CHEM 1364
Test 2
Spring 2013 (Buckley)

Point totals are indicated in parentheses to the right of each problem number.

1. (4 points) Balance each of the following equations.

\[
\text{CaO (s) + } 2\text{HCl (aq)} \rightarrow \text{CaCl}_2 (aq) + \text{H}_2\text{O (l)}
\]

\[
2\text{NaOH (aq) + } \text{H}_2\text{SO}_4 (aq) \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O (l)}
\]

\[
2\text{BiCl}_3 (aq) + 3\text{H}_2\text{S (aq)} \rightarrow \text{Bi}_2\text{S}_3 (s) + 6\text{HCl (aq)}
\]

\[
\text{C}_2\text{H}_6\text{O (g) + } 3\text{O}_2 (g) \rightarrow 2\text{CO}_2 (g) + 3\text{H}_2\text{O (g)}
\]

2. (4 points) What is the percent carbon in the compound \(\text{C}_{12}\text{H}_{22}\text{O}_{11}\)? Show your work.

\[
\% \text{C} = \frac{12 \times 12}{12 \times 12 + 22 \times 1 + 11 \times 16} \times 100\% = 42.14\%
\]

3. (4 points) A compound is found to contain 39.3\% C, 8.20\% H, and 52.5\% O by mass.

   a. What is the empirical formula for the compound?

   \[
   \begin{align*}
   \text{C:} & \quad \frac{3.275}{12} = 3.275 \div 12 = 1.00 \times 2 = 2 \quad \text{Since factor is 2}\ \\
   \text{H:} & \quad \frac{3.275}{1} = 3.275 \quad 2.30 \times 2 = 4.60 \quad \text{Multiply by 2.}
   \end{align*}
   \]

   \[
   \text{O:} \quad \frac{52.5}{16} = 3.281 \div 16 = 1.00 \times 2 = 2
   \]

   \[
   \text{The empirical formula is } \text{C}_2\text{H}_4\text{O}_2
   \]

   b. If the molar mass of the compound is found to be 183, what is the molecular formula for the compound?

   The molar mass of the empirical formula \( \text{C}_2\text{H}_4\text{O}_2 \) is 68.

   \[
   183 \div 68 = 2.68 \quad \text{1.5 times goes into 183 three times}
   \]

   \[
   \text{The molecular formula is } \text{C}_6\text{H}_{15}\text{O}_6
   \]
4. (10 points) Find the quantities indicated below. Show your work.

a. How many grams are in 2.14 mole of PF₃?
\[ m = 2.14 \text{ mol} \times 188 \text{ g/mol} = 403.52 \text{ g} \]

b. How many moles are in 475 g of Ba(NO₃)₂?
\[ n = \frac{475 \text{ g}}{261 \text{ g/mol}} = 1.82 \text{ mol} \]

c. How many oxygen atoms are in one molecule of C₆H₆O?
\[ 6 \text{ atoms} \times \frac{1 \text{ mol} \text{ C}_6 \text{H}_6 \text{O}}{1 \text{ mol} \text{ C}_6 \text{H}_6 \text{O}} = 6 \text{ atoms} \]

d. How many hydrogen atoms are in 10.0-g of H₂O?
\[ 2 \text{ atoms} \times \frac{1 \text{ mol} \text{ H}_2 \text{O}}{18 \text{ g/mol} \text{ H}_2 \text{O}} = 6.9 \times 10^{-2} \text{ mol} \]

e. How many moles of hydrogen atoms are in 38.4-g of CH₄?
\[ 4 \text{ atoms} \times \frac{1 \text{ mol} \text{ CH}_4}{16 \text{ g/mol} \text{ CH}_4} = 2.4 \text{ mol} \]

5. (5 points) Indicate for each of the following whether it is soluble or insoluble

1. Ba(NO₃)₂ \hspace{1cm} \text{Soluble}
2. CaCO₃ \hspace{1cm} \text{Insoluble}
3. NH₄Cl \hspace{1cm} \text{Soluble}
4. PbS \hspace{1cm} \text{Insoluble}
5. Na₃PO₄ \hspace{1cm} \text{Soluble}
6. (5 points) Indicate whether each of the following acids is a strong acid or a weak acid
   
a. HNO₃ \textit{Strong} 
  
b. HF \textit{Weak} 
  
c. H₂CO₃ \textit{Weak} 
  
d. H₂SO₃ \textit{Weak} 
  
e. HC₂H₃O₂ \textit{Weak} 

7. (6 points) Consider the following metathesis reaction:
   
   \[
   \text{Ba(NO}_3\text{)}_2 (aq) + \text{K}_2\text{SO}_4 (aq) \rightarrow \text{BaSO}_4 (s) + 2\text{KNO}_3 (aq)
   \]
   
a. Complete and balance the equation being sure to include the physical states with the products.
   
