

Acids and Bases

- ___ 1. The pH of a solution is 2 at 25 °C. What is the pOH of this solution? (1) 0; (2) 2; (3) 12; (4) 14.
- ___ 2. In a solution with a pH of 3 the color of (1) litmus is red; (2) litmus is blue; (3) phenolphthalein is red; (4) phenolphthalein is blue.
- ___ 3. What is the total number of moles of H⁺ ions that will neutralize 2.0 moles of OH⁻ ions? (1) 1.0; (2) 2.0; (3) 17; (4) 34.
- ___ 4. Which salt hydrolyzes in water to form a solution that is acidic? (1) KCl; (2) NH₄Cl; (3) NaCl; (4) LiCl.
- ___ 5. Which particle is amphiprotic? (1) HNO₃; (2) NO₃⁻; (3) NH₃; (4) NH₄⁺.
- ___ 6. As 50. milliliters of 0.1 M HCl is added to 100 milliliters of 0.1 M NaOH the pH of the NaOH solution (1) decreases; (2) increases; (3) remains the same.
- ___ 7. Which compound is an electrolyte? (1) C₆H₁₂O₆; (2) C₁₂H₂₂O₁₁; (3) C₂H₅OH; (4) CH₃COOH.
- ___ 8. The hydroxide ion concentration is greater than the hydronium ion concentration in a 0.1 M solution of (1) NaOH; (2) CH₃OH; (3) HNO₃; (4) H₂SO₄.
- ___ 9. What is the pH of a solution whose hydronium ion concentration is 0.0001 moles per liter? (1) 1; (2) 10; (3) 14; (4) 4.
- ___ 10. The conjugate base of the bisulfite ion is the (1) sulfide ion; (2) sulfite ion; (3) bisulfate ion; (4) sulfate ion.
- ___ 11. A weak acid (HX) has an equilibrium constant of 1.0 X 10⁻⁸. What is the pH of a 1.0 M solution of this acid? (1) 1; (2) 7; (3) 8; (4) 4.
- ___ 12. If 6 milliliters of 1M HCl is exactly neutralized by 3 milliliters of KOH then the molarity of the KOH is (1) 1M; (2) 2M; (3) 3M; (4) 9M.
- ___ 13. The pH of 0.001M HCl is (1) 1; (2) 2; (3) 3; (4) 4.
- ___ 14. NH₃ + H₂O = NH₄⁺ + OH⁻ Given the above reaction the two Bronsted acids are (1) NH₃ and H₂O; (2) NH₃ and OH⁻; (3) NH₄⁺ and H₂O; (4) NH₄⁺ and OH⁻.
- ___ 15. An organic compound whose water solution turns litmus red is (1) CH₃OH; (2) C₆H₁₂; (3) CH₃COOH; (4) C₆H₁₂O₆.
- ___ 16. Which could act as either a Bronsted acid or a Bronsted base? (1) chloride ion; (2) sulfide ion; (3) bisulfide ion; (4) carbonate ion.
- ___ 17. Which solution will be exactly neutralized by 1.0 liter of 1.0M NaOH? (1) 1.0 liter of 0.50M HCl; (2) 1.0 liter of 2.0M HCl; (3) 0.50 liter of 0.50M HCl; (4) 0.50 liter of 2.0M HCl.
- ___ 18. Which pH indicates the highest concentration of hydronium ions? (1) 1; (2) 7;

- (3) 10; (4) 14.
- ___ 19. Which 0.1M aqueous solution is the poorest conductor of electricity? (1) C_2H_5OH ; (2) HCl ; (3) H_2SO_4 ; (4) NH_3 .
- ___ 20. Which of the following 0.1 M solutions is the best conductor of electricity? (1) HNO_3 ; (2) HNO_2 ; (3) NH_3 ; (4) CH_3COOH .
