Worksheet # 13

Stoichiometry

1. A laboratory method of preparing O_2 gas involves the decomposition of solid $KClO_3$ according to the following unbalanced equation: $KClO_3(s) \rightarrow KCl(s) + O_2(g)$
   a) How many moles of O_2 (g) can be produced by the decomposition of 32.8 g $KClO_3$?
   b) How many grams of $KClO_3$ must be decomposed to produce 50.0 g O_2?
   c) How many grams of KCl are formed when 23.8 grams O_2 are formed in the decomposition of $KClO_3$?

2. Suppose 9.5 g of gaseous C_2H_2 reacts with excess O_2 according to the reaction below. What is the mass of CO_2 produced?

$$C_2H_2(g) + O_2(g) \rightarrow CO_2(g) + H_2O(\ell)$$

3. Chlorine gas is made in the laboratory by the reaction of gaseous hydrochloric acid with solid manganese(IV) oxide to produce aqueous manganese(II) chloride, water, and chlorine. If 13.7 g of manganese(IV) oxide reacts with excess hydrochloric acid, how much chlorine is formed?

4. Solid bismuth oxide can react with carbon to form bismuth metal and carbon monoxide. How many grams of bismuth oxide reacted if 60.7 grams of bismuth is formed?

5. Solid chromium(III) oxide can react with gaseous hydrogen sulfide to form solid chromium(III) sulfide and water. How many grams of chromium(III) oxide are required to form 83.4 g of chromium(III) sulfide?

6. Solid potassium nitrate decomposes on heating to form solid potassium oxide, nitrogen, and oxygen. How many grams of potassium nitrate must be heated to form 86.6 kg of oxygen?

7. Solid silver oxide decomposes at temperatures in excess of 300 °C, yielding metallic silver and oxygen gas. A 3.13 g sample of impure silver oxide yields 0.187 g oxygen. If silver oxide is the only source of O_2, what is the percent silver oxide by mass in the sample?

8. The mineral galena (lead(II) sulfide) can be roasted it in the presence of oxygen to form solid lead(II) oxide and sulfur dioxide. A 5.77 g sample of impure galena yields 2.11 g lead(II) oxide. If the galena is the only source of lead(II) oxide, what is the percent galena in the impure sample?

9. How many moles of CO_2 are produced by the reaction of 6.0 mol of $MgCO_3$?

$$MgCO_3 = MgO + CO_2$$

10. Suppose that 1.6 mol $Al_2(SO_4)_3$ are produced. How many moles of H_2O are also produced?

$$2Al(OH)_3 + 3H_2SO_4 = Al_2(SO_4)_3 + 6H_2O$$

11. According to reaction equation below, how many moles of $H_2C_2O_4$ react completely with 1.5 mol of $KMnO_4$?

$$2KMnO_4 + 5H_2C_2O_4 + 6HCl = 2MnCl_2 + 10\ CO_2 + 2KCl + 8H_2O$$

12. When 0.45 mol of CO_2 are produced by the reaction above, how many grams of H_2O are also produced?

13. How many grams of H_2SO_4 are required for the complete reaction of 65.0 g of $Al(OH)_3$?

$$2Al(OH)_3 + 3H_2SO_4 = Al_2(SO_4)_3 + 6H_2O$$

14. How many grams of HCl are required for the complete reaction of 316 g $KMnO_4$?

$$2KMnO_4 + 5H_2C_2O_4 + 6HCl = 2MnCl_2 + 10CO_2 + 2KCl + 8H_2O$$

Answers to Worksheet #13

Stoichiometry

The first step to stoichiometry is to write and balance the equation. If an equation is given to you, always check to make sure that it is balanced! Once the equation is balanced, use the stoichiometric coefficients and dimensional analysis to go from what you know everything about to what you want to know.

1. $\underline{2}\ KClO_3(s) \rightarrow \underline{2}\ KCl(s) + \underline{3}\ O_2(g)$

a) $$mol O_2 = 32.8 g KClO_3 \left| \frac{1 mol KClO_3}{122.55 g} \right| \frac{3 mol O_2}{2 mol KClO_3} \Bigg| = 0.401 mol O_2$$

b) $$mass(g) KClO_3 = 50.0 g O_2 \left| \frac{1 mol O_2}{32.00 g} \right| \frac{2 mol KClO_3}{3 mol O_2} \Bigg| \frac{122.55 g}{1 mol KClO_3} \Bigg| = 128 g KClO_3$$

c) $$mass(g) KCl = 23.8 g O_2 \left| \frac{1 mol O_2}{32.00 g} \right| \frac{2 mol KCl}{3 mol O_2} \Bigg| \frac{74.55 g}{1 mol KCl} \Bigg| = 37.0 g KCl$$

2. $\underline{2}\ C_2H_2(g) + \underline{5}\ O_2(g) \rightarrow \underline{4}\ CO_2(g) + \underline{2}\ H_2O(\ell)$

$$mass(g) CO_2 = 9.5 g C_2H_2 \left| \frac{1 mol C_2H_2}{26.036 g} \right| \frac{4 mol CO_2}{2 mol C_2H_2} \Bigg| \frac{44.01 g}{1 mol CO_2} \Bigg| = 32 g CO_2$$

