

CHAPTER EIGHT

pH Problems

8.42 The pH of a 0.0642 *M* solution of a monoprotic acid is 3.86. Is this a strong acid?

8.43 Calculate the pH of a 0.20 *M* ammonium acetate (CH₃COONH₄) solution.

8.44 The ion product of D₂O is 1.35 × 10⁻¹⁵ at 25°C. (a) Calculate pD where pD = -log [D⁺]. (b) For what values of pD will a solution be acidic in D₂O? (c) Derive a relation between pD and pOD.

8.45 What is the pH of 250.0 mL of an aqueous solution containing 0.616 g of the strong acid trifluoromethane sulfonic acid (CF₃SO₃H)?

8.46 When the concentration of a strong acid is not substantially higher than 1.0 × 10⁻⁷ *M*, the ionization of water must be taken into account in the calculation of the solution's pH. (a) Derive an expression for the pH of a strong acid solution, including the contribution to [H⁺] from H₂O. (b) Calculate the pH of a 1.0 × 10⁻⁷ *M* HCl solution.

8.47 Calculate the pH of a 1-L solution containing 0.150 mole of CH₃COOH and 0.100 mole of HCl.

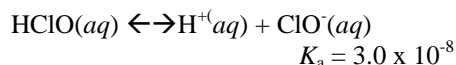
8.48 A 1.87-g sample of Mg reacts with 80.0 mL of a HCl solution whose pH is -0.544. What is the pH of the solution after all the Mg has reacted? Assume constant volume.

8.49 You are given two beakers, one containing an aqueous solution of strong acid (HA) and the other an aqueous solution of weak acid (HB) of the same concentration. Describe how you would compare the strengths of these two acids by (a) measuring the pH, (b) measuring electrical conductance, (c) studying the rate of hydrogen gas evolution when these solutions are reacted with an active metal such as Mg or Zn.

8.50 Calcium hypochlorite [Ca(OCl)₂] is used as a disinfectant for swimming pools. When dissolved in water it produces hypochlorous acid

$$\text{Ca(OCl)}_2(s) + 2\text{H}_2\text{O}(l) \rightleftharpoons 2\text{HClO}(aq) + \text{Ca(OH)}_2(s)$$

which ionizes as follows:



As strong oxidizing agents, both HClO and ClO⁻ can kill bacteria by destroying their cellular components. However, too high a HClO concentration is irritating to the eyes of swimmers and too high a concentration of ClO⁻ will cause the ions to decompose in sunlight. The recommended pH for pool water is 7.8. Calculate the percent of these species present at this pH.

8.51 About half of the hydrochloric acid produced annually in the United States (3.0 billion pounds) is used in metal pickling. This process involves the removal of metal oxide layers from metal surfaces to prepare them for coating. (a) Write the overall and net ionic equations for the reaction between iron(III) oxide, which represents the rust layer over iron, and HCl. Identify the Brønsted acid and base. (b) Hydrochloric acid is also used to remove scale (which is mostly CaCO₃) from water pipes (see p. 112). Hydrochloric acid reacts with calcium carbonate in two stages; the first stage forms the bicarbonate ion, which then reacts further to form carbon dioxide. Write equations for these two stages and for the overall reaction. (c) Hydrochloric acid is used to recover oil from the ground. It dissolves rocks (often CaCO₃) so that the oil can flow more easily. In one process, a 15 percent (by mass) HCl solution is injected into an oil well to dissolve the rocks. If the density of the acid solution is 1.073 g/mL, what is the pH of the solution?