CH 221 Practice Problem Set #6

*This is a **practice problem set** and not the actual graded problem set that you will turn in for credit.*
Answers to each problem can be found at the end of this assignment.

Covering: **Chapter Six and Chapter Seven (7.1-7.2 *only*)** *and* **Chapter Guide Six**
Important Tables and/or Constants: 1 mol = 6.022 x 10^{23}, "Have No Fear Of Ice Clear Brew" (7 Diatomics),**Solubility Table** (in the "Net Ionics" lab or here: **https://mhchem.org/sol**), 1000 mL = 1L

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1. Calculate the weight percent of lead in PbS, lead(II) sulfide. What mass of lead (in grams) is present in 10.0 g of PbS?
2. Succinic acid occurs in fungi and lichens. Its empirical formula is $C_2H_3O_2$ and its molar mass is 118.1 g/mol. What is its molecular formula?
3. A large family of boron-hydrogen compounds has the general formula B_xH_y. One member of this family contains 88.5% B; the remainder is hydrogen. Which of the following is its empirical formula: BH_2, BH_3, B_2H_5, B_5H_7, or B_5H_{11}?
4. A new compound containing xenon and fluorine was isolated by shining sunlight on a mixture of Xe (0.526 g) and F_2 gas. If you isolate 0.678 g of the new compound, what is its empirical formula?
5. The "alum" used in cooking is potassium aluminum sulfate hydrate, $KAl(SO_4)_2 * x\ H_2O$. To find the value of *x*, you can heat a sample of the compound to drive off all of the water and leave only $KAl(SO_4)_2$. Assume you heat 4.74 g of the hydrated compound and that the sample loses 2.16 g of water. What is the value of *x?*
6. Direct reaction of iodine (I_2) and chlorine (Cl_2) produces an iodine chloride, I_xCl_y, a bright yellow solid. If you completely used up 0.678 g of iodine and produced 1.246 g of I_xCl_y, what is the empirical formula of the compound? A later experiment showed that the molar mass of I_xCl_y was 467 g/mol. What is the molecular formula of the compound?
7. Some potassium dichromate ($K_2Cr_2O_7$), 2.335 g, is dissolved in enough water to make exactly 500. mL of solution. What is the molar concentration of the potassium dichromate? What are the molar concentrations of the K^+ and $Cr_2O_7^{2-}$ ions?
8. For each solution, identify the ions that exist in aqueous solution, and specify the concentration of each ion.
   a. 0.25 M $(NH_4)_2SO_4$
   b. 0.123 M Na_2CO_3
   c. 0.056 M HNO_3
9. What volume of 0.109 M HNO_3, in milliliters, is required to react completely with 2.50 g of $Ba(OH)_2$? $2\ HNO_3(aq) + Ba(OH)_2(s) \rightarrow 2\ H_2O(l) + Ba(NO_3)_2(aq)$
10. You have 0.954 g of an unknown acid, H_2A, which reacts with NaOH according to the balanced equation: $\mathbf{H_2A(aq) + 2\ NaOH(aq) \rightarrow Na_2A(aq) + 2\ H_2O(l)}$ If 36.04 mL of 0.509 M NaOH is required to titrate the acid to the equivalence point, what is the molar mass of the acid?
11. Balance the following equations:
    a. $Cr(s) + O_2(g) \rightarrow Cr_2O_3(s)$
    b. $Cu_2S(s) + O_2(g) \rightarrow Cu(s) + SO_2(g)$
    c. $C_6H_5CH_3(l) + O_2(g) \rightarrow H_2O(l) + CO_2(g)$

12. Balance the following equations and name each reactant and product:
    a. $Fe_2O_3(s) + Mg(s) \rightarrow MgO(s) + Fe(s)$
    b. $AlCl_3(s) + NaOH(aq) \rightarrow Al(OH)_3(s) + NaCl(aq)$
    c. $NaNO_3(s) + H_2SO_4(l) \rightarrow Na_2SO_4(s) + HNO_3(l)$
    d. $NiCO_3(s) + HNO_3(aq) \rightarrow Ni(NO_3)_2(aq) + CO_2(g) + H_2O(l)$
13. Which compound or compounds in each of the following groups is (are) expected to be soluble in water?
    a. $CuO, CuCl_2, FeCO_3$
    b. $AgI, Ag_3PO_4, AgNO_3$
    c. $K_2CO_3, KI, KMnO_4$
14. The following compounds are water-soluble. What ions are produced by each compound in aqueous solution?
    a. KOH
    b. $LiNO_3$
    c. K_2SO_4
    d. $(NH_4)_2SO_4$
15. Decide whether each of the following is water-soluble. If soluble, tell what ions are produced.
    a. Na_2CO_3
    b. NiS
    c. $CuSO_4$
    d. $BaBr_2$
16. Predict the products of each precipitation reaction. Balance the completed equation, and then write the net ionic equation.
    a. $NiCl_2(aq) + (NH_4)_2S(aq) \rightarrow$
    b. $Mn(NO_3)_2(aq) + Na_3PO_4(aq) \rightarrow$
17. Balance the following equations, and then write the net ionic equation.
    a. $(NH_4)_2CO_3(aq) + Cu(NO_3)_2(aq) \rightarrow CuCO_3(s) + NH_4NO_3(aq)$
    b. $Pb(OH)_2(s) + HCl(aq) \rightarrow PbCl_2(s) + H_2O(l)$
    c. $BaCO_3(s) + HCl(aq) \rightarrow BaCl_2(aq) + H_2O(l) + CO_2(g)$
18. Determine the oxidation number of each element in the following ions or compounds.
    a. BrO_3^- b. $C_2O_4^{2-}$ c. F^- d. CaH_2 e. H_4SiO_4 f. HSO_4^-
19. Which two of the following reactions are oxidation–reduction reactions? Explain your answer in each case. Classify the remaining reaction.
    a. $Zn(s) + 2\ NO_3^{-1}(aq) + 4\ H^+(aq) \rightarrow Zn^{2+}(aq) + 2\ NO_2(g) + 2\ H_2O(l)$
    b. $Zn(OH)_2(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + 2\ H_2O(l)$
    c. $Ca(s) + 2\ H_2O(l) \rightarrow Ca(OH)_2(s) + H_2(g)$
20. In the following reactions, decide which reactant is oxidized and which is reduced. Designate the oxidizing agent and the reducing agent.
    a. $C_2H_4(g) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 2\ H_2O(g)$
    b. $Si(s) + 2\ Cl_2(g) \rightarrow SiCl_4(l)$

