Name: Date: Period:

Stoichiometry Review

1. Use the reaction below to answer the following questions:

$$Na_2SiO_3 + 8\ HF \rightarrow H_2SiF_6 + 2\ NaF + 3\ H_2O$$

   a. How many moles of hydrofluoric acid are needed to react with 0.300 moles of Na_2SiO_3?

   b. How many grams of sodium fluoride are produced when 0.500 moles of hydrofluoric acid reacts with excess Na_2SiO_3?

   c. How many grams of Na_2SiO_3 are required to react with 80.4 grams of hydrofluoric acid?

   d. At STP, how many liters of water vapor are produced from the reaction of 5.77 moles of hydrofluoric acid?

2. When glucose ($C_6H_{12}O_6$) is burned in oxygen, carbon dioxide and water are produced:

$$C_6H_{12}O_6 + 9\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$$

a. How many moles of water are produced when 0.450 moles of glucose are burned?

b. If 284.7 grams of glucose are burned, how many moles of carbon dioxide are formed?

c. How many grams of glucose are required to react with 43.8 grams of oxygen gas?

d. If 124L of carbon dioxide are produced, how many moles of oxygen gas reacted?

3. Use the reaction below to answer the following questions:

$$Fe_2O_3 + 3\ CO \rightarrow 2\ Fe + 3\ CO_2$$

a. Calculate the number of moles of carbon monoxide required to produce 9.4 moles of iron.

b. If 2.44 moles of carbon monoxide react, how many grams of carbon dioxide are produced?

c. How many grams of iron (III) oxide are required to produce 72.1 grams of iron?

d. If 15.22 moles of iron (III) oxide reacted, how many liters of carbon dioxide were produced? Assume STP.

e. If 133L of carbon monoxide were consumed, how many liters of carbon dioxide were produced? Assume STP

4. Use the reaction below to answer the following questions:

$$C_6H_6 + Br_2 \rightarrow C_6H_5Br + HBr$$

a. How many moles of bromine are required to react with 3.11 moles of benzene (C_6H_6)?

b. If 61.92 grams of benzene are consumed, how many moles of hydrobromic acid are formed?

c. How many grams of bromobenzene (C_6H_5Br) are produced from the reaction of 117.83 grams of benzene (C_6H_6)?

d. If 124L of bromine gas are consumed, how many grams of hydrobromic acid are produced?

Solutions:

1. Reaction for this problem is:

$$Na_2SiO_3 + 8\ HF \rightarrow H_2SiF_6 + 2\ NaF + 3\ H_2O$$

   a. This is a moles to moles problem, so only one step is required:

   Moles Na_2SiO_3 → Moles HF

$$0.300 \text{ moles } Na_2SiO_3 \text{ x } \frac{8 \text{ moles HF}}{1 \text{ mole } Na_2SiO_3} = 2.40 \text{ moles HF}$$

   b. This is a moles to grams problem, so two steps are required:

   Moles HF → Moles NaF → Grams NaF

   Molar mass of NaF = 1(22.99) + 1(18.998) = 41.998 g/mol

$$0.500 \text{ moles HF x } \frac{2 \text{ moles NaF}}{8 \text{ mole HF}} \text{ x } \frac{41.988\text{g NaF}}{1 \text{ mole NaF}} = 5.25\text{g NaF}$$

   c. This is a grams to grams problem, so three steps are required

   Grams HF → Moles HF → Moles Na_2SiO_3 → Grams Na_2SiO_3

   Molar mass of HF = 1(1.008) + 1(18.998) = 20.006 g/mol

   Molar mass of Na_2SiO_3 = 2(22.99) + 1(28.086) + 3(15.999) = 122.063 g/mol

$$80.4\text{g HF x } \frac{1 \text{ mole HF}}{20.006\text{g HF}} \text{ x } \frac{1 \text{ mole } Na_2SiO_3}{8 \text{ moles HF}} \text{ x } \frac{122.063\text{g } Na_2SiO_3}{1 \text{ mole } Na_2SiO_3} = 61.3\text{g } Na_2SiO_3$$

   d. This is a moles to volume problem, so two steps are required:

   Moles HF → Moles H_2O → Volume H_2O

$$5.77 \text{ moles HF x } \frac{3 \text{ moles } H_2O}{8 \text{ moles HF}} \text{ x } \frac{22.4\text{L } H_2O}{1 \text{ mole } H_2O} = 48.5\text{L } H_2O$$

2. Reaction for this problem is:

$$C_6H_{12}O_6 + 9\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$$

a. This is a moles to moles problem, so only one step is required:

Moles $C_6H_{12}O_6$ → Moles H_2O

$$0.450 \text{ moles } C_6H_{12}O_6 \text{ x } \frac{6 \text{ moles } H_2O}{1 \text{ mole } C_6H_{12}O_6} = 2.70 \text{ moles } H_2O$$

b. This is a grams to moles problem, so two steps are required:

Grams $C_6H_2O_6$ → Moles $C_6H_{12}O_6$ → Moles CO_2

Molar mass of $C_6H_{12}O_6$ = 6(12.011) + 12(1.008) + 6(15.999) = 180.156 g/mol

$$284.7\text{g } C_6H_{12}O_6 \text{ x } \frac{1 \text{ moles } C_6H_{12}O_6}{180.156\text{g } C_6H_{12}O_6} \text{ x } \frac{6 \text{ moles } CO_2}{1 \text{ mole } C_6H_{12}O_6} = 9.482 \text{ moles } CO_2$$

c. This is a grams to grams problem, so three steps are required

Grams O_2 → Moles O_2 → Moles $C_6H_{12}O_6$ → Grams $C_6H_{12}O_6$

Molar mass of O_2 = 2(15.999) = 31.998 g/mol

Molar mass of $C_6H_{12}O_6$ = 6(12.011) + 12(1.008) + 6(15.999) = 180.156 g/mol

$$43.8\text{g } O_2 \text{ x } \frac{1 \text{ mole } O_2}{31.998\text{g } O_2} \text{ x } \frac{1 \text{ mole } C_6H_{12}O_6}{9 \text{ moles } O_2} \text{ x } \frac{180.156\text{g } C_6H_{12}O_6}{1 \text{ mole } C_6H_{12}O_6} = 27.4\text{g } C_6H_{12}O_6$$

d. This is a volume to moles problem, so two steps are required:

