532. The $[H_3O^+]$ of a solution of acetoacetic acid, CH_3COCH_2COOH, is 4.38×10^{-3} M at 25°C. The concentration of nonionized acid is 0.0731 M at equilibrium. Calculate K_a for acetoacetic acid at 25°C.

533. The K_a of 2-chloropropanoic acid, $CH_3CHClCOOH$, is 1.48×10^{-3}. Calculate the $[H_3O^+]$ and the pH of a 0.116 M solution of 2-chloropropionic acid. Let $x = [H_3O^+]$. The degree of ionization of the acid is too large to ignore. If your set up is correct, you will have a quadratic equation to solve.

534. Sulfuric acid ionizes in two steps in water solution. For the first ionization shown in the following equation, the K_a is so large that in moderately dilute solution the ionization can be considered 100%.

$$H_2SO_4 + H_2O \rightarrow H_3O^+ + HSO_4^-$$

The second ionization is fairly strong, and $K_a = 1.3 \times 10^{-2}$:

$$HSO_4^- + H_2O \rightleftarrows H_3O^+ + SO_4^{2-}$$

Calculate the total $[H_3O^+]$ and pH of a 0.0788 M H_2SO_4 solution. Hint: If the first ionization is 100%, what will $[HSO_4^-]$ and $[H_3O^+]$ be? Remember to account for the already existing concentration of H_3O^+ in the second ionization. Let $x = [SO_4^{2-}]$.

535. The hydronium ion concentration of a 0.100 M solution of cyanic acid, HOCN, is found to be 5.74×10^{-3} M at 25°C. Calculate the ionization constant of cyanic acid. What is the pH of this solution?

536. A solution of hydrogen cyanide, HCN, has a 0.025 M concentration. The cyanide ion concentration is found to be 3.16×10^{-6} M.

a. What is the hydronium ion concentration of this solution?
b. What is the pH of this solution?
c. What is the concentration of nonionized HCN in the solution? Be sure to use the correct number of significant figures.
d. Calculate the ionization constant of HCN.
e. How would you characterize the strength of HCN as an acid?
f. Determine the $[H_3O^+]$ for a 0.085 M solution of HCN.

537. A 1.20 M solution of dichloroacetic acid, CCl_2HCOOH, at 25°C has a hydronium ion concentration of 0.182 M.

a. What is the pH of this solution?
b. What is the K_a of dichloroacetic acid at 25°C?
c. What is the concentration of nonionized dichloroacetic acid in this solution?
d. What can you say about the strength of dichloroacetic acid?

538. Phenol, C_6H_5OH, is a very weak acid. The pH of a 0.215 M solution of phenol at 25°C is found to be 5.61. Calculate the K_a for phenol.

539. A solution of the simplest amino acid, glycine (NH_2CH_2COOH), is prepared by dissolving 3.75 g in 250.0 mL of water at 25°C. The pH of this solution is found to be 0.890.

a. Calculate the molarity of the glycine solution.
b. Calculate the K_a for glycine.

540. Trimethylamine, $(CH_3)_3N$, dissociates in water the same way that NH_3 does—by accepting a proton from a water molecule. The $[OH^-]$ of a 0.0750 M solution of trimethylamine at 25°C is 2.32×10^{-3} M. Calculate the pH of this solution and the K_b of trimethylamine.

541. Dimethylamine, $(CH_3)_2NH$, is a weak base similar to the trimethylamine in item 540. A 5.00×10^{-3} M solution of dimethylamine has a pH of 11.20 at 25°C. Calculate the K_b of dimethylamine. Compare this K_b with the K_b for trimethylamine that you calculated in item 540. Which substance is the stronger base?

542. Hydrazine dissociates in water solution according to the following equations:

$$H_2NNH_2 + H_2O(l) \rightleftarrows H_2NNH_3^+(aq) + OH^-(aq)$$
$$H_2NNH_3^+(aq) + H_2O(l) \rightleftarrows H_3NNH_3^{2+}(aq) + OH^-(aq)$$

The K_b of this second dissociation is 8.9×10^{-16}, so it contributes almost no hydroxide ions in solution and can be ignored here.

a. The pH of a 0.120 M solution of hydrazine at 25°C is 10.50. Calculate K_b for the first ionization of hydrazine. Assume that the original concentration of H_2NNH_2 does not change.
b. Make the same assumption as you did in (a) and calculate the $[OH^-]$ of a 0.020 M solution.
c. Calculate the pH of the solution in (b).

Equilibrium of Salts, K_{sp}: Chap. 18, Sec. 4

543. Silver bromate, $AgBrO_3$, is slightly soluble in water. A saturated solution is found to contain 0.276 g $AgBrO_3$ dissolved in 150.0 mL of water. Calculate K_{sp} for silver bromate.

544. 2.50 L of a saturated solution of calcium fluoride leaves a residue of 0.0427 g of CaF_2 when evaporated to dryness. Calculate the K_{sp} of CaF_2.

545. The K_{sp} of calcium sulfate, $CaSO_4$, is 9.1×10^{-6}. What is the molar concentration of $CaSO_4$ in a saturated solution?

546. A salt has the formula X_2Y, and its K_{sp} is 4.25×10^{-7}.

a. What is the molarity of a saturated solution of the salt?
b. What is the molarity of a solution of AZ if its K_{sp} is the same value?

In each of the following problems, include the calculated ion product with your answer.

547. Will a precipitate of $Ca(OH)_2$ form when 320. mL of a 0.046 M solution of NaOH mixes with 400. mL of a 0.085 M $CaCl_2$ solution? K_{sp} of $Ca(OH)_2$ is 5.5×10^{-6}.

548. 20.00 mL of a 0.077 M solution of silver nitrate, $AgNO_3$, is mixed with 30.00 mL of a 0.043 M solution of sodium acetate, $NaC_2H_3O_2$. Does a precipitate form? The K_{sp} of $AgC_2H_3O_2$ is 2.5×10^{-3}.

549. If you mix 100. mL of 0.036 M $Pb(C_2H_3O_2)_2$ with 50. mL of 0.074 M NaCl, will a precipitate of $PbCl_2$ form? The K_{sp} of $PbCl_2$ is 1.9×10^{-4}.