Answers to the Practice Problem Set:

1. 86.59%, 8.66 g
2. $C_4H_6O_4$
3. B_5H_7
4. XeF_2
5. x = 12
6. I_2Cl_6
7. $[Cr_2O_7^{2-}] = [K_2Cr_2O_7] = 0.0159$ M, $[K^+] = 0.0318$ M
8. a. 0.50 M NH_4^+; 0.25 M SO_4^{2-} b. 0.246 M Na^+; 0.123 M CO_3^{2-} c. 0.056 M H^+; 0.056 M NO_3^-
9. 268 mL
10. 104 g/mol
11. *Answers:*
    a. $4\ Cr(s) + 3\ O_2(g) \rightarrow 2\ Cr_2O_3(s)$
    b. $Cu_2S(s) + O_2(g) \rightarrow 2\ Cu(s) + SO_2(g)$
    c. $C_6H_5CH_3(\ell) + 9\ O_2(g) \rightarrow 4\ H_2O(\ell) + 7\ CO_2(g)$
12. *Answers:*
    a. $Fe_2O_3(s) + 3\ Mg(s) \rightarrow 3\ MgO(s) + 2\ Fe(s)$
    iron(III) oxide, magnesium, magnesium oxide, iron
    b. $AlCl_3(s) + 3\ NaOH(aq) \rightarrow Al(OH)_3(s) + 3\ NaCl(aq)$
    aluminum chloride, sodium hydroxide, aluminum hydroxide, sodium chloride
    c. $2\ NaNO_3(s) + H_2SO_4(\ell) \rightarrow Na_2SO_4(s) + 2\ HNO_3(\ell)$
    sodium nitrate, hydrogen sulfate (sulfuric acid), sodium sulfate, hydrogen nitrate (nitric acid)
    d. $NiCO_3(s) + 2\ HNO_3(aq) \rightarrow Ni(NO_3)_2(aq) + CO_2(g) + H_2O(\ell)$
    nickel(II) carbonate, hydrogen nitrate (nitric acid), nickel(II) nitrate, carbon dioxide, water
13. a. $CuCl_2$ b. $AgNO_3$ c. all three compounds
14. a. K^+ and OH^- ions b. Li^+ and NO_3^- ions c. K^+ and SO_4^{2-} ions d. NH_4^+ and SO_4^{2-} ions
15. a. soluble, Na^+ and CO_3^{2-} ions b. insoluble c. soluble, Cu^{2+} and SO_4^{2-} ions d. soluble, Ba^{2+} and Br^- ions
16. *Answers:*
    a. $NiCl_2(aq) + (NH_4)_2S(aq) \rightarrow NiS(s) + 2\ NH_4Cl(aq)$
    $Ni^{2+}(aq) + S^{2-}(aq) \rightarrow NiS(s)$
    b. $3\ Mn(NO_3)_2(aq) + 2\ Na_3PO_4(aq) \rightarrow Mn_3(PO_4)_2(s) + 6\ NaNO_3(aq)$
    $3\ Mn^{2+}(aq) + 2\ PO_4^{3-}(aq) \rightarrow Mn_3(PO_4)_2(s)$
17. *Answers:*
    a. $(NH_4)_2CO_3(aq) + Cu(NO_3)_2 \rightarrow CuCO_3(s) + 2\ NH_4NO_3(aq)$
    $CO_3^{2-}(aq) + Cu^{2+}(aq) \rightarrow CuCO_3(s)$
    b. $Pb(OH)_2(s) + 2\ HCl(aq) \rightarrow PbCl_2(s) + 2\ H_2O(\ell)$
    $Pb(OH)_2(s) + 2\ H^+(aq) + 2\ Cl^-(aq) \rightarrow PbCl_2(s) + 2\ H_2O(\ell)$
    c. $BaCO_3(s) + 2\ HCl(aq) \rightarrow BaCl_2(aq) + H_2O(\ell) + CO_2(g)$

$$BaCO_3(s) + 2\ H^+(aq) \rightarrow Ba^{2+}(aq) + H_2O(\ell) + CO_2(g)$$

18. *Answers:*
    a. Br is +5 and O is –2
    b. C is +3 and O is –2
    c. F is –1
    d. Ca is +2 and H is –1
    e. H is +1, Si is +4, and O is –2
    f. H is +1, S is +6, and O is –2

19. *Answers:*
    a. oxidation-reduction reaction
    Oxidation # of Zn changes from 0 to +2, N changes from +5 to +4
    b. acid-base reaction
    c. oxidation-reduction reaction
    Oxidation number of Ca changes from 0 to +2, H from +1 to 0

20. a. C_2H_4 is oxidized / reducing agent; O_2 is reduced / oxidizing agent b. Si is oxidized / reducing agent; Cl_2 is reduced / oxidizing agent