

**Homework #5**

*Chemistry, 7th ed., 4.1-4.3 & 4.5-4.8, Zumdahl & Zumdahl*  
(questions from *Introductory Chemistry, 2nd ed., Zumdahl*)

Wallace

revised 05/05/2009

**15.1 Solubility:**

2. Discuss how an ionic solute dissolves in water. How are the strong interionic forces in the solid overcome to permit the solid to dissolve? How are the dissolved positive and negative ions shielded from one another, preventing them from recombining to form the solid?
  
6. Why are some molecular solids (such as sugar) very soluble in water? What feature in the structure of sugar molecules makes their interaction with water favor the forming of a solution?

**15.4 Molarity:**

30. A solution that is 0.50 M in  $\text{CuCl}_2$  contains \_\_\_\_\_ mol of  $\text{Cu}^{2+}$  and \_\_\_\_\_ mol of  $\text{Cl}^-$  per liter.
  
34. For the following solution, the number of moles of solute is given, followed by the total volume of solution prepared. Calculate the molarity.
  - a. 0.50 mol KBr; 250 mL
  
36. For the following solution, the mass of the solute is given, followed by the total volume of solution prepared. Calculate the molarity.
  - a. 4.25g  $\text{CuCl}_2$ ; 125 mL
  
44. What number of moles of the indicated solute does each of the following solutions contain?
  - a. 122 mL of 0.451 M HCl solution
  - b. 2.78 L of 0.101 M KOH solution
  
50. Calculate the number of moles of each ion present in each of the following solutions.
  - a. 10.2 mL of 0.451 M  $\text{AlCl}_3$  solution
  - b. 5.51 L of 0.103 M  $\text{Na}_3\text{PO}_4$  solution
  - c. 1.75 mL of 1.25 M  $\text{CuCl}_2$  solution

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**15.5 Dilution:**

58. Concentrated sulfuric acid is typically 18.1 M  $\text{H}_2\text{SO}_4$ . Calculate the volume (in mL) of concentrated sulfuric acid needed to prepare 125 mL of 0.100 M  $\text{H}_2\text{SO}_4$  solution
60. If 75 mL of 0.211 M NaOH is diluted to a final volume of 125 mL, what is the concentration of NaOH in the diluted solution?

**7.2 Solid forms:**

4. When two solutions of ionic substances are mixed and a precipitate forms, what is the net charge of the precipitate? Why?
6. When an ionic substance dissolves, the resulting solution contains the separated \_\_\_\_\_.
12. On the basis of the general solubility rules given in table 7.1, predict which of the following substances are likely to be soluble in water.
- Barium nitrate
  - Potassium carbonate
  - Sodium sulfate
  - Copper (II) hydroxide
  - Mercury (I) chloride
  - Ammonium phosphate
  - Chromium (III) sulfide
  - Lead sulfate
16. On the basis of the general solubility rules given in Table 7.1, predict the identity of the precipitate that forms when aqueous solutions of the following substances are mixed. In no precipitate is likely, indicate which rules(s) applies.
- Mercuric nitrate,  $\text{Hg}(\text{NO}_3)_2$ , and sodium sulfide,  $\text{Na}_2\text{S}$
  - Sulfuric acid,  $\text{H}_2\text{SO}_4$ , and calcium nitrate,  $\text{Ca}(\text{NO}_3)_2$
  - Ammonium chloride,  $\text{NH}_4\text{Cl}$ , and silver nitrate,  $\text{AgNO}_3$

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20. Balance each of the following equations that describe precipitation reactions.
- $\text{AgNO}_3(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{Ag}_2\text{SO}_4(\text{s}) + \text{HNO}_3(\text{aq})$
  - $\text{Ca}(\text{NO}_3)_2(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{CaSO}_4(\text{s}) + \text{HNO}_3(\text{aq})$
  - $\text{Pb}(\text{NO}_3)_2(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{PbSO}_4(\text{s}) + \text{HNO}_3(\text{aq})$
22. For each of the following precipitation reactions, complete and balance the equation, indicating clearly which product is the precipitate.
- $\text{NiCl}_2(\text{aq}) + \text{H}_2\text{S}(\text{aq}) \rightarrow$
  - $\text{CuSO}_4(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow$
  - $\text{Ba}(\text{NO}_3)_2(\text{aq}) + \text{Na}_2\text{CO}_3(\text{aq}) \rightarrow$

**7.3 Describing aqueous reactions:**

24. Ions that do not directly participate in a reaction in solution are called \_\_\_\_\_ ions.
26. Write balanced net ionic equations for the reactions that occur when the following aqueous solutions are mixed. If no reaction is likely to occur, so indicate.
- Iron (III) nitrate and potassium hydroxide
  - Nickel (II) chloride and hydrosulfuric acid
  - Silver nitrate and ammonium chloride

**7.4 Acids/Bases:**

32. According to the simple Arrhenius theory, a(n) \_\_\_\_\_ is a substance that produces hydrogen ions,  $\text{H}^+$ , when dissolved in water.
34. The common strong acids are  $\text{H}_2\text{SO}_4$ ,  $\text{HNO}_3$ , and \_\_\_\_\_.
38. In addition to the strong bases  $\text{NaOH}$  and  $\text{KOH}$  discussed in this chapter, the hydroxide compounds of other Group 1 elements also behave as strong bases when dissolved in water. Write equations for  $\text{RbOH}$  and  $\text{CsOH}$  that show what ions they form when they dissolve in water.

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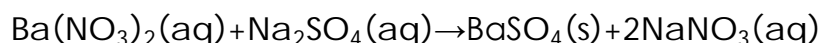
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40. Below are indicated the products of acid—base reactions. Complete (and balance) the equations to show which strong acids/strong bases have reacted to form these products.
- \_\_\_\_\_  $\rightarrow$  KCl(aq) + H<sub>2</sub>O(l)
  - \_\_\_\_\_  $\rightarrow$  Na<sub>2</sub>SO<sub>4</sub>(aq) + H<sub>2</sub>O(l)
  - \_\_\_\_\_  $\rightarrow$  CsClO<sub>4</sub>(aq) + H<sub>2</sub>O(l)
  - \_\_\_\_\_  $\rightarrow$  KNO<sub>3</sub>(aq) + H<sub>2</sub>O(l)

**15.6 Solution stoichiometry:**

64. What volume (in mL) of 0.25 M Na<sub>2</sub>SO<sub>4</sub> solution is needed to precipitate all the barium, as BaSO<sub>4</sub>(s), from 12.5 mL of 0.15 M Ba(NO<sub>3</sub>)<sub>2</sub> solution?



68. Aluminum ion may be precipitated from aqueous solution by addition of hydroxide ion, forming Al(OH)<sub>3</sub>. A large excess of hydroxide ion must not be added, however, because the precipitate of Al(OH)<sub>3</sub> will redissolve to form a soluble aluminum/hydroxide complex. How many grams of solid NaOH should be added to 10.0 mL of 0.250 M AlCl<sub>3</sub> to just precipitate all the aluminum?

**15.7 Neutralization:**

70. What volume of 0.175 M HCl solution is needed to exactly neutralize 24.9 mL of 0.451 M NaOH solution?
72. The total acidity in water samples can be determined by neutralization with standard sodium hydroxide solution. What is the total concentration of hydrogen ion, H<sup>+</sup>, present in a water sample if 100. mL of the sample requires 7.2 mL of 2.5 × 10<sup>-3</sup> M NaOH to be neutralized?