Chapter 10 Blackboard Homework key (Updated Sp 2012)

1) The fertilizer ammonium sulfate, $(NH_4)_2SO_4$, is prepared by the reaction of ammonia, NH_3, with sulfuric acid: $2\ NH_3\ (g) + H_2SO_4\ (aq) \rightarrow (NH_4)_2SO_4\ (aq)$

   How many moles of ammonium sulfate are produced if 1.50 moles of ammonia react completely at STP?

   Answer: The balanced equation indicates that 2 moles of NH_3 react to produce 1 mole of $(NH_4)_2SO_4$.

$$1.50 \text{ moles } NH_3 \times \frac{1 \text{ mol } (NH_4)_2SO_4}{2 \text{ mol } NH_3} = \mathbf{0.750 \text{ moles } (NH_4)_2SO_4}$$

2) Use the chemical reaction in problem #1 to determine how many moles of ammonia are required to react with 2.50 moles of sulfuric acid.

   Answer: The balanced equation indicates that 2 moles of NH_3 react with 1 mole of H_2SO_4.

$$2.50 \text{ moles } H_2SO_4 \times \frac{2 \text{ mol } NH_3}{1 \text{ mol } H_2SO_4} = \mathbf{5.00 \text{ moles } NH_3}$$

3) Use the chemical reaction in problem #1 to determine the mass of ammonium sulfate produced if 50.0 L of ammonia gas react completely at STP.

   Answer: The balanced equation indicates that 2 moles of NH_3 react to produce 1 mole of $(NH_4)_2SO_4$. Because the reaction occurs at STP, 1 mole of NH_3 gas occupies 22.4 L.

$$50.0 \text{ L } NH_3 \times \frac{\text{mol } NH_3}{22.4 \text{ L } NH_3} \times \frac{1 \text{ mol } (NH_4)_2SO_4}{2 \text{ mol } NH_3} \times \frac{132.17 \text{ g } (NH_4)_2SO_4}{\text{mol } (NH_4)_2SO_4} = \mathbf{148 \text{ g } (NH_4)_2SO_4}$$

4) Use the chemical reaction in problem #1 to determine the volume (in L) of ammonia gas required to produce 150.0 g of ammonium sulfate at STP.

   Answer: The balanced equation indicates that 1 mole of $(NH_4)_2SO_4$ is produced when 2 moles of NH_3 react. Because the reaction occurs at STP, 1 mole of NH_3 gas occupies 22.4 L.

$$150.0 \text{ g } (NH_4)_2SO_4 \times \frac{\text{mol } (NH_4)_2SO_4}{132.17 \text{ g } (NH_4)_2SO_4} \times \frac{2 \text{ mol } NH_3}{1 \text{ mol } (NH_4)_2SO_4} \times \frac{22.4 \text{ L } NH_3}{\text{mol } NH_3} = \mathbf{50.8 \text{ L } NH_3}$$

5) Propane, C_3H_8 (g), burns in oxygen to produce carbon dioxide gas and steam. The balanced equation for the reaction is $C_3H_8\ (g) + 5\ O_2\ (g) \rightarrow 3\ CO_2\ (g) + 4\ H_2O\ (g)$

   How many moles of oxygen are required to react completely with 5.00 moles of propane?

$$5.00 \text{ moles } C_3H_8 \times \frac{5 \text{ mol } O_2}{1 \text{ mol } C_3H_8} = \mathbf{25.0 \text{ moles } C_3H_8}$$

6) Use the chemical equation in problem #5 to determine how many moles of steam are produced when 10.0 moles of oxygen react completely.

$$10.0 \text{ moles } O_2 \times \frac{4 \text{ mol } H_2O}{5 \text{ mol } O_2} = \mathbf{8.00 \text{ moles } H_2O}$$

7) Use the chemical equation in problem #5 to determine what volume (in L) of carbon dioxide gas is produced when 5.00 g of propane is burned at STP.

   Answer: The balanced equation indicates that 1 mole of C_3H_8 reacts to produce 3 moles of CO_2. Because the reaction occurs at STP, 1 mole of CO_2 gas occupies 22.4L.

$$5.00 \text{ g } C_3H_8 \times \frac{\text{mol } C_3H_8}{44.11 \text{ g } C_3H_8} \times \frac{3 \text{ mol } CO_2}{1 \text{ mol } C_3H_8} \times \frac{22.4 \text{ L } CO_2}{\text{mol } CO_2} = \mathbf{7.62 \text{ L } CO_2}$$

8) Use the chemical equation in problem #5 to determine what mass of propane must have burned to produce 75.0 L of steam at STP.

Answer: The balanced equation indicates that 1 mole of C_3H_8 reacts to produce 4 moles of H_2O. Because the reaction occurs at STP, 1 mole of H_2O gas occupies 22.4L.

$$75.0 \text{ L } H_2O \times \frac{\text{mol } H_2O}{22.4 \text{ L } H_2O} \times \frac{1 \text{ mol } C_3H_8}{4 \text{ mol } H_2O} \times \frac{44.11 \text{ g } C_3H_8}{\text{mol } C_3H_8} = \mathbf{36.9 \text{ g } C_3H_8}$$

9) Use the chemical equation in problem #5 to determine what mass of steam is produced when 11.5 g of oxyen react completely.

$$11.5 \text{g} O_2 \times \frac{1 \text{mol} O_2}{32.00 \text{g} O_2} \times \frac{4 \text{mol} H_2O}{5 \text{ mol} O_2} \times \frac{18.02 \text{g} H_2O}{1 \text{mol} H_2O} = \mathbf{5.18 \text{ g } H_2O}$$

