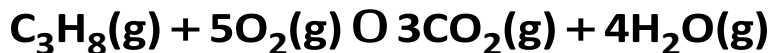


**MATH SKILLS TRANSPARENCY MASTER**

# 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.



To convert

number of moles of known substance	to	number of moles of unknown substance	use this	mole ratio
$\text{C}_3\text{H}_8$		$\text{O}_2$		$\frac{5 \text{ mol O}_2}{1 \text{ mol C}_3\text{H}_8}$
$\text{C}_3\text{H}_8$		$\text{CO}_2$		$\frac{3 \text{ mol CO}_2}{1 \text{ mol C}_3\text{H}_8}$
$\text{C}_3\text{H}_8$		$\text{H}_2\text{O}$		$\frac{4 \text{ mol H}_2\text{O}}{1 \text{ mol C}_3\text{H}_8}$
$\text{O}_2$		$\text{C}_3\text{H}_8$		$\frac{1 \text{ mol C}_3\text{H}_8}{5 \text{ mol O}_2}$
$\text{O}_2$		$\text{CO}_2$		$\frac{3 \text{ mol CO}_2}{5 \text{ mol O}_2}$
$\text{O}_2$		$\text{H}_2\text{O}$		$\frac{4 \text{ mol H}_2\text{O}}{5 \text{ mol O}_2}$
$\text{CO}_2$		$\text{C}_3\text{H}_8$		$\frac{1 \text{ mol C}_3\text{H}_8}{3 \text{ mol CO}_2}$
$\text{CO}_2$		$\text{O}_2$		$\frac{5 \text{ mol O}_2}{3 \text{ mol CO}_2}$
$\text{CO}_2$		$\text{H}_2\text{O}$		$\frac{4 \text{ mol H}_2\text{O}}{3 \text{ mol CO}_2}$
$\text{H}_2\text{O}$		$\text{C}_3\text{H}_8$		$\frac{1 \text{ mol C}_3\text{H}_8}{4 \text{ mol H}_2\text{O}}$
$\text{H}_2\text{O}$		$\text{O}_2$		$\frac{5 \text{ mol O}_2}{4 \text{ mol H}_2\text{O}}$
$\text{H}_2\text{O}$		$\text{CO}_2$		$\frac{3 \text{ mol CO}_2}{4 \text{ mol H}_2\text{O}}$

**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.

- Copper(II) oxide ( $\text{CuO}$ ) decomposes into copper ( $\text{Cu}$ ) and oxygen ( $\text{O}_2$ ) gas. What mass of copper will be produced by the decomposition of 1.25 kg  $\text{CuO}$ ?  
\_\_\_\_\_
- Ammonia ( $\text{NH}_3$ ) is produced by the reaction of nitrogen ( $\text{N}_2$ ) and hydrogen ( $\text{H}_2$ ) gases. How much ammonia will be produced if 22.0 g  $\text{H}_2$  reacts with excess  $\text{N}_2$ ?  
\_\_\_\_\_
- The reaction of sodium ( $\text{Na}$ ) and water ( $\text{H}_2\text{O}$ ) produces sodium hydroxide ( $\text{NaOH}$ ) and hydrogen ( $\text{H}_2$ ) gas. What mass of hydrogen gas is produced if 17.54 g  $\text{NaOH}$  is produced by the reaction?  
\_\_\_\_\_
- The combustion of acetic acid ( $\text{HC}_2\text{H}_3\text{O}_2$ ) produces carbon dioxide ( $\text{CO}_2$ ) and water ( $\text{H}_2\text{O}$ ). What mass of carbon dioxide will be produced from the combustion of 25.0 g  $\text{HC}_2\text{H}_3\text{O}_2$ ?  
\_\_\_\_\_
- 20.0 g of iron(III) sulfide ( $\text{Fe}_2\text{S}_3$ ) was prepared by heating iron ( $\text{Fe}$ ) and excess sulfur ( $\text{S}$ ). 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			

# Solving Stoichiometric Mass-to-Mass Conversion Problems

Use with Chapter 11,  
Section 11.2

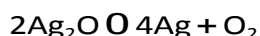
unknown substance

What mass in grams of silver (Ag) will be produced when 125 g of silver oxide (Ag<sub>2</sub>O) decomposes?

known substance

## Step 1

Write the balanced equation.



