Name _____ Date _____ Class _____

Using Mole Ratios

Use with Chapter 11, Section 11.2

Mole ratios relate moles of unknown and known substances in a balanced chemical equation and are used to make stoichiometric mole-to-mole conversions between molar amounts of unknown and known substances.

$$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$$

To convert

number of moles of known substance	to	number of moles of unknown substance	use this	mole ratio
C_3H_8		O_2		$\frac{5\ mol\ O_2}{1\ mol\ C_3H_8}$
C_3H_8		CO_2		$\frac{3\ mol\ CO_2}{1\ mol\ C_3H_8}$
C_3H_8		H_2O		$\frac{4\ mol\ H_2O}{1\ mol\ C_3H_8}$
O_2		C_3H_8		$\frac{1\ mol\ C_3H_8}{5\ mol\ O_2}$
O_2		CO_2		$\frac{3\ mol\ CO_2}{5\ mol\ O_2}$
O_2		H_2O		$\frac{4\ mol\ H_2O}{5\ mol\ O_2}$
CO_2		C_3H_8		$\frac{1\ mol\ C_3H_8}{3\ mol\ CO_2}$
CO_2		O_2		$\frac{5\ mol\ O_2}{3\ mol\ CO_2}$
CO_2		H_2O		$\frac{4\ mol\ H_2O}{3\ mol\ CO_2}$
H_2O		C_3H_8		$\frac{1\ mol\ C_3H_8}{4\ mol\ H_2O}$
H_2O		O_2		$\frac{5\ mol\ O_2}{4\ mol\ H_2O}$
H_2O		CO_2		$\frac{3\ mol\ CO_2}{4\ mol\ H_2O}$

Name _____ Date _____ Class _____

MATH SKILLS TRANSPARENCY WORKSHEET 16

Using Mole Ratios

Use with Chapter 11, Section 11.2

For each of the following problems, write the balanced chemical equation that represents the reaction. Then complete the table below by identifying the known substance, the unknown substance, and the mole ratio that you would use to solve each problem correctly.

1. Copper(II) oxide (CuO) decomposes into copper (Cu) and oxygen (O_2) gas. What mass of copper will be produced by the decomposition of 1.25 kg CuO?

_____

2. Ammonia (NH_3) is produced by the reaction of nitrogen (N_2) and hydrogen (H_2) gases. How much ammonia will be produced if 22.0 g H_2 reacts with excess N_2?

_____

3. The reaction of sodium (Na) and water (H_2O) produces sodium hydroxide (NaOH) and hydrogen (H_2) gas. What mass of hydrogen gas is produced if 17.54 g NaOH is produced by the reaction?

_____

4. The combustion of acetic acid ($HC_2H_3O_2$) produces carbon dioxide (CO_2) and water (H_2O). What mass of carbon dioxide will be produced from the combustion of 25.0 g $HC_2H_3O_2$?

_____

5. 20.0 g of iron(III) sulfide (Fe_2S_3) was prepared by heating iron (Fe) and excess sulfur (S). What mass of iron was used in the preparation?

_____

Problem	Chemical Formula of Known Substance	Chemical Formula of Unknown Substance	Mole Ratio
1			
2			
3			
4			
5			

Name _____ Date _____ Class _____

Solving Stoichiometric Mass-to-Mass Conversion Problems

Use with Chapter 11, Section 11.2

unknown substance

What mass in grams of silver (Ag) will be produced when 125 g of silver oxide (Ag_2O) decomposes?

known substance

Step 1

Write the balanced equation.

$$2Ag_2O \rightarrow 4Ag + O_2$$

Step 2

Find the number of moles of known substance using mass-to-mole conversion.

$$1\ \text{mol}\ Ag_2O \times \frac{2\ \text{mol Ag}}{1\ \text{mol}\ Ag_2O} \times \frac{107.87\ \text{g Ag}}{1\ \text{mol Ag}} = 215.74\ \text{g Ag}$$

$$1\ \text{mol}\ Ag_2O \times \frac{1\ \text{mol O}}{1\ \text{mol}\ Ag_2O} \times \frac{16.00\ \text{g O}}{1\ \text{mol O}} = 16.00\ \text{g O}$$

$$\text{Molar mass}\ Ag_2O = 231.74\ \text{g}\ Ag_2O$$

$$125\ \text{g}\ Ag_2O \times \frac{1\ \text{mol}\ Ag_2O}{231.74\ \text{g}\ Ag_2O} = 0.539\ \text{mol}\ Ag_2O$$

number of moles of known substance

Step 3

Determine the number of moles of the unknown substance from the number of moles of the known substance using mole-to-mole conversions.