   \[
   \text{Ba(NO}_3\text{)}_2 (aq) + \text{K}_2\text{SO}_4 (aq) \rightarrow \text{BaSO}_4 (s) + 2\text{KNO}_3 (aq)
   \]
   
b. From your answer in b, write the complete ionic equation.
   
   \[
   \text{Ba}^{2+} (aq) + 2\text{NO}_3^{-} (aq) + 2\text{K}^+ (aq) + 2\text{SO}_4^{2-} (aq) \rightarrow \text{BaSO}_4 (s) + 2\text{K}^+ (aq) + 2\text{NO}_3^{-} (aq)
   \]
   
c. From your answer in c, write the net ionic equation.
   
   \[
   \text{Ba}^{2+} (aq) + \text{SO}_4^{2-} (aq) \rightarrow \text{BaSO}_4 (s)
   \]
8. (8 points) The reaction when propane, \( \text{C}_3\text{H}_8 \), is combusted in the presence of oxygen is:

\[
\text{C}_3\text{H}_8 (\text{g}) + 5 \text{O}_2 (\text{g}) \rightarrow 3 \text{CO}_2 (\text{g}) + 4 \text{H}_2\text{O} (\text{g})
\]

a. How many grams of carbon dioxide could be produced from the combustion of 45.5-g of \( \text{C}_3\text{H}_8 \), assuming there is plenty of oxygen? Show your work.

\[
2 \text{ g CO}_2 = \frac{45.5 \text{ g C}_3\text{H}_8}{1} \times \frac{1 \text{ mol C}_3\text{H}_8}{44 \text{ g C}_3\text{H}_8} \times \frac{3 \text{ mol CO}_2}{1 \text{ mol C}_3\text{H}_8} \times \frac{44 \text{ g CO}_2}{1 \text{ mol CO}_2} = \boxed{136.7 \text{ g CO}_2}
\]

b. How many grams of oxygen would be required to react with the 45.5-g of \( \text{C}_3\text{H}_8 \) in the combustion process? Show your work.

\[
\text{g O}_2 = \frac{45.5 \text{ g C}_3\text{H}_8}{1} \times \frac{1 \text{ mol C}_3\text{H}_8}{44 \text{ g C}_3\text{H}_8} \times \frac{5 \text{ mol O}_2}{1 \text{ mol C}_3\text{H}_8} \times \frac{32 \text{ g O}_2}{1 \text{ mol O}_2} = \boxed{165.0 \text{ g O}_2 \text{ required}}
\]

c. If 117.5-g of \( \text{CO}_2 \) are actually produced in the reaction when it is carried out, what is the percent yield?

\[
\% \text{ yield} = \frac{\text{Actual}}{\text{Theoretical}} \times 100\% = \boxed{86.1\%}
\]
9. (8 points) Consider the reaction:

\[ 2 \text{NaOH (aq)} + \text{SO}_2 (g) \rightarrow \text{Na}_2\text{SO}_3 (aq) + \text{H}_2\text{O (l)} \]

a. 75.0-g of NaOH are reacted with 80.0-g of SO\(_2\). Which of these two is the limiting reactant? Be sure to show your work and explain your reasoning as to which is the limiting reactant.

\[ ? \ g \ \text{SO}_2 = \frac{75.0 \ g \ \text{NaOH}}{40 \ g \ \text{NaOH}} \times \frac{1 \ \text{mol} \ \text{NaOH}}{2 \ \text{mol} \ \text{NaOH}} \times \frac{64 \ g \ \text{SO}_2}{1 \ \text{mol} \ \text{SO}_2} \]

\[ = 60.0 \ g \ \text{SO}_2 \]

Since you only need 60 g of SO\(_2\) to use up the NaOH, THEN you have PLenty and NaOH is limiting.

b. How many grams of Na\(_2\)SO\(_3\) could be produced from the reaction in part a? Show your work.

Based on NaOH since it is limiting

\[ ? \ g \ \text{Na}_2\text{SO}_3 = \frac{75.0 \ g \ \text{NaOH}}{40 \ g \ \text{NaOH}} \times \frac{1 \ \text{mol} \ \text{NaOH}}{2 \ \text{mol} \ \text{Na}_2\text{SO}_3} \times \frac{126 \ g \ \text{Na}_2\text{SO}_3}{1 \ \text{mol} \ \text{Na}_2\text{SO}_3} \]

\[ = 118 \ g \ \text{Na}_2\text{SO}_3 \]