## Step 2

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

$$1 \text{ mol Ag}_2\text{O} \times \frac{2 \text{ mol Ag}}{1 \text{ mol Ag}_2\text{O}} \times \frac{107.87 \text{ g Ag}}{1 \text{ mol Ag}} = 215.74 \text{ g Ag}$$

$$1 \text{ mol Ag}_2\text{O} \times \frac{1 \text{ mol O}}{1 \text{ mol Ag}_2\text{O}} \times \frac{16.00 \text{ g O}}{1 \text{ mol O}} = 16.00 \text{ g O}$$

Molar mass Ag<sub>2</sub>O = 231.74 g Ag<sub>2</sub>O

$$125 \text{ g Ag}_2\text{O} \times \frac{1 \text{ mol Ag}_2\text{O}}{231.74 \text{ g Ag}_2\text{O}} = 0.539 \text{ mol Ag}_2\text{O}$$

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.

$$0.539 \text{ g Ag}_2\text{O} \times \frac{4 \text{ mol Ag}}{2 \text{ mol Ag}_2\text{O}} = 1.08 \text{ mol Ag}$$

number of moles of unknown substance

## Step 4

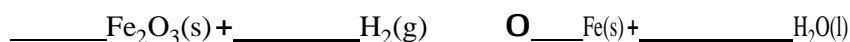
Determine the mass of the unknown substance using mole-to-mass conversion.

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

Use with Chapter 11,  
Section 11.2

# Solving Stoichiometric Mass-to-Mass Conversion Problems

1. The reaction of iron(III) oxide ( $\text{Fe}_2\text{O}_3$ ) and hydrogen ( $\text{H}_2$ ) is represented by the following unbalanced chemical equation.



Determine the mass in grams of hydrogen gas needed to react completely with 33.5 g  $\text{Fe}_2\text{O}_3$ .

**Step 1.**

**Step 2.**

**Step 3.**

**Step 4.**

2. Determine the mass in grams of copper(II) sulfide ( $\text{Cu}_2\text{S}$ ) formed when 15.0 g copper(I) chloride ( $\text{CuCl}$ ) reacts with excess hydrogen sulfide ( $\text{H}_2\text{S}$ ) according to the following unbalanced chemical equation.



**Step 1.**

**Step 2.**

**Step 3.**

**Step 4.**

Name \_\_\_\_\_ Date \_\_\_\_\_ Class \_\_\_\_\_

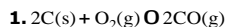
## MATH SKILLS TRANSPARENCY WORKSHEET

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## Determining Mole Ratios

Use with Chapter 11,  
Section 11.1

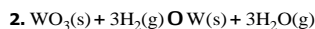
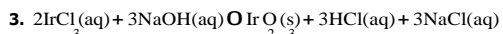
Determine the mole ratios for each of the following balanced chemical equations.

1 mol  $\text{O}_2$ /2 mol C

2 mol CO/2 mol C

2 mol C/1 mol  $\text{O}_2$ 2 mol CO/1 mol  $\text{O}_2$ 

2 mol C/2 mol CO

1 mol  $\text{O}_2$ /2 mol CO3 mol  $\text{H}_2$ /1 mol  $\text{WO}_3$ 1 mol W/1 mol  $\text{WO}_3$ 3 mol  $\text{H}_2\text{O}$ /1 mol  $\text{WO}_3$ 1 mol  $\text{WO}_3$ /3 mol  $\text{H}_2$ 1 mol W/3 mol  $\text{H}_2$ 3 mol  $\text{H}_2\text{O}$ /3 mol  $\text{H}_2$ 1 mol  $\text{WO}_3$ /1 mol W3 mol  $\text{H}_2$ /1 mol W3 mol  $\text{H}_2\text{O}$ /1 mol W1 mol  $\text{WO}_3$ /3 mol  $\text{H}_2\text{O}$ 3 mol  $\text{H}_2$ /3 mol  $\text{H}_2\text{O}$ 1 mol W/3 mol  $\text{H}_2\text{O}$ 3 mol NaOH/2 mol  $\text{IrCl}_3$ 1 mol  $\text{Ir}_2\text{O}_3$ /2 mol  $\text{IrCl}_3$ 3 mol HCl/2 mol  $\text{IrCl}_3$ 3 mol NaCl/2 mol  $\text{IrCl}_3$ 2 mol  $\text{IrCl}_3$ /3 mol NaOH1 mol  $\text{Ir}_2\text{O}_3$ /3 mol NaOH