$$0.539\ \text{g}\ Ag_2O \times \frac{4\ \text{mol Ag}}{2\ \text{mol}\ Ag_2O} = 1.08\ \text{mol Ag}$$

number of moles of unknown substance

Step 4

Determine the mass of the unknown substance using mole-to-mass conversion.

$$1.08\ \text{mol Ag} \times \frac{107.87\ \text{g Ag}}{1\ \text{mol Ag}} = 116\ \text{g Ag}$$

Name _____ Date _____ Class _____

MATH SKILLS TRANSPARENCY WORKSHEET 17

Solving Stoichiometric Mass-to-Mass Conversion Problems

Use with Chapter 11, Section 11.2

1. The reaction of iron(III) oxide (Fe_2O_3) and hydrogen (H_2) is represented by the following unbalanced chemical equation.

_____$Fe_2O_3(s)$ + _____$H_2(g)$ **O** ___$Fe(s)$ + _____$H_2O(l)$

Determine the mass in grams of hydrogen gas needed to react completely with 33.5 g Fe_2O_3.

Step 1.

Step 2.

Step 3.

Step 4.

2. Determine the mass in grams of copper(II) sulfide (Cu_2S) formed when 15.0 g copper(I) chloride (CuCl) reacts with excess hydrogen sulfide (H_2S) according to the following unbalanced chemical equation.

_____$CuCl(aq)$ + _____$H_2S(g)$ **O** __$Cu_2S(s)$ + _____$HCl(aq)$

Step 1.

Step 2.

Step 3.

Step 4.

Name_____ Date_____ Class _____

MATH SKILLS TRANSPARENCY WORKSHEET 15

Determining Mole Ratios

Use with Chapter 11, Section 11.1

Determine the mole ratios for each of the following balanced chemical equations.

1. $2C(s) + O_2(g) \rightarrow 2CO(g)$

1 mol O_2/2 mol C **2 mol CO/2 mol C**

2 mol C/1 mol O_2 **2 mol CO/1 mol O_2**

2 mol C/2 mol CO **1 mol O_2/2 mol CO**

2. $WO_3(s) + 3H_2(g) \rightarrow W(s) + 3H_2O(g)$

3 mol H_2/1 mol WO_3 **1 mol W/1 mol WO_3** **3 mol H_2O/1 mol WO_3**

1 mol WO_3/3 mol H_2 **1 mol W/3 mol H_2** **3 mol H_2O/3 mol H_2**

1 mol WO_3/1 mol W **3 mol H_2/1 mol W** **3 mol H_2O/1 mol W**

1 mol WO_3/3 mol H_2O **3 mol H_2/3 mol H_2O** **1 mol W/3 mol H_2O**

3. $2IrCl_3(aq) + 3NaOH(aq) \rightarrow Ir_2O_3(s) + 3HCl(aq) + 3NaCl(aq)$

3 mol NaOH/2 mol $IrCl_3$ **1 mol Ir_2O_3/2 mol $IrCl_3$**

3 mol HCl/2 mol $IrCl_3$ **3 mol NaCl/2 mol $IrCl_3$**

2 mol $IrCl_3$/3 mol NaOH **1 mol Ir_2O_3/3 mol NaOH**

3 mol HCl/3 mol NaOH **3 mol NaCl/3 mol NaOH**

2 mol $IrCl_3$/1 mol Ir_2O_3 **3 mol NaOH/1 mol Ir_2O_3**

3 mol HCl/1 mol Ir_2O_3 **3 mol NaCl/1 mol Ir_2O_3**

2 mol $IrCl_3$/3 mol HCl **3 mol NaOH/3 mol HCl**

1 mol Ir_2O_3/3 mol HCl **3 mol NaCl/3 mol HCl**

2 mol $IrCl_3$/3 mol NaCl **3 mol NaOH/3 mol NaCl**

1 mol Ir_2O_3/3 mol NaCl **3 mol HCl/3 mol NaCl**

Name_____ Date_____ Class _____

MATH SKILLS TRANSPARENCY WORKSHEET 16

Using Mole Ratios

Use with Chapter 11, Section 11.2

For each of the following problems, write the balanced chemical equation that represents the reaction. Then complete the table below by identifying the known substance, the unknown substance, and the mole ratio that you would use to solve each problem correctly.