- ___ 21. Which of the following is the weakest Bronsted acid? (1) HBr ; (2) HI ; (3) HCl ; (4) HF .
- ___ 22. When K_2CO_3 dissolves in water the resulting solution turn litmus paper (1) red and is acidic; (2) blue and is acidic; (3) red and is basic; (4) blue and is basic.
- ___ 23. A 30 milliliter sample of HCl is completely neutralized by 10. milliliters of a 1.5 M $NaOH$ solution. What is the molarity of the HCl solution? (1) 0.25; (2) 0.50; (3) 1.5; (4) 4.5.
- ___ 24. Which could be the pH of a solution whose hydronium ion concentration is less than the hydroxide ion concentration? (1) 9; (2) 2; (3) 3; (4) 4.
- ___ 25. A solution of which metallic ion would have an acid pH? (1) sodium; (2) aluminum; (3) potassium; (4) lithium.
- ___ 26. Which compound is the weakest electrolyte? (1) HCl ; (2) HNO_3 ; (3) H_2S ; (4) H_2SO_4 .
- ___ 27. Which hydrogen ion concentration indicates the most acidic solution? (1) $1 \times 10^{-11}M$; (2) $1 \times 10^{-9}M$; (3) $1 \times 10^{-7}M$; (4) $1 \times 10^{-5}M$.
- ___ 28. Which compound is correctly classified as a salt? (1) KNO_3 ; (2) HNO_3 ; (3) CH_3COOH ; (4) C_2H_5OH .
- ___ 29. How many milliliters of 2.0 M $NaOH$ are needed to exactly neutralize 50 mL of 2.0 M HCl ? (1) 25; (2) 50; (3) 100; (4) 200.
- ___ 30. In the reaction $H_2O + H_2O \rightleftharpoons H_3O^{1+} + OH^{1-}$ water is acting as (1) a Bronsted acid only; (2) a Bronsted base only; (3) neither a Bronsted acid nor base; (4) both a Bronsted acid and base.
- ___ 31. Which of the following combinations when dissolved in water would produce an acidic buffer? (1) KCl and $NaCl$; (2) $NaOH$ and HOH ; (3) $NaCl$ and HCl ; (4) CH_3COOH and $NaCH_3COO$.
- ___ 32. When titrating a strong acid and a weak base the stoichiometric point may have a pH of (1) 0; (2) 7; (3) 5; (4) 9.
- ___ 33. Which 0.1 molar aqueous solution contains the highest concentration of OH^{1-} ions? (1) CH_3OH ; (2) $NaOH$; (3) C_2H_5OH ; (4) NH_3 .
- ___ 34. Red litmus will turn blue when placed in an aqueous solution of (1) HCl ; (2) CH_3COOH ; (3) KOH ; (4) CH_3OH .
- ___ 35. Which ion is amphiprotic? (1) Cl^{1-} ; (2) HSO_4^{1-} ; (3) O^{2-} ; (4) NH_4^{1+} .

- ___ 36. A solution at 25 degrees Celsius with a pH of 7 contains (1) more hydronium ions than hydroxide ions; (2) fewer hydronium ions than hydroxide ions; (3) an equal number of hydronium ions and hydroxide ions; (4) no hydronium ions or hydroxide ions.
- ___ 37. Which acid is almost completely ionized in a dilute solution at 25 °C? (1) CH₃COOH; (2) H₂S; (3) H₃PO₄; (4) HNO₃.
- ___ 38. A solution of potassium carbonate would have a pH closest to (1) 1; (2) 5; (3) 3; (4) 8.
- ___ 39. How many liters of 2.5 M HCl are required to exactly neutralize 1.5 liters of 5.0 M NaOH? (1) 1.0; (2) 2.0; (3) 3.0; (4) 4.0.
- ___ 40. What are the Bronsted-Lowry bases in the following reaction:
 $\text{H}_2\text{S} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^{1+} + \text{HS}^{1-}$? (1) H₂S and H₂O; (2) H₂S and H₃O¹⁺; (3) HS¹⁻ and H₂O; (4) HS¹⁻ and H₃O¹⁺.