Volume CO_2 → Moles CO_2 → Moles O_2

$$124\text{L } CO_2 \text{ x } \frac{1 \text{ mole } CO_2}{22.4\text{L } CO_2} \text{ x } \frac{9 \text{ moles } O_2}{6 \text{ moles } CO_2} = 8.30 \text{ moles } O_2$$

3. Reaction for this problem is:

$$Fe_2O_3 + 3\ CO \rightarrow 2\ Fe + 3\ CO_2$$

a. This is a moles to moles problem, so only one step is required:

Moles Fe → Moles CO

$$9.4 \text{ moles Fe x } \frac{3 \text{ moles CO}}{1 \text{ mole Fe}} = 28 \text{ moles CO}$$

b. This is a moles to grams problem, so two steps are required:

Moles CO → Moles CO_2 → Grams CO_2

Molar mass of CO_2 = 1(12.011) + 2(15.999) = 44.009 g/mol

$$2.44 \text{ moles CO x} \frac{3 \text{ moles } CO_2}{3 \text{ moles CO}} \text{ x } \frac{44.009\text{g } CO_2}{1 \text{ mole } CO_2} = 107\text{g } CO_2$$

c. This is a grams to grams problem, so three steps are required

Grams Fe → Moles Fe → Moles Fe_2O_3 → Grams Fe_2O_3

Molar mass of Fe = 1(55.845) = 55.845 g/mol

Molar mass of Fe_2O_3 = 2(55.845) + 3(15.999) = 159.687 g/mol

$$72.1\text{g Fe x } \frac{1 \text{ mole Fe}}{55.845\text{g Fe}} \text{ x } \frac{1 \text{ mole } Fe_2O_3}{2 \text{ moles Fe}} \text{ x } \frac{159.687\text{g } Fe_2O_3}{1 \text{ mole } Fe_2O_3} = 103\text{g } Fe_2O_3$$

d. This is a moles to volume problem, so two steps are required:

Moles Fe_2O_3 → Moles CO_2 → Volume CO_2

$$15.22 \text{ moles } Fe_2O_3 \text{ x } \frac{3 \text{ moles } CO_2}{1 \text{ mole } Fe_2O_3} \text{ x } \frac{22.4\text{L } CO_2}{1 \text{ mole } CO_2} = 1023\text{L } CO_2$$

e. This is a volume to volume problem, so three steps are required:

Volume CO → Moles CO → Moles CO_2 → Volume CO_2

$$133\text{L CO x } \frac{1 \text{ mole CO}}{22.4\text{L CO}} \text{ x } \frac{3 \text{ moles } CO_2}{3 \text{ mole CO}} \text{ x } \frac{22.4\text{L } CO_2}{1 \text{ mole } CO_2} = 133\text{L } CO_2$$

4. Reaction for this problem is:

$$C_6H_6 + Br_2 \rightarrow C_6H_5Br + HBr$$

a. This is a moles to moles problem, so only one step is required:

Moles $C_6H_6 \rightarrow$ Moles Br_2

$$3.11 \text{ moles } C_6H_6 \text{ x } \frac{1 \text{ mole } Br_2}{1 \text{ mole } C_6H_6} = 3.11 \text{ moles } Br_2$$

b. This is a grams to moles problem, so two steps are required:

Grams $C_6H_6 \rightarrow$ Moles $C_6H_6 \rightarrow$ Moles HBr

Molar mass of C_6H_6 = 6(12.011) + 6(1.008) = 78.114 g/mol

$$61.92\text{g } C_6H_6 \text{ x } \frac{1 \text{ mole } C_6H_6}{78.114\text{g } C_6H_6} \text{ x } \frac{1 \text{ mole HBr}}{1 \text{ mole } C_6H_6} = 0.7927 \text{ moles HBr}$$

c. This is a grams to grams problem, so three steps are required

Grams $C_6H_6 \rightarrow$ Moles $C_6H_6 \rightarrow$ Moles $C_6H_5Br \rightarrow$ Grams C_6H_5Br

Molar mass of C_6H_6 = 6(12.011) + 6(1.008) = 78.114 g/mol

Molar mass of C_6H_5Br = 6(12.011) + 5(1.008) + 1(79.904) = 157.01 g/mol

$$117.83\text{g } C_6H_6 \text{ x } \frac{1 \text{ mole } C_6H_6}{78.114\text{g } C_6H_6} \text{ x } \frac{1 \text{ mole } C_6H_5Br}{1 \text{ mole } C_6H_6} \text{ x } \frac{157.01\text{g } C_6H_5Br}{1 \text{ mole } C_6H_5Br} = 236.84$$

d. This is a volume to grams problem, so three steps are required:

Volume $Br_2 \rightarrow$ Moles $Br_2 \rightarrow$ Moles HBr $\rightarrow$ Grams HBr

$$124\text{L } Br_2 \text{ x } \frac{1 \text{ mole } Br_2}{22.4\text{L } Br_2} \text{ x } \frac{1 \text{ mole HBr}}{1 \text{ mole } Br_2} \text{ x } \frac{80.912\text{g HBr}}{1 \text{ mole HBr}} = 448 \text{ grams HBr}$$