 25.0 mL of a 0.100 *M* solution of HCl, NH_3, or NH_4Cl, as shown above. Each solution is at 25°C.

   (a) Determine the pH of the solution in beaker 1. Justify your answer.

   (b) In beaker 2, the reaction $NH_3(aq) + H_2O(l) \rightleftarrows NH_4^+(aq) + OH^-(aq)$ occurs. The value of K_b for $NH_3(aq)$ is 1.8×10^{-5} at 25°C.

      (i) Write the K_b expression for the reaction of $NH_3(aq)$ with $H_2O(l)$.

      (ii) Calculate the $[OH^-]$ in the solution in beaker 2.

   (c) In beaker 3, the reaction $NH_4^+(aq) + H_2O(l) \rightleftarrows NH_3(aq) + H_3O^+(aq)$ occurs.

      (i) Calculate the value of K_a for $NH_4^+(aq)$ at 25°C.

      (ii) The contents of beaker 2 are poured into beaker 3 and the resulting solution is stirred. Assume that volumes are additive. Calculate the pH of the resulting solution.

   (d) The contents of beaker 1 are poured into the solution made in part (c)(ii). The resulting solution is stirred. Assume that volumes are additive.

      (i) Is the resulting solution an effective buffer? Justify your answer.

      (ii) Calculate the final $[NH_4^+]$ in the resulting solution at 25°C.