- ___ 41. When additional solid NaCl dissolves in a solution of NaCl in water the pH of the solution (1) decreases; (2) increases; (3) remains the same.
- ___ 42. When hydrochloric acid is neutralized by sodium hydroxide then the salt formed is sodium (1) hydrochlorate; (2) chlorate; (3) chloride; (4) perchloride.
- ___ 43. The ionization constant of 1.8×10^{-5} is for a weak acid. A reasonable pH for a 0.1 M solution of this acid would be (1) 1; (2) 9; (3) 3; (4) 14.
- ___ 44. A 1 molal solution of magnesium chloride has a higher boiling point than a 1 molal solution of solution of (1) FeCl₃; (2) CaCl₂; (3) BaCl₂; (4) NaCl.
- ___ 45. A water solution of which gas contains more hydroxide ions than hydronium ions? (1) HCl; (2) NH₃; (3) CO₂; (4) SO₂.
- ___ 46. The following are hydrogen ion concentrations. Which hydrogen ion concentration indicates the strongest acid? (1) 1.0×10^{-4} ; (2) 2.0×10^{-5} ; (3) 3.0×10^{-6} ; (4) 4.0×10^{-7} .
- ___ 47. How many milliliters of 0.200 molar NaOH are needed to neutralize 100 milliliters of 0.100 molar HCl? (1) 40.0; (2) 50.0; (3) 100.; (4) 200.
- ___ 48. Given the following reaction: $\text{H}_2\text{SO}_4 + \text{H}_2\text{O} \rightleftharpoons \text{HSO}_4^{1-} + \text{H}_3\text{O}^{1+}$. The two Bronsted-Lowry acids are (1) H₂SO₄ and H₂O; (2) H₂SO₄ and H₃O¹⁺; (3) H₂O and H₃O¹⁺; (4) HSO₄¹⁻ and H₃O¹⁺.
- ___ 49. Neutralization of 15 milliliters of a 1.0-molar solution of KOH requires 5 milliliters of hydrochloric acid. What is the molarity of the HCl solution? (1) 1.0; (2) 2.0; (3) 3.0; (4) 6.0.
- ___ 50. Which solution is the best conductor of electricity? (1) 1.0 M boric acid; (2) 1.0 M carbonic acid; (3) 1.0 M acetic acid; (4) 1.0 M hydrochloric acid.
- ___ 51. If the [H¹⁺] of a solution is 1×10^{-2} M the pH of the solution will be (1) 1; (2) 2; (3) 11; (4) 12.

- ___ 52. A salt whose water solution has a pH closest to 7 is (1) $\text{NaC}_2\text{H}_3\text{O}_2$; (2) NaCl ; (3) Na_3PO_4 ; (4) Na_2CO_3 .
- ___ 53. Which 0.1 M solution would have the smallest pH value? (1) HCl ; (2) H_2O ; (3) KOH ; (4) NaCl .
- ___ 54. During acid-base neutralization how many moles of hydroxide ions will react with one mole of hydrogen ions? (1) 1.0 mole; (2) 0.5 mole; (3) 17.007 moles; (4) 22.4 moles.
- ___ 55. A water solution of KCl would have a pH closest to (1) 5; (2) 7; (3) 3; (4) 9.
- ___ 56. If 50 ml. of a 0.20 M solution of NaOH are required to titrate 10 ml. of an acid solution then what is the concentration of the acid solution? (1) 1.0 M; (2) 2.5 M; (3) 0.10 M; (4) 0.50 M.
- ___ 57. What is the pH of a solution that has a hydronium concentration of 0.001 mole per liter? (1) 1; (2) 2; (3) 3; (4) 11.