3 mol HCl/3 mol NaOH

3 mol NaCl/3 mol NaOH

2 mol  $\text{IrCl}_3$ /1 mol  $\text{Ir}_2\text{O}_3$ 3 mol NaOH/1 mol  $\text{Ir}_2\text{O}_3$ 3 mol HCl/1 mol  $\text{Ir}_2\text{O}_3$ 3 mol NaCl/1 mol  $\text{Ir}_2\text{O}_3$ 2 mol  $\text{IrCl}_3$ /3 mol HCl

3 mol NaOH/3 mol HCl

1 mol  $\text{Ir}_2\text{O}_3$ /3 mol HCl

3 mol NaCl/3 mol HCl

2 mol  $\text{IrCl}_3$ /3 mol NaCl

3 mol NaOH/3 mol NaCl

1 mol  $\text{Ir}_2\text{O}_3$ /3 mol NaCl

3 mol HCl/3 mol NaCl

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## MATH SKILLS TRANSPARENCY WORKSHEET

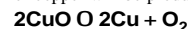
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## Using Mole Ratios

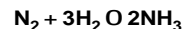
Use with Chapter 11,  
Section 11.2

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.

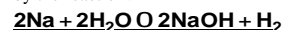
1. Copper(II) oxide (CuO) decomposes into copper (Cu) and oxygen (
- $\text{O}_2$
- ) gas. What mass of copper will be produced by the decomposition of 1.25 kg CuO?



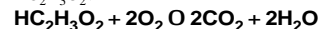
2. Ammonia (
- $\text{NH}_3$
- ) is produced by the reaction of nitrogen (
- $\text{N}_2$
- ) and hydrogen (
- $\text{H}_2$
- ) gases. How much ammonia will be produced if 22.0 g
- $\text{H}_2$
- reacts with excess
- $\text{N}_2$
- ?



3. The reaction of sodium (Na) and water (
- $\text{H}_2\text{O}$
- ) produces sodium hydroxide (NaOH) and hydrogen (
- $\text{H}_2$
- ) gas. What mass of hydrogen gas is produced if 17.54 g NaOH is produced by the reaction?



4. The combustion of acetic acid (
- $\text{HC}_2\text{H}_3\text{O}_2$
- ) produces carbon dioxide (
- $\text{CO}_2$
- ) and water (
- $\text{H}_2\text{O}$
- ). What mass of carbon dioxide will be produced from the combustion of 25.0 g
- $\text{HC}_2\text{H}_3\text{O}_2$
- ?



5. 20.0 g of iron(III) sulfide (
- $\text{Fe}_2\text{S}_3$
- ) 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	CuO	Cu	2 mol Cu/2 mol CuO
2	$\text{H}_2$	$\text{NH}_3$	2 mol $\text{NH}_3$ /3 mol $\text{H}_2$
3	NaOH	$\text{H}_2$	1 mol $\text{H}_2$ /2 mol NaOH
4	$\text{HC}_2\text{H}_3\text{O}_2$	$\text{CO}_2$	2 mol $\text{CO}_2$ /1 mol $\text{HC}_2\text{H}_3\text{O}_2$
5	$\text{Fe}_2\text{S}_3$	Fe	2 mol Fe/1 mol $\text{Fe}_2\text{S}_3$

Name \_\_\_\_\_ Date \_\_\_\_\_ Class \_\_\_\_\_

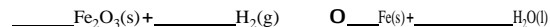
## MATH SKILLS TRANSPARENCY WORKSHEET

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## Solving Stoichiometric Mass-to-Mass Conversion Problems

Use with Chapter 11,  
Section 11.2

1. The reaction of iron(III) oxide ( $\text{Fe}_2\text{O}_3$ ) and hydrogen ( $\text{H}_2$ ) is represented by the following unbalanced chemical equation.



Determine the mass in grams of hydrogen gas needed to react completely with 33.5 g  $\text{Fe}_2\text{O}_3$ .