3. $\underline{4}\ HCl(g) + \_\ MnO_2(s) \rightarrow \_\ MnCl_2(aq) + \underline{2}\ H_2O(\ell) + \_\ Cl_2(g)$

$$mass(g) Cl_2 = 13.7 g MnO_2 \left| \frac{1 mol MnO_2}{86.94 g} \right| \frac{1 mol Cl_2}{1 mol MnO_2} \Bigg| \frac{70.90 g}{1 mol Cl_2} \Bigg| = 11.2 g Cl_2$$

4. $\_\ Bi_2O_3(s) + \underline{3}\ C(s) \rightarrow \underline{2}\ Bi(s) + \underline{3}\ CO(g)$

$$mass(g) Bi_2O_3 = 60.7 g Bi \left| \frac{1 mol Bi}{209.0 g} \right| \frac{1 mol Bi_2O_3}{2 mol Bi} \Bigg| \frac{466.0 g}{mol Bi_2O_3} \Bigg| = 67.7 g Bi_2O_3$$

5. $\_\ Cr_2O_3(s) + \underline{3}\ H_2S(g) \rightarrow \_\ Cr_2S_3(s) + \underline{3}\ H_2O(\ell)$

$$mass(g) Cr_2O_3 = 83.4 g Cr_2S_3 \left| \frac{1 mol Cr_2S_3}{200.21 g} \right| \frac{1 mol Cr_2O_3}{1 mol Cr_2S_3} \Bigg| \frac{152.00 g}{1 mol Cr_2O_3} \Bigg| = 63.3 g Cr_2O_3$$

6. $\underline{4}KNO_3(s) \rightarrow \underline{2}K_2O(s) + \underline{2}N_2(g) + \underline{5}O_2(g)$

$$mass(g)KNO_3 = 86.6gO_2\left|\frac{1molO_2}{32.00g}\right|\frac{4molKNO_3}{5molO_2}\left|\frac{101.11g}{1molKNO_3}\right| = 219gKNO_3$$

7. $\underline{2}\ Ag_2O(s) \rightarrow \underline{4}\ Ag(s) + \_\ O_2(g)$

$$mass(g)Ag_2O = 0.187gO_2\left|\frac{1molO_2}{32.00g}\right|\frac{2molAg_2O}{1molO_2}\left|\frac{231.8g}{1molAg_2O}\right| = 2.71gAg_2O$$

$$\%Ag_2O = \left(\frac{2.71g}{3.13g}\right)100 = 86.6\%$$

8. $\underline{2}PbS(s) + \underline{3}O_2(g) \rightarrow \underline{2}PbO(s) + \underline{2}SO_2(g)$

$$mass(g)PbS = 2.11gPbO\left|\frac{1molPbO}{223.2g}\right|\frac{2molPbS}{2molPbO}\left|\frac{239.27g}{1molPbS}\right| = 2.26gPbS$$

$$\%PbS = \left(\frac{2.26g}{5.77g}\right)100 = 39.2\%$$

9. 6.0 mol CO_2 $\left(? \text{ mol } CO_2 = 6.0 \text{ mol } \cancel{MgCO_3} \cdot \frac{\text{mol } CO_2}{\text{mol } \cancel{MgCO_3}}\right)$

10. 9.6 mol H_2O $\left(? \text{ mol } H_2O = 1.6 \text{ mol } \cancel{Al_2(SO_4)_3} \cdot \frac{6 \text{ mol } H_2O}{\text{mol } \cancel{Al_2(SO_4)_3}}\right)$

11. 3.8 mol $H_2C_2O_5$ $\left(? \text{ mol } H_2C_2O_4 = 1.5 \text{ mol } \cancel{KMnO_4} \cdot \frac{5 \text{ mol } H_2C_2O_5}{2 \text{ mol } \cancel{KMnO_4}}\right)$

12. 6.5 g H_2O $\left(? \text{ g } H_2O = 0.45 \text{ mol } \cancel{CO_2} \cdot \frac{8 \text{ mol } \cancel{H_2O}}{10 \text{ mol } \cancel{CO_2}} \cdot \frac{18.0 \text{ g } H_2O}{\text{mol } \cancel{H_2O}}\right)$

13. 122 g H_2SO_4 $\left(? \text{ g } H_2SO_4 = 65.0 \text{ g } \cancel{Al(OH)_3} \cdot \frac{\text{mol } \cancel{Al(OH)_3}}{78.0 \text{ g } \cancel{Al(OH)_3}} \cdot \frac{3 \text{ mol } \cancel{H_2SO_4}}{2 \text{ mol } \cancel{Al(OH)_3}} \cdot \frac{98.1 \text{ g } H_2SO_4}{\text{mol } \cancel{H_2SO_4}}\right)$

14. 219 g HCl $\left(? \text{ g HCl} = 316 \text{ g } \cancel{K\ MnO_4} \cdot \frac{\text{mol } \cancel{K\ MnO_4}}{158 \text{ g } \cancel{KMnO_4}} \cdot \frac{6 \text{ mol } \cancel{HCl}}{2 \text{ mol } \cancel{KMnO_4}} \cdot \frac{36.5 \text{ g HCl}}{\text{mol } \cancel{HCl}}\right)$