- ___ 58. In a solution litmus is blue. The pH of the solution could be (1) 10; (2) 2; (3) 3; (4) 4.
- ___ 59. If 50 milliliters of a 1.0 M NaOH solution is needed to exactly neutralize 10 milliliters of an HCl solution then the molarity of the HCl solution is (1) 1.0 M; (2) 0.20 M; (3) 5.0 M; (4) 10. M.
- ___ 60. What is the equilibrium constant of water at 25 degrees Celcius? (1) 1.0×10^{-14} ; (2) 1.0×10^{-7} ; (3) 1.0×10^{14} ; (4) 1.0×10^7 .
- ___ 61. What is the pH of a 0.001 M solution of HCl ? (1) 1; (2) 7; (3) 3; (4) 11.
- ___ 62. Which of the following acids has the weakest conjugate base? (1) HCl ; (2) H_3PO_4 ; (3) HF ; (4) H_2S .
- ___ 63. Phenolphthalein has a pink color in a solution which has a pH of (1) 1; (2) 5; (3) 7; (4) 11.
- ___ 64. A Lewis base is a(n) (1) electron pair donor; (2) electron pair acceptor; (3) proton donor; (4) proton acceptor..
- ___ 65. How many milliliters of 0.4 M HCl are required to completely neutralize 200 milliliters of 0.16 M potassium hydroxide? (1) 500; (2) 200; (3) 80; (4) 30.
- ___ 66. Which compound in a water solution would turn red litmus paper blue? (1) HNO_3 ; (2) $\text{C}_2\text{H}_5\text{OH}$; (3) $\text{HC}_2\text{H}_3\text{O}_2$; (4) NaOH .
- ___ 67. The pH of a solution is 1. The hydrogen ion concentration of this solution in moles per liter is* (1) 1; (2) 10; (3) 0.01; (4) 0.1.
- ___ 68. As the concentration of a KOH solution increases the number of moles of HCl needed to neutralize the KOH solution (1) decreases; (2) increases; (3) remains the same.

- ___ 69. The pH of a 0.001 M HCl solution is closest to (1) 1; (2) 7; (3) 3; (4) 10.
- ___ 70. One liter of 1 M NaOH will completely neutralize one liter of (1) 1 M H₂SO₄; (2) 2 M H₂SO₄; (3) 0.5 M H₂SO₄; (4) 1.5 M H₂SO₄.
- ___ 71. Which 0.1 M acid solution contains the highest concentration of H₃O¹⁺ ions? (1) H₂S; (2) H₃PO₄; (3) HNO₂; (4) HF.
- ___ 72. How much water is formed when 1.0 mole of HCl reacts completely with 1.0 mole of NaOH? (1) 1.0 mole; (2) 2.0 moles; (3) 0.50 mole; (4) 0.25 mole.
- ___ 73. Which substance is amphiprotic? (1) HI; (2) NH₄¹⁺; (3) HNO₃; (4) HS¹⁻.
- ___ 74. Which relationship between the concentrations always exists in an aqueous solution that is basic? (1) [H¹⁺] equals zero.; (2) [H¹⁺] equals [OH¹⁻].; (3) [H¹⁺] is less than [OH¹⁻].; (4) [H¹⁺] is greater than [OH¹⁻].
- ___ 75. Which compound is an electrolyte? (1) C₆H₁₂O₆; (2) C₁₂H₂₂O₁₁; (3) CH₃CH₂OH; (4) CH₃COOH.
- ___ 76. As a solution of NaOH is added to a solution of HCl at constant temperature the product of [H₃O⁺][OH⁻] (1) decreases; (2) increases; (3) remains the same.
- ___ 77. What volume of a 0.200 M NaOH solution is needed to exactly neutralize 40.0 milliliters of a 0.100 M HCl solution? (1) 10.0 mL; (2) 20.0 mL; (3) 40.0 mL; (4) 80.0 mL.
