Name: _____
Hour: ____ Date: _____

Chemistry: *Stoichiometry – Problem Sheet 1*

Directions: *Solve each of the following problems. Show your work, including proper units, to earn full credit.*

1. Silver and nitric acid react according to the following balanced equation:

$$3\ Ag(s) + 4\ HNO_3(aq) \rightarrow 3\ AgNO_3(aq) + 2\ H_2O(l) + NO(g)$$

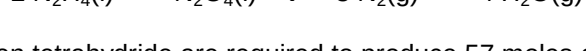
A. How many moles of silver are needed to react with 40 moles of nitric acid?

B. From the amount of nitric acid given in Part A, how many moles of silver nitrate will be produced?

C. From the amount of nitric acid given in Part A, how many moles of water will be produced?

D. From the amount of nitric acid given in Part A, how many moles of nitrogen monoxide will be made?

2. Given the balanced equation:



$$2\ N_2H_4(l) + N_2O_4(l) \rightarrow 3\ N_2(g) + 4\ H_2O(g)$$

A. How many moles of dinitrogen tetrahydride are required to produce 57 moles of nitrogen?

B. How many moles of dinitrogen tetroxide are required to produce 57 moles of nitrogen?

C. How many moles of water are produced when 57 moles of nitrogen are made?

3. Calculate the mass of aluminum oxide produced when 3.75 moles of aluminum burn in oxygen.

Answers:

1A. 30 mol Ag	1C. 20 mol H_2O	2A. 38 mol N_2H_4	2C. 76 mol H_2O
1B. 30 mol $AgNO_3$	1D. 10 mol NO	2B. 19 mol N_2O_4	3. 191 g Al_2O_3

4. At a very high temperature, manganese is isolated from its ore, manganomanganic oxide, via the following balanced equation:

$$3\ Mn_3O_4(s) + 8\ Al(s) \rightarrow 4\ Al_2O_3(s) + 9\ Mn(s)$$

A. How many manganese atoms are liberated if 54.8 moles of Mn_3O_4 react with excess aluminum.

B. How many moles of aluminum oxide are made if 3580 g of manganomanganic oxide are consumed?

C. How many moles of manganomanganic oxide will react with 5.33×10^{25} atoms of aluminum?

D. If 4.37 moles of aluminum are consumed, how many molecules of aluminum oxide are produced?

5. Camels store the fat tristearin ($C_{57}H_{110}O_6$) in the hump. Besides being a source of energy, the fat is a source of water for the camel because when the fat is burned, the following reaction occurs:

$$2\ C_{57}H_{110}O_6(s) + 163\ O_2(g) \rightarrow 114\ CO_2(g) + 110\ H_2O(l)$$

A. At STP, what volume of oxygen is required to consume 0.64 moles of tristearin?

B. At STP, what volume of carbon dioxide is produced in Part A?

C. If 22.4 L of oxygen is consumed at STP, how many moles of water are produced?

D. Find the mass of tristearin required to produce 55.56 moles of water (about 1 liter of liquid water).

Answers:

4A. 9.9×10^{25} atoms Mn	4C. 33.2 mol Mn_3O_4	5A. 1168 L O_2	5C. 0.675 mol H_2O
4B. 20.9 mol Al_2O_3	4D. 1.3×10^{24} m'cules Al_2O_3	5B. 817 L CO_2	5D. 899 g $C_{57}H_{110}O_6$

KEY

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1. Silver and nitric acid react according to the following balanced equation:

$$3\ Ag(s) + 4\ HNO_3(aq) \rightarrow 3\ AgNO_3(aq) + 2\ H_2O(l) + NO(g)$$

A. How many moles of silver are needed to react with 40 moles of nitric acid?

$$x\ \text{mol Ag} = 40\ \text{mol HNO}_3\left(\frac{3\ \text{mol Ag}}{4\ \text{mol HNO}_3}\right) = 30\ \text{mol Ag}$$

