29. Identify each substance as an acid or a base and write a chemical equation showing how it is an acid or a base according to the Arrhenius definition.
(a) $H_2SO_4(aq)$
(b) $Sr(OH)_2(aq)$
(c) $HBr(aq)$
(d) $NaOH(aq)$

31. For each reaction, identify the Brønsted–Lowry acid, the Brønsted–Lowry base, the conjugate acid, and the conjugate base.
(a) $HBr(aq) + H_2O(l) \longrightarrow H_3O^+(aq) + Br^-(aq)$
(b) $NH_3(aq) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$
(c) $HNO_3(aq) + H_2O(l) \longrightarrow H_3O^+(aq) + NO_3^-(aq)$
(d) $C_5H_5N(aq) + H_2O(l) \rightleftharpoons C_5H_5NH^+(aq) + OH^-(aq)$

33. Determine whether each pair is a conjugate acid–base pair.
(a) NH_3, NH_4^+
(b) HCl, HBr
(c) $C_2H_3O_2^-$, $HC_2H_3O_2$
(d) HCO_3^-, NO_3^-

35. Write the formula for the conjugate base of each acid.
(a) HCl
(b) H_2SO_3
(c) $HCHO_2$
(d) HF

37. Write the formula for the conjugate acid of each base.
(a) NH_3
(b) ClO_4^-
(c) HSO_4^-
(d) CO_3^{2-}

39. Write a neutralization reaction for each acid and base pair.
(a) $HI(aq)$ and $NaOH(aq)$
(b) $HBr(aq)$ and $KOH(aq)$
(c) $HNO_3(aq)$ and $Ba(OH)_2(aq)$
(d) $HClO_4(aq)$ and $Sr(OH)_2(aq)$

41. Write a balanced chemical equation showing how each metal reacts with HBr.
(a) Rb
(b) Mg
(c) Ba
(d) Al

43. Write a balanced chemical equation showing how each metal oxide reacts with HI.
(a) MgO
(b) K_2O
(c) Rb_2O
(d) CaO

45. Predict the products of each reaction.
(a) $HClO_4(aq) + Fe_2O_3(s) \longrightarrow$
(b) $H_2SO_4(aq) + Sr(s) \longrightarrow$
(c) $H_3PO_4(aq) + KOH(aq) \longrightarrow$

47. Four solutions of unknown HCl concentration are titrated with solutions of NaOH. The following table lists the volume of each unknown HCl solution, the volume of NaOH solution required to reach the equivalence point, and the concentration of each NaOH solution. Calculate the concentration (in M) of the unknown HCl solution in each case.

HCl Volume (mL)	NaOH Volume (mL)	[NaOH] (M)
(a) 25.00 mL	28.44 mL	0.1231 M
(b) 15.00 mL	21.22 mL	0.0972 M
(c) 20.00 mL	14.88 mL	0.1178 M
(d) 5.00 mL	6.88 mL	0.1325 M

49. A 25.00-mL sample of an H_2SO_4 solution of unknown concentration is titrated with a 0.1322 M KOH solution. A volume of 41.22 mL of KOH is required to reach the equivalence point. What is the concentration of the unknown H_2SO_4 solution?

53. Classify each acid as strong or weak.
(a) HCl
(b) HF
(c) HBr
(d) H_2SO_3

55. Determine $[H_3O^+]$ in each acid solution. If the acid is weak, indicate the value that $[H_3O^+]$ is less than.
(a) 1.7 M HBr
(b) 1.5 M HNO_3
(c) 0.38 M H_2CO_3
(d) 1.75 M $HCHO_2$

57. Classify each base as strong or weak.
(a) LiOH
(b) NH_4OH
(c) $Ca(OH)_2$
(d) NH_3

59. Determine $[OH^-]$ in each base solution. If the acid is weak, indicate the value that $[OH^-]$ is less than.
(a) 0.25 M NaOH
(b) 0.25 M NH_3
(c) 0.25 M $Sr(OH)_2$
(d) 1.25 M KOH

63. Calculate $[OH^-]$ given $[H_3O^+]$ in each aqueous solution and classify the solution as acidic or basic.
(a) $[H_3O^+] = 1.5 \times 10^{-9}$ M
(b) $[H_3O^+] = 9.3 \times 10^{-9}$ M
(c) $[H_3O^+] = 2.2 \times 10^{-6}$ M
(d) $[H_3O^+] = 7.4 \times 10^{-4}$ M

65. Calculate $[H_3O^+]$ given $[OH^-]$ in each aqueous solution and classify each solution as acidic or basic.
(a) $[OH^-] = 2.7 \times 10^{-12}$ M
(b) $[OH^-] = 2.5 \times 10^{-2}$ M
(c) $[OH^-] = 1.1 \times 10^{-10}$ M
(d) $[OH^-] = 3.3 \times 10^{-4}$ M

67. Classify each solution as acidic, basic, or neutral according to its pH value.
(a) pH = 8.0
(b) pH = 7.0
(c) pH = 3.5
(d) pH = 6.1

69. Calculate the pH of each solution.
(a) $[H_3O^+] = 1.7 \times 10^{-8}$ M
(b) $[H_3O^+] = 1.0 \times 10^{-7}$ M
(c) $[H_3O^+] = 2.2 \times 10^{-6}$ M
(d) $[H_3O^+] = 7.4 \times 10^{-4}$ M

71. Calculate $[H_3O^+]$ for each solution.
(a) pH = 8.55
(b) pH = 11.23
(c) pH = 2.87
(d) pH = 1.22

73. Calculate the pH of each solution.
(a) $[OH^-] = 1.9 \times 10^{-7}$ M
(b) $[OH^-] = 2.6 \times 10^{-8}$ M
(c) $[OH^-] = 7.2 \times 10^{-11}$ M
(d) $[OH^-] = 9.5 \times 10^{-2}$ M

75. Calculate $[OH^-]$ for each solution.
(a) pH = 4.25
(b) pH = 12.53
(c) pH = 1.50
(d) pH = 8.25

77. Calculate the pH of each solution:
(a) 0.0155 M HBr
(b) 1.28×10^{-3} M KOH
(c) 1.89×10^{-3} M HNO_3
(d) 1.54×10^{-4} M $Sr(OH)_2$

79. Detemine the pOH of each solution and classify it as acidic, basic, or neutral.
(a) $[OH^-] = 1.5 \times 10^{-9}$ M
(b) $[OH^-] = 7.0 \times 10^{-5}$ M
(c) $[OH^-] = 1.0 \times 10^{-7}$ M
(d) $[OH^-] = 8.8 \times 10^{-3}$ M

81. Determine the pOH of each solution.
(a) $[H_3O^+] = 1.2 \times 10^{-8}$ M
(b) $[H_3O^+] = 5.5 \times 10^{-2}$ M
(c) $[H_3O^+] = 3.9 \times 10^{-9}$ M
(d) $[H_3O^+] = 1.88 \times 10^{-13}$ M

83. Determine the pH of each solution and classify it as acidic, basic, or neutral.
(a) pOH = 8.5
(b) pOH = 4.2
(c) pOH = 1.7
(d) pOH = 7.0

85. Determine whether or not each mixture is a buffer.
(a) HCl and HF
(b) NaOH and NH_3
(c) HF and NaF
(d) $HC_2H_3O_2$ and $KC_2H_3O_2$

87. Write reactions showing how each of the buffers in Problem 85 would neutralize added HCl.

89. What substance could you add to each solution to make it a buffer solution?
(a) 0.100 M $NaC_2H_3O_2$
(b) 0.500 M H_3PO_4
(c) 0.200 M $HCHO_2$