CHEM 1312
Practice Set
Acids & Bases

1. (14.44) Give three examples of molecules or ions that are Brønsted-Lowry bases but not Arrhenius bases.

2. (14.46) Give the formula for the conjugate base of each of the following Brønsted-Lowry acids:
   a. HSO_4^- d. H_2SO_3
   b. $H_2PO_4^-$ e. NH_4^+
   c. H_2O f. NH_3

3. (14.47) Give the formula for the conjugate base of each of the following Brønsted-Lowry bases:
   a. SO_3^{-2} d. H_2O
   b. CH_3NH_2 e. OH^-
   c. HCO_3^- f. H^-

4. (14.48) For each of the following reactions, identify the Brønsted-Lowry acids and bases and the conjugate acid-base pairs:
   a. $CH_3CO_2H(aq) + NH_3(aq) \leftrightharpoons NH_4^+(aq) + CH_3CO_2^-$
   b. $CO_3^{-2}(aq) + H_3O^+(aq) \leftrightharpoons H_2O(l) + HCO_3^-(aq)$
   c. $HSO_3^-(aq) + H_2O(l) \leftrightharpoons H_3O^+(aq) + SO_3^{-2}(aq)$
   d. $HSO_3^-(aq) + H_2O(l) \leftrightharpoons H_2SO_3(aq) + OH^-(aq)$

5. (14.50) Determine from the following species, the strong acid or strong base in aqueous solution:
   a. HNO_2 b. HNO_3 c. NH_4^+ d. Cl^-
   e. H^- f. O^{-2} g. H_2SO_4

6. (14.52) Of the conjugate acid-base pairs HF/F^-, HCl/Cl^-, and HCN/CN^-, complete the following equation with the pair that gives an equilibrium $K_c > 1$.

   _____ + $H_2PO_4^-$ $\leftrightharpoons$ _____ + H_3PO_4

7. (14.53) Of the conjugate acid-base pairs HSO_4^-/SO_4^{-2}, NH_4^+/NH_3, and HNO_3/NO_3^-, complete the following equation with the pair that gives an equilibrium $K_c > 1$.

   _____ + H_2S $\leftrightharpoons$ _____ + HS^-

8. (14.54) Arrange each group of compounds in order of increasing acid strength. Explain your reasoning.
    a. HCl, H_2S, PH_3
    b. NH_3, PH_3, AsH_3
    c. $HBrO$, $HBro_3$, $HBrO_4$

9. (14.55) Arrange each group of compounds in order of decreasing acid strength. Explain your reasoning.
    a. H_2O, H_2S, H_2Se
    b. $HClO_3$, $HBrO_3$, HIO_3
    c. PH_3, H_2S, HCl

10. (14.56) Identify the strongest acid in each of the following sets. Explain your reasoning.
    a. H_2O, HF, or HCL
    b. $HClO_2$, $HClO_3$, or $HBrO_3$
    c. HBr, H_2S, or H_2Se

11. (14.57) Identify the weakest acid in each of the following sets. Explain your reasoning.
    a. H_2SO_3, $HClO_3$, or $HClO_4$
    b. NH_3, H_2O, or H_2S
    c. $B(OH)_3$, $Al(OH)_3$, or $Ga(OH)_3$

12. (14.60) For each of the following equations, calculate $[OH^-]$ from $[H_3O^+]$, or $[H_3O^+]$ from $[OH^-]$. Classify each solution as acidic, basic, or neutral.
    a. $[H_3O^+] = 3.4 \times 10^{-9}$ M
    b. $[OH^-] = 1.0 \times 10^{-10}$ M
    c. $[H_3O^+] = 8.6 \times 10^{-5}$ M
    d. $[OH^-] = 0.010$ M
    e. $[H_3O^+] = 1.0 \times 10^{-7}$ M