10) Fermentation is a complex chemical process of making wine by converting glucose into ethanol and carbon dioxide: $C_6H_{12}O_6 \text{ (s)} \rightarrow 2\ C_2H_5OH \text{ (l)} + 2\ CO_2 \text{ (g)}$

Calculate the mass of ethanol produced if 5.00 g of glucose decomposes completely.

$$5.00 \text{ g } C_6H_{12}O_6 \times \frac{\text{mol } C_6H_{12}O_6}{180.18 \text{ g } C_6H_{12}O_6} \times \frac{2 \text{ mol } C_2H_5OH}{1 \text{ mol } C_6H_{12}O_6} \times \frac{46.08 \text{ g } C_2H_5OH}{\text{mol } C_2H_5OH} = \mathbf{2.56 \text{ g } C_2H_5OH}$$

11) Use the chemical equation in problem #10 to calculate the volume of carbon dioxide gas produced at STP when 100.0 g of glucose reacts.

$$100.0 \text{ g } C_6H_{12}O_6 \times \frac{\text{mol } C_6H_{12}O_6}{180.18 \text{ g } C_6H_{12}O_6} \times \frac{2 \text{ mol } CO_2}{1 \text{ mol } C_6H_{12}O_6} \times \frac{22.4 \text{ L } CO_2}{\text{mol } CO_2} = \mathbf{24.9 \text{ L } CO_2}$$

12) Nitric oxide, NO(g), reacts with oxygen to produce NO_2(g): $2NO(g) + O_2(g) \rightarrow 2\ NO_2(g)$
How many moles of NO_2 are produced from 30.0 moles of oxygen?

$$30.0 \text{ mol } O_2 \times \frac{2 \text{ mol } NO_2}{1 \text{ mol } O_2} = \mathbf{60.0 \text{ mol } NO_2}$$

13) Use the chemical equation in question #12 to calculate the mass of O_2 that must have reacted to produce 85.0 g of NO_2.

$$85.0 \text{g} NO_2 \times \frac{1 \text{mol} NO_2}{46.01 \text{g } NO_2} \times \frac{1 \text{mol } O_2}{2 \text{ mol} NO_2} \times \frac{32.00 \text{g} O_2}{1 \text{mol } O_2} = \mathbf{29.6 \text{ g } O_2}$$

14) Consider the following reaction: $Pb(NO_3)_2 \text{ (aq)} + 2\ KI \text{ (aq)} \rightarrow PbI_2 \text{ (s)} + 2\ KNO_3 \text{ (aq)}$ What is the precipitate produced in this reaction?

Answer: A **precipitate** is an **insoluble *solid*** formed when two aqueous solutions react. In the reaction above, the only solid is **PbI_2, so it is the precipitate**.

15) Use the chemical equation in question #14 to calculate the moles of KNO_3 produced from 15.0 moles of lead(II) nitrate.

$$15.0 \text{mol} Pb(NO_3)_2 \times \frac{2 \text{mol } KNO_3}{1 \text{ mol} Pb(NO_3)_2} = \mathbf{30.0 \text{ mol } KNO_3}$$

16) Use the chemical equation in question #14 to calculate the mass of PbI_2 produced from 75.00 g of potassium iodide.

$$75.00 \text{ g KI} \times \frac{\text{mol KI}}{166.00 \text{ g KI}} \times \frac{1 \text{ mol } PbI_2}{2 \text{ mol KI}} \times \frac{461.00 \text{ g } PbI_2}{\text{mol } PbI_2} = \mathbf{104.1 \text{ g } PbI_2}$$

17) Calculate the number of moles of Al that will react with 5.0 moles of HCl. Balance first!

<u>2</u> Al(s) + <u>6</u> HCl(aq) ⟶ <u>2</u> $AlCl_3$(aq) + <u>3</u> H_2(g)

$$5.0\ \text{mol HCl} \times \frac{2\ \text{mol Al}}{6\ \text{mol HCl}} = \mathbf{1.7\ mol\ Al}$$

18) Use the chemical equation in question #17 to calculate the mass of $AlCl_3$ produced from 25.0 g of hydrochloric acid.

$$25.0\text{g HCl} \times \frac{1\ \text{mol HCl}}{36.46\text{g HCl}} \times \frac{2\ \text{mol AlCl}_3}{6\ \text{mol HCl}} \times \frac{133.33\text{g AlCl}_3}{1\ \text{mol AlCl}_3} = \mathbf{30.5\ g\ AlCl_3}$$

19) Use the chemical equation in question #17 to calculate the liters of of hydrogen gas produced from 15.00 g of aluminum.

$$15.00\text{g Al} \times \frac{1\ \text{mol Al}}{26.98\ \text{g Al}} \times \frac{3\ \text{mol H}_2}{2\ \text{mol Al}} \times \frac{22.4\text{L H}_2}{1\ \text{mol H}_2} = \mathbf{18.7\ L\ H_2}$$

20) Use the chemical equation in question #17 to calculate the mass of aluminum that must have reacted to produce 18.0 grams of hydrogen gas.

$$18.0\ \text{g H}_2 \times \frac{1\ \text{mol H}_2}{2.02\ \text{g H}_2} \times \frac{2\ \text{mol Al}}{3\ \text{mol H}_2} \times \frac{26.98\text{g Al}}{1\ \text{mol Al}} = \mathbf{1.60x10^2\ g\ Al}$$