B. From the amount of nitric acid given in Part A, how many moles of silver nitrate will be produced?

$$x\ \text{mol AgNO}_3 = 40\ \text{mol HNO}_3\left(\frac{3\ \text{mol AgNO}_3}{4\ \text{mol HNO}_3}\right) = 30\ \text{mol AgNO}_3$$

C. From the amount of nitric acid given in Part A, how many moles of water will be produced?

$$x\ \text{mol H}_2\text{O} = 40\ \text{mol HNO}_3\left(\frac{2\ \text{mol H}_2\text{O}}{4\ \text{mol HNO}_3}\right) = 20\ \text{mol H}_2\text{O}$$

D. From the amount of nitric acid given in Part A, how many moles of nitrogen monoxide will be made?

$$x\ \text{mol NO} = 40\ \text{mol HNO}_3\left(\frac{1\ \text{mol NO}}{4\ \text{mol HNO}_3}\right) = 10\ \text{mol NO}$$

2. Given the balanced equation: $2\ N_2H_4(l) + N_2O_4(l) \rightarrow 3\ N_2(g) + 4\ H_2O(g)$

A. How many moles of dinitrogen tetrahydride are required to produce 57 moles of nitrogen?

$$x\ \text{mol N}_2\text{H}_4 = 57\ \text{mol N}_2\left(\frac{2\ \text{mol N}_2\text{H}_4}{3\ \text{mol N}_2}\right) = 38\ \text{mol N}_2\text{H}_4$$

B. How many moles of dinitrogen tetroxide are required to produce 57 moles of nitrogen?

$$x\ \text{mol N}_2\text{O}_4 = 57\ \text{mol N}_2\left(\frac{2\ \text{mol N}_2\text{O}_4}{3\ \text{mol N}_2}\right) = 19\ \text{mol N}_2\text{O}_4$$

C. How many moles of water are produced when 57 moles of nitrogen are made?

$$x\ \text{mol H}_2\text{O} = 57\ \text{mol N}_2\left(\frac{4\ \text{mol H}_2\text{O}}{3\ \text{mol N}_2}\right) = 76\ \text{mol H}_2\text{O}$$

3. Calculate the mass of aluminum oxide produced when 3.75 moles of aluminum burn in oxygen.

4 Al + 3 O_2 → 2 Al_2O_3
3.75 mol excess x g

$$x\ \text{g Al}_2\text{O}_3 = 3.75\ \text{mol Al}\left(\frac{2\ \text{mol Al}_2\text{O}_3}{4\ \text{mol Al}}\right)\left(\frac{102\ \text{g Al}_2\text{O}_3}{1\ \text{mol Al}_2\text{O}_3}\right) = 191\ \text{g Al}_2\text{O}_3$$

Answers:
1A. 30 mol Ag
1B. 30 mol $AgNO_3$
1C. 20 mol H_2O
1D. 10 mol NO
2A. 38 mol N_2H_4
2B. 19 mol N_2O_4
2C. 76 mol H_2O
3. 191 g Al_2O_3

4. At a very high temperature, manganese is isolated from its ore, manganomanganic oxide, via the following balanced equation:

$$3\ Mn_3O_4(s) + 8\ Al(s) \rightarrow 4\ Al_2O_3(s) + 9\ Mn(s)$$

A. How many manganese atoms are liberated if 54.8 moles of Mn_3O_4 react with excess aluminum.

$$x\ \text{atoms Mn} = 54.8\ \text{mol}\ Mn_3O_4\left(\frac{9\ \text{mol Mn}}{3\ \text{mol}\ Mn_3O_4}\right)\left(\frac{6.02\times10^{23}\ \text{atoms Mn}}{1\ \text{mol Mn}}\right) = 9.9\times10^{25}\ \text{atoms Mn}$$