13. (14.61) For each of the following equations, calculate $[OH^-]$ from $[H_3O^+]$, or $[H_3O^+]$ from $[OH^-]$. Classify each solution as acidic, basic, or neutral.
    a. $[H_3O^+] = 2.5 \times 10^{-4}$ M
    b. $[OH^-] = 5.6 \times 10^{-9}$ M
    c. $[OH^-] = 1.0 \times 10^{-7}$ M
    d. $[H_3O^+] = 2.0$ M
    e. $[OH^-] = 1.5 \times 10^{-3}$ M

14. (14.62) Water superheated under pressure to 200. ^oC and 750. atm has $K_w = 1.5 \times 10^{-11}$. Find $[H_3O^+]$ and $[OH^-]$ at 200. ^oC. Predict if the water is acidic, basic, or neutral.

15. (14.65) What is the pH to the correct number of significant figures for solutions with the following concentrations of H_3O^+ or OH^-:

    a. $[OH^-] = 7.6 \times 10^{-3}$ M
    b. $[H_3O^+] = 5.0$ M
    c. $[H_3O^+] = 2.18 \times 10^{-10}$ M
    d. $[H_3O^+] = 1 \times 10^{-8}$ M
    e. $[OH^-] = 1.0 \times 10^{-7}$ M

16. (14.66) Calculate $[H_3O^+]$ for solutions having the following pH values:

    a. 4.1
    b. 14.25
    c. 10.82
    d. -1.0
    e. 0.00
    f. 5.238

17. (14.67) Calculate $[H_3O^+]$ for solutions having the following pH values:

    a. 9.0
    b. 15.18
    c. 7.00
    d. 2.63
    e. -0.3
    f. 10.756

18. (14.68) Predict the most appropriate indicator (thymol blue, alizarin yellow, chlorphenol red, or methyl orange) to detect the following pH changes:

    a. 7 to 5
    b. 8 to 10
    c. 3 to 5

19. (14.70) A solution of NaOH has a pH of 10.50. Calculate number of grams of CaO required to dissolve in sufficient water to make 1.00 L of a solution having the same pH.

20. (14.71) A solution of KOH has a pH of 10.00. Calculate number of grams of SrO required to dissolve in sufficient water to make 2.00 L of a solution having the same pH.

21. (14.72) Calculate the pH of solutions prepared by:

    a. Dissolve 4.8 g of lithium hydroxide in water to give a 250. mL solution.
    b. Dissolve 0.93 g of hydrogen chloride in water to give a 0.40 L solution.
    c. Dilute 50.0 mL of 0.10 M HCl to 1.00 L.
    d. Mix 100.0 mL of 2.0×10^{-3} M HCl and 400.0 mL of 1.0×10^{-3} M $HClO_4$ (Assume that volumes are additive).

22. (14.73) Calculate the pH of solutions prepared by:

    a. Dissolve 0.20 g of sodium oxide in water to give a 100. mL solution.
    b. Dissolve 1.26 g of pure nitric acid in water to give a 0.500 L solution.
    c. Dilute 40.0 mL of 0.075 M $Ba(OH)_2$ to 300.0 mL.
    d. Mix equal volumes of 0.20 M HCl and 0.50 M HNO_3 (Assume that volumes are additive).

23. (14.74) Look up the values of K_a in Appendix C for C_6H_5OH, HNO_3, CH_3CO_2H, and HOCl. Arrange these acids in order of:
    a. Increasing strength
    b. Decreasing percent dissociation
    c. Estimate $[H_3O^+]$ in a 1.0 M solution for each acid

24. (14.77) Lactic acid ($C_3H_6O_3$), which occurs in sour milk and foods such as sauerkraut, is a weak monoprotic acid. The pH of a 0.10 M solution of lactic acid is 2.43. Determine the value for K_a.

25. (14.78) Acrylic acid ($C_3H_4O_2$) is used in the manufacture of paints and plastics. The pK_a of acrylic acid is 4.25.
    a. Calculate the pH and the concentrations of all species (H_3O^+, $C_3H_3O_2^-$, $C_3H_4O_2$, and OH^-) in 0.150 M acrylic acid.

    b. Calculate the percent dissociation in 0.0500 M acrylic acid.