1. Copper(II) oxide (CuO) decomposes into copper (Cu) and oxygen (O_2) gas. What mass of copper will be produced by the decomposition of 1.25 kg CuO?

$2CuO \rightarrow 2Cu + O_2$

2. Ammonia (NH_3) is produced by the reaction of nitrogen (N_2) and hydrogen (H_2) gases. How much ammonia will be produced if 22.0 g H_2 reacts with excess N_2?

$N_2 + 3H_2 \rightarrow 2NH_3$

3. The reaction of sodium (Na) and water (H_2O) produces sodium hydroxide (NaOH) and hydrogen (H_2) gas. What mass of hydrogen gas is produced if 17.54 g NaOH is produced by the reaction?

$2Na + 2H_2O \rightarrow 2NaOH + H_2$

4. The combustion of acetic acid ($HC_2H_3O_2$) produces carbon dioxide (CO_2) and water (H_2O). What mass of carbon dioxide will be produced from the combustion of 25.0 g $HC_2H_3O_2$?

$HC_2H_3O_2 + 2O_2 \rightarrow 2CO_2 + 2H_2O$

5. 20.0 g of iron(III) sulfide (Fe_2S_3) was prepared by heating iron (Fe) and excess sulfur (S). What mass of iron was used in the preparation?

$2Fe + 3S \rightarrow Fe_2S_3$

Problem	Chemical Formula of Known Substance	Chemical Formula of Unknown Substance	Mole Ratio
1	CuO	Cu	2 mol Cu/2 mol CuO
2	H_2	NH_3	2 mol NH_3/3 mol H_2
3	NaOH	H_2	1 mol H_2/2 mol NaOH
4	$HC_2H_3O_2$	CO_2	2 mol CO_2/1 mol $HC_2H_3O_2$
5	Fe_2S_3	Fe	2 mol Fe/1 mol Fe_2S_3

Name _____ Date _____ Class _____

MATH SKILLS TRANSPARENCY WORKSHEET 17

Solving Stoichiometric Mass-to-Mass Conversion Problems

Use with Chapter 11, Section 11.2

1. The reaction of iron(III) oxide (Fe_2O_3) and hydrogen (H_2) is represented by the following unbalanced chemical equation.

_____$Fe_2O_3(s)$ + _____$H_2(g)$ **O** ___$Fe(s)$ + _____$H_2O(l)$

Determine the mass in grams of hydrogen gas needed to react completely with 33.5 g Fe_2O_3.

Step 1. $Fe_2O_3 + 3H_2 \rightarrow 2Fe + 3H_2O$

Step 2. $1\ \text{mol } Fe_2O_3 \times 2\ \text{mol Fe}/1\ \text{mol } Fe_2O_3 \times 55.85\ \text{g Fe}/1\ \text{mol Fe} = 111.7\ \text{g Fe}$

$1\ \text{mol } Fe_2O_3 \times 3\ \text{mol O}/1\ \text{mol } Fe_2O_3 \times 16.00\ \text{g O}/1\ \text{mol O} = 48.00\ \text{g O}$

Molar mass $Fe_2O_3 = 159.7\ \text{g/mol } Fe_2O_3$

$33.5\ \text{g } Fe_2O_3 \times 1\ \text{mol } Fe_2O_3/159.7\ \text{g } Fe_2O_3 = 0.210\ \text{mol } Fe_2O_3$

Step 3. $0.210\ \text{mol } Fe_2O_3 \times 3\ \text{mol } H_2/1\ \text{mol } Fe_2O_3 = 0.630\ \text{g/mol } H_2$