B. How many moles of aluminum oxide are made if 3580 g of manganomanganic oxide are consumed?

$$x\ \text{mol}\ Al_2O_3 = 3580\ \text{g}\ Mn_3O_4\left(\frac{1\ \text{mol}\ Mn_3O_4}{229\ \text{g}\ Mn_3O_4}\right)\left(\frac{4\ \text{mol}\ Al_2O_3}{3\ \text{mol}\ Mn_3O_4}\right) = 20.9\ \text{mol}\ Al_2O_3$$

C. How many moles of manganomanganic oxide will react with 5.33 x 10^{25} atoms of aluminum?

$$x\ \text{mol}\ Mn_3O_4 = 5.33\times10^{25}\ \text{atoms Al}\left(\frac{1\ \text{mol Al}}{6.02\times10^{23}\ \text{atoms Al}}\right)\left(\frac{3\ \text{mol}\ Mn_3O_4}{8\ \text{mol Al}}\right) = 33.2\ \text{mol}\ Mn_3O_4$$

D. If 4.37 moles of aluminum are consumed, how many molecules of aluminum oxide are produced?

$$x\ \text{m'cules}\ Al_2O_3 = 4.37\ \text{mol Al}\left(\frac{4\ \text{mol}\ Al_2O_3}{8\ \text{mol Al}}\right)\left(\frac{6.02\times10^{23}\ \text{m'cules}\ Al_2O_3}{1\ \text{mol}\ Al_2O_3}\right) = 1.3\times104\ \text{m'cules}\ Al_2O_3$$

5. Camels store the fat tristearin ($C_{57}H_{110}O_6$) in the hump. Besides being a source of energy, the fat is a source of water for the camel because when the fat is burned, the following reaction occurs:

$$2\ C_{57}H_{110}O_6(s) + 163\ O_2(g) \rightarrow 114\ CO_2(g) + 110\ H_2O(l)$$

A. At STP, what volume of oxygen is required to consume 0.64 moles of tristearin?

$$x\ \text{L}\ O_2 = 0.64\ \text{mol}\ C_{57}H_{110}O_6\left(\frac{163\ \text{mol}\ O_2}{2\ \text{mol}\ C_{57}H_{110}O_6}\right)\left(\frac{22.4\ \text{L}\ CO_2}{1\ \text{mol}\ O_2}\right) = 1168\ \text{L}\ O_2$$

B. At STP, what volume of carbon dioxide is produced in Part A?

$$x\ \text{L}\ CO_2 = 0.64\ \text{mol}\ C_{57}H_{110}O_6\left(\frac{114\ \text{mol}\ CO_2}{2\ \text{mol}\ C_{57}H_{110}O_6}\right)\left(\frac{22.4\ \text{L}\ CO_2}{1\ \text{mol}\ CO_2}\right) = 817\ \text{L}\ CO_2$$

C. If 22.4 L of oxygen is consumed at STP, how many moles of water are produced?

$$x\ \text{mol}\ H_2O = 22.4\ \text{L}\ O_2\left(\frac{1\ \text{mol}\ O_2}{22.4\ \text{L}\ O_2}\right)\left(\frac{110\ \text{mol}\ H_2O}{163\ \text{mol}\ O_2}\right) = 0.675\ \text{mol}\ H_2O$$

D. Find the mass of tristearin required to produce 55.56 moles of water (about 1 liter of liquid water).

$$x\ \text{g}\ C_{57}H_{110}O_6 = 55.6\ \text{mol}\ H_2O\left(\frac{2\ \text{mol}\ C_{57}H_{110}O_6}{110\ \text{mol}\ H_2O}\right)\left(\frac{890\ \text{g}\ C_{57}H_{110}O_6}{1\ \text{mol}\ C_{57}H_{110}O_6}\right) = 899\ \text{g}\ C_{57}H_{110}O_6$$

Answers:

4A. 9.9 x 10^{25} atoms Mn
4B. 20.9 mol Al_2O_3
4C. 33.2 mol Mn_3O_4
4D. 1.3 x 10^{24} m'cules Al_2O_3
5A. 1168 L O_2
5B. 817 L CO_2
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