

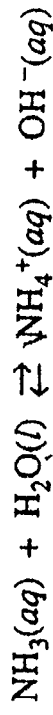
1. The acid ionization constant,  $K_a$ , for propanoic acid,  $C_2H_5COOH$ , is  $1.3 \times 10^{-5}$ .
- Calculate the hydrogen ion concentration,  $[H^+]$ , in a 0.20-molar solution of propanoic acid.
  - Calculate the percentage of propanoic acid molecules that are ionized in the solution in (a).



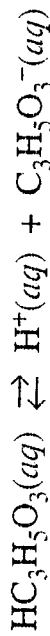
1. Methylamine,  $CH_3NH_2$ , is a weak base that reacts according to the equation above. The value of the ionization constant,  $K_b$ , is  $5.25 \times 10^{-4}$ . Methylamine forms salts such as methylammonium nitrate,  $(CH_3NH_3^+)(NO_3^-)$ .
- Calculate the hydroxide ion concentration,  $[OH^-]$ , of a 0.225-molar aqueous solution of methylamine.

7. A chemical reaction occurs when 100. milliliters of 0.200-molar  $HCl$  is added dropwise to 100. milliliters of 0.100-molar  $Na_3PO_4$  solution.

- Write the two net ionic equations for the formation of the major products.
- Identify the species that acts as both a Brønsted acid and as a Brønsted base in the equations in (a). Draw the Lewis electron-dot diagram for this species.



1. In aqueous solution, ammonia reacts as represented above. In 0.0180 M  $\text{NH}_3(aq)$  at 25°C, the hydroxide ion concentration,  $[\text{OH}^-]$ , is  $5.60 \times 10^{-4}$  M. In answering the following, assume that temperature is constant at 25°C and that volumes are additive.
  - (a) Write the equilibrium-constant expression for the reaction represented above.
  - (b) Determine the pH of 0.0180 M  $\text{NH}_3(aq)$ .
  - (c) Determine the value of the base ionization constant,  $K_b$ , for  $\text{NH}_3(aq)$ .
  - (d) Determine the percent ionization of  $\text{NH}_3$  in 0.0180 M  $\text{NH}_3(aq)$ .
  
8. Give a brief explanation for each of the following.
  - (a) For the diprotic acid  $\text{H}_2\text{S}$ , the first dissociation constant is larger than the second dissociation constant by about  $10^5$  ( $K_1 \approx 10^5 K_2$ ).
  - (b) In water,  $\text{NaOH}$  is a base but  $\text{HOCl}$  is an acid.
  - (c)  $\text{HCl}$  and  $\text{HI}$  are equally strong acids in water but, in pure acetic acid,  $\text{HI}$  is a stronger acid than  $\text{HCl}$ .
  - (d) When each is dissolved in water,  $\text{HCl}$  is a much stronger acid than  $\text{HF}$ .



1. Lactic acid,  $\text{HC}_3\text{H}_5\text{O}_3$ , is a monoprotic acid that dissociates in aqueous solution, as represented by the equation above. Lactic acid is 1.66 percent dissociated in 0.50 M  $\text{HC}_3\text{H}_5\text{O}_3(\text{aq})$  at 298 K. For parts (a) through (d) below, assume the temperature remains at 298 K.

(a) Write the expression for the acid-dissociation constant,  $K_a$ , for lactic acid and calculate its value.

(b) Calculate the pH of 0.50 M  $\text{HC}_3\text{H}_5\text{O}_3$ .



1. Hypobromous acid, HOBr, is a weak acid that dissociates in water, as represented by the equation above.

(a) Calculate the value of  $[\text{H}^+]$  in an HOBr solution that has a pH of 4.95.

(b) Write the equilibrium constant expression for the ionization of HOBr in water, then calculate the concentration of HOBr(aq) in an HOBr solution that has  $[\text{H}^+]$  equal to  $1.8 \times 10^{-5}$  M.

(c) HOBr is a weaker acid than  $\text{HBrO}_3$ . Account for this fact in terms of molecular structure.

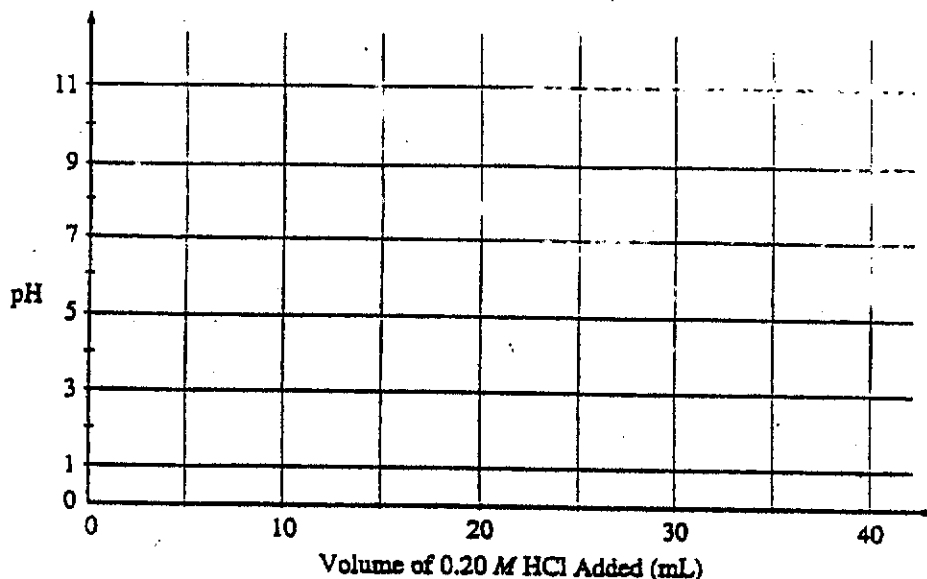
Part A  
(20 percent)

Solve the following problem.

1. The acid ionization constant,  $K_a$ , for propanoic acid,  $C_2H_5COOH$ , is  $1.3 \times 10^{-5}$ .
  - (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 0.35-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.

- ACID / BASE
8. A volume of 30.0 mL of 0.10 M  $NH_3(aq)$  is titrated with 0.20 M  $HCl(aq)$ . The value of the base-dissociation constant,  $K_b$ , for  $NH_3$  in water is  $1.8 \times 10^{-5}$  at 25°C.

- (a) Write the net-ionic equation for the reaction of  $NH_3(aq)$  with  $HCl(aq)$ .
- (b) Using the axes provided below, sketch the titration curve that results when a total of 40.0 mL of 0.20 M  $HCl(aq)$  is added dropwise to the 30.0 mL volume of 0.10 M  $NH_3(aq)$ .



- (c) From the table below, select the most appropriate indicator for the titration. Justify your choice.

Indicator	$pK_a$
Methyl Red	5.5
Bromothymol Blue	7.1
Phenolphthalein	8.7

- (d) If equal volumes of 0.10 M  $NH_3(aq)$  and 0.10 M  $NH_4Cl(aq)$  are mixed, is the resulting solution acidic, neutral, or basic? Explain.