Step 4. $1\ \text{mol } H_2 \times 2\ \text{mol H}/1\ \text{mol } H_2 \times 1.01\ \text{g H}/1\ \text{mol H} = 2.02\ \text{g H}$

Molar mass $H_2 = 2.02\ \text{g/mol } H_2$

$0.630\ \text{mol } H_2 \times 2.02\ \text{g } H_2/1\ \text{mol } H_2 = 1.27\ \text{g } H_2$

2. Determine the mass in grams of copper(II) sulfide (Cu_2S) formed when 15.0 g copper(I) chloride (CuCl) reacts with excess hydrogen sulfide (H_2S) according to the following unbalanced chemical equation.

_____$CuCl(aq)$ + _____$H_2S(g)$ **O** ___$Cu_2S(s)$ + _____$HCl(aq)$

Step 1. $2CuCl(aq) + H_2S \rightarrow Cu_2S + 2HCl$

Step 2. $1\ \text{mol CuCl} \times 1\ \text{mol Cu}/1\ \text{mol CuCl} \times 63.55\ \text{g Cu}/1\ \text{mol Cu} = 63.55\ \text{g Cu}$

$1\ \text{mol CuCl} \times 1\ \text{mol Cl}/1\ \text{mol CuCl} \times 35.45\ \text{g Cl}/1\ \text{mol Cl} = 35.45\ \text{g Cl}$

Molar mass CuCl = 99.00 g/mol CuCl

$15.0\ \text{g CuCl} \times 1\ \text{mol CuCl}/99.00\ \text{g CuCl} = 0.152\ \text{mol CuCl}$

Step 3. $0.152\ \text{mol CuCl} \times 1\ \text{mol } Cu_2S/2\ \text{mol CuCl} = 0.0760\ \text{g/mol } Cu_2S$

Step 4. $1\ \text{mol } Cu_2S \times 2\ \text{mol Cu}/1\ \text{mol } Cu_2S \times 63.55\ \text{g Cu}/1\ \text{mol Cu} = 127.10\ \text{g Cu}$

$1\ \text{mol } Cu_2S \times 1\ \text{mol S}/1\ \text{mol } Cu_2S \times 32.07\ \text{g S}/1\ \text{mol S} = 32.07\ \text{g S}$

Molar mass $Cu_2S = 159.17\ \text{g/mol } Cu_2S$

$0.0760\ \text{mol } Cu_2S \times 159.17\ \text{g } Cu_2S/1\ \text{mol } Cu_2S = 12.1\ \text{g } Cu_2S$

Name _____ Date _____ Class _____

MATH SKILLS TRANSPARENCY WORKSHEET 18

Unit Cells of Crystals

Use with Chapter 12, Section 12.3

1. Explain what a crystalline solid is.
A crystalline solid is a solid with an orderly, geometric, three-dimensional structure.

2. How many surfaces, or faces, do most crystal unit cells have? Which type of unit cell has a different number of faces? What is that number?
six; hexagonal system; eight

3. How many corners do most unit cells have? Which type of unit cell has a different number of corners? What is that number?
eight; hexagonal system; twelve

4. What do the letters a, b, and c in the transparency represent?
The letters represent the edges of the faces of a unit cell.

5. What do the symbols a., □, and 'Y represent?
The symbols represent the angles between the faces of a unit cell.

6. How many dimensions (length, width, depth) are needed to classify a unit cell?
three

7. How many faces are needed to determine the dimensions of a unit cell? **two**

8. How many angle measurements are needed to classify a unit cell? **three**

9. Identify the types of unit cells that have three equal dimensions.
cubic and rhombohedral

10. Identify the types of unit cells that have equal angles.
cubic, tetragonal, and orthorhombic

11. How does the cubic unit cell differ from the rhombohedral unit cell?
The three equal angles in the cubic unit cell are right angles; in the rhombohedral unit cell, the

12. Which unit cells meet the requirements a = b and a . = □?
cubic, tetragonal, hexagonal, and rhombohedral

13. How does the triclinic unit cell differ from all the other unit cells?
In a triclinic unit cell, no angles are equal and no dimensions are equal.