- ___ 78. In the reaction NH_{3(g)} + H₂O_(l) <=====> NH₄¹⁺_(aq) + OH¹⁻_(aq) which pair are Bronsted bases? (1) NH₃ and H₂O; (2) NH₃ and OH¹⁻; (3) NH₄¹⁺ and H₂O; (4) NH₄¹⁺ and OH¹⁻.
- ___ 79. According to the Bronsted-Lowry theory an acid is any species that can (1) donate a proton; (2) accept a proton; (3) donate an electron; (4) accept an electron.
- ___ 80. Which is a net ionic equation for a neutralization reaction? (1) H¹⁺ + HCO₃¹⁻ ----> H₂CO₃; (2) NH₄¹⁺ + OH¹⁻ ----> NH₄OH; (3) Ag¹⁺ + Cl¹⁻ ----> AgCl; (4) H¹⁺ + OH¹⁻ ----> H₂O.
- ___ 81. When substance X is dissolved in water the only positive ions in the solution are hydrogen ions. Substance X could be (1) NaOH; (2) NaH; (3) H₂S; (4) NH₃.
- ___ 82. How many milliliters of 2.5 M HCl are required to exactly neutralize 15 milliliters of 5.0 M NaOH? (1) 10; (2) 20; (3) 30; (4) 40.
- ___ 83. Which solution can turn phenolphthalein pink? (1) CH₃OH (aq); (2) CH₃COOH (aq); (3) HCl (aq); (4) NaOH (aq).
- ___ 84. In the reaction HBr + H₂O <=====> H₃O¹⁺ + Br¹⁻ which is a conjugate acid-base pair? (1) HBr and Br¹⁻; (2) HBr and H₂O; (3) H₃O¹⁺ and Br¹⁻; (4) H₃O and HBr.
- ___ 85. What is the ionization constant for water at 25 °C? (1) 1.0 x 10⁻¹⁴; (2) 1.0 x 10⁻⁷; (3) 1.0 x 10⁷; (4) 1.0 x 10¹⁴.
- ___ 86. The pH of a 0.1 M CH₃COOH solution is (1) less than 1; (2) greater than 1 but

less than 7; (3) equal to 7; (4) greater than 7 but less than 14.

- ___ 87. Which equation represents a neutralization reaction? (1) $\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2$; (2) $2\text{HCl} + \text{Zn} \rightarrow \text{ZnCl}_2 + \text{H}_2$; (3) $\text{H}_2\text{SO}_4 + \text{CaCO}_3 \rightarrow \text{CaSO}_4 + \text{H}_2\text{O} + \text{CO}_2$; (4) $\text{HNO}_3 + \text{KOH} \rightarrow \text{KNO}_3 + \text{H}_2\text{O}$.
- ___ 88. Which of the following is the strongest Bronsted-Lowry base? (1) HS_1^- ; (2) S^{2-} ; (3) HSO_4^{1-} ; (4) NO_3^{1-} .
- ___ 89. When the salt NaHCO_3 is dissolved in water the solution becomes (1) basic due to the production of H_3O^{1+} ions; (2) acidic due to the production of H_3O^{1+} ions; (3) basic due to the production of OH^{1-} ions; (4) acidic due to the production of OH^{1-} ions.
- ___ 90. Which of the following is the strongest Bronsted acid? (1) HNO_2 ; (2) H_2S ; (3) CH_3COOH ; (4) H_3PO_4 .
- ___ 91. Pure water at 25 °C has a pH of (1) 1×10^{-7} ; (2) 1×10^{-14} ; (3) 7; (4) 14.
- ___ 92. Which metal will react spontaneously with $\text{HCl}(\text{aq})$? (1) Au; (2) Ag; (3) Cu; (4) Mg.
- ___ 93. In the reaction $\text{HCl} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^{1+} + \text{Cl}^{1-}$ a conjugate acid-base pair is (1) HCl and H_3O^{1+} ; (2) HCl and H_2O ; (3) HCl and Cl^{1-} ; (4) H_2O and Cl^{1-} .