Step 1.  $\text{Fe}_2\text{O}_3 + 3\text{H}_2 \rightarrow 2\text{Fe} + 3\text{H}_2\text{O}$

Step 2.  $1 \text{ mol Fe}_2\text{O}_3 \times 2 \text{ mol Fe} / 1 \text{ mol Fe}_2\text{O}_3 \times 55.85 \text{ g Fe} / 1 \text{ mol Fe} = 111.7 \text{ g Fe}$   
 $1 \text{ mol Fe}_2\text{O}_3 \times 3 \text{ mol O} / 1 \text{ mol Fe}_2\text{O}_3 \times 16.00 \text{ g O} / 1 \text{ mol O} = 48.00 \text{ g O}$   
 Molar mass  $\text{Fe}_2\text{O}_3 = 159.7 \text{ g/mol Fe}_2\text{O}_3$   
 $33.5 \text{ g Fe}_2\text{O}_3 \times 1 \text{ mol Fe}_2\text{O}_3 / 159.7 \text{ g Fe}_2\text{O}_3 = 0.210 \text{ mol Fe}_2\text{O}_3$

Step 3.  $0.210 \text{ mol Fe}_2\text{O}_3 \times 3 \text{ mol H}_2 / 1 \text{ mol Fe}_2\text{O}_3 = 0.630 \text{ g/mol H}_2$

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  $\text{H}_2 = 2.02 \text{ g/mol H}_2$   
 $0.630 \text{ mol H}_2 \times 2.02 \text{ g H}_2 / 1 \text{ mol H}_2 = 1.27 \text{ g H}_2$

2. Determine the mass in grams of copper(II) sulfide ( $\text{Cu}_2\text{S}$ ) formed when 15.0 g copper(I) chloride ( $\text{CuCl}$ ) reacts with excess hydrogen sulfide ( $\text{H}_2\text{S}$ ) according to the following unbalanced chemical equation.



Step 1.  $2\text{CuCl}(\text{aq}) + \text{H}_2\text{S} \rightarrow \text{Cu}_2\text{S} + 2\text{HCl}$

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

Step 3.  $0.152 \text{ mol CuCl} \times 1 \text{ mol Cu}_2\text{S} / 2 \text{ mol CuCl} = 0.0760 \text{ g/mol Cu}_2\text{S}$

Step 4.  $1 \text{ mol Cu}_2\text{S} \times 2 \text{ mol Cu} / 1 \text{ mol Cu}_2\text{S} \times 63.55 \text{ g Cu} / 1 \text{ mol Cu} = 127.10 \text{ g Cu}$   
 $1 \text{ mol Cu}_2\text{S} \times 1 \text{ mol S} / 1 \text{ mol Cu}_2\text{S} \times 32.07 \text{ g S} / 1 \text{ mol S} = 32.07 \text{ g S}$   
 Molar mass  $\text{Cu}_2\text{S} = 159.17 \text{ g/mol Cu}_2\text{S}$   
 $0.0760 \text{ mol Cu}_2\text{S} \times 159.17 \text{ g Cu}_2\text{S} / 1 \text{ mol Cu}_2\text{S} = 12.1 \text{ g Cu}_2\text{S}$

Name \_\_\_\_\_ Date \_\_\_\_\_ Class \_\_\_\_\_

## MATH SKILLS TRANSPARENCY WORKSHEET

18

## Unit Cells of Crystals

Use with Chapter 12,  
Section 12.3

- Explain what a crystalline solid is.  
**A crystalline solid is a solid with an orderly, geometric, three-dimensional structure.**
- 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**
- 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**
- What do the letters a, b, and c in the transparency represent?  
**The letters represent the edges of the faces of a unit cell.**
- What do the symbols  $\alpha$ ,  $\beta$ , and  $\gamma$  represent?  
**The symbols represent the angles between the faces of a unit cell.**
- How many dimensions (length, width, depth) are needed to classify a unit cell?  
**three**
- How many faces are needed to determine the dimensions of a unit cell? **two**
- How many angle measurements are needed to classify a unit cell? **three**
- Identify the types of unit cells that have three equal dimensions.  
**cubic and rhombohedral**
- Identify the types of unit cells that have equal angles.  
**cubic, tetragonal, and orthorhombic**
- 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**
- Which unit cells meet the requirements  $a = b$  and  $\alpha = \beta = \gamma$ ?  
**cubic, tetragonal, hexagonal, and rhombohedral**
- 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.**