- ___ 94. As the H_3O^{1+} ion concentration of a solution increases the pH of the solution (1) decreases; (2) increases; (3) remains the same.
- ___ 95. In the reaction $\text{H}_2\text{O} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^{1+} + \text{OH}^{1-}$ the water is acting as (1) a proton acceptor only; (2) a proton donor only; (3) both a proton acceptor and donor; (4) neither a proton acceptor nor donor.
- ___ 96. Which solution will turn litmus from red to blue? (1) $\text{H}_2\text{S}(\text{aq})$; (2) $\text{NH}_3(\text{aq})$; (3) $\text{SO}_2(\text{aq})$; (4) $\text{CO}_2(\text{aq})$.
- ___ 97. The pH of a solution is 8. At 1 atmosphere and 25 °C the product of the $[\text{H}_3\text{O}^{1+}]$ $[\text{OH}^{1-}]$ is (1) 1×10^{-2} ; (2) 1×10^{-6} ; (3) 1×10^{-8} ; (4) 1×10^{-14} .
- ___ 98. Which is an amphiprotic ion? (1) HSO_4^{1-} ; (2) NH_4^{1+} ; (3) NO_3^{1-} ; (4) Cl^{1-} .
- ___ 99. If HCl and H_2O react together in an acid-base reaction to form their Bronsted-Lowry conjugates the products would be (1) HCl and H_3O^{1+} ; (2) Cl^{1-} and OH^{1-} ; (3) Cl_2 and H_2 ; (4) Cl^{1-} and H_3O^{1+} .
- ___ 100. What is the hydronium ion concentration of a solution at 25 °C whose hydrogen ion concentration is 1×10^{-8} ? (1) 1×10^{-6} ; (2) 1×10^{-7} ; (3) 1×10^{-8} ; (4) 1×10^{-14} .
- ___ 101. An 0.1 M acid solution at 25 °C would conduct electricity best if the acid had a K_a value of (1) 1.0×10^{-7} ; (2) 1.8×10^{-5} ; (3) 6.7×10^{-4} ; (4) 1.7×10^{-2} .
- ___ 102. If 50 mL of a 0.01 M HCl solution is required to neutralize exactly 25 milliliters of NaOH then what is the concentration of the base? (1) 0.01 M; (2) 0.02 M; (3) 0.005 M; (4) 0.04 M.
- ___ 103. When tested a solution turns red litmus to blue. This indicates that the solution

contains more (1) H^{1+} ions than OH^{1-} ions; (2) H_3O^{1+} ions than OH^{1-} ions; (3) OH^{1-} ions than H_3O^{1+} ions; (4) H^{1+} and OH^{1-} ions than H_2O molecules.

- ___ 104. What is the pH of an aqueous solution of $\text{C}_6\text{H}_{12}\text{O}_6$? (1) 1; (2) 7; (3) 11; (4) 14.
- ___ 105. A sample of pure water contains (1) neither OH^{1-} ions nor H_3O^{1+} ions; (2) equal concentrations of OH^{1-} and H_3O^{1+} ions; (3) a larger concentration of H_3O^{1+} ions than OH^{1-} ions; (4) a smaller concentration of H_3O^{1+} ions than OH^{1-} ions.
- ___ 106. Which of the following acids ionizes to the least extent at 25 °C? (1) HF; (2) HNO_2 ; (3) H_2S ; (4) H_2O .
- ___ 107. Which substance is amphiprotic? (1) H_2SO_4 ; (2) HNO_3 ; (3) NH_3 ; (4) HBr .
- ___ 108. As 0.1 M HCl is added to 0.1 M KOH the pH of the basic solution (1) decreases and basicity decreases; (2) increases and basicity decreases; (3) decreases and basicity increases; (4) increases and basicity increases.