

CHEMISTRY

Matter and Change

Notes 2: Stoichiometry

Defining Stoichiometry

Particle and Mole Relationships

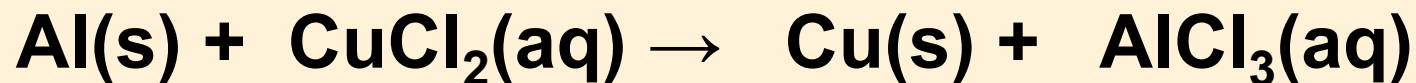
- Chemical reactions stop when one of the reactants is used up.
- **Stoichiometry** is the study of quantitative relationships between the amounts of reactants used and amounts of products formed by a chemical reaction.



Defining Stoichiometry

Particle and Mole Relationships (cont.)

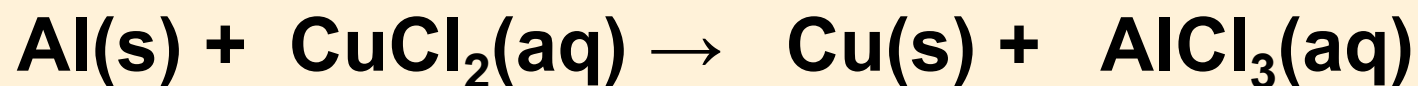
- Stoichiometry is based on the law of conservation of mass.
- The mass of reactants equals the mass of the products.
- Balance this chemical equation:



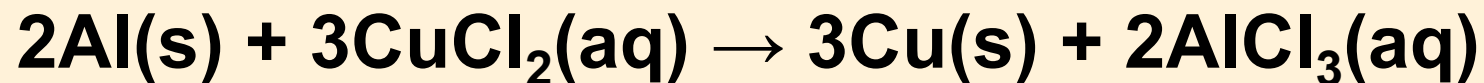
Defining Stoichiometry

Particle and Mole Relationships (cont.)

- Balance this chemical equation:



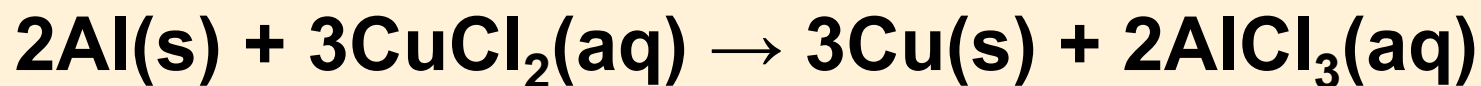
- Balanced equation:



Defining Stoichiometry

Particle and Mole Relationships (cont.)

- A **mole ratio** is a ratio between the numbers of moles of any two substances in a balanced equation.
- What is the mole ratio of copper to aluminum in this chemical equation?

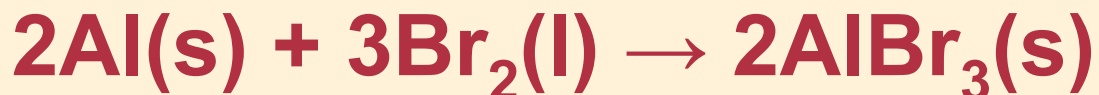


- Answer: 2 mol Al : 3 mole Cu
or
3 mole Cu : 2 mol Al



Section Check

Which of the following is a correct mole ratio for the following equation?



A. 2 mol Al : 3 mol Br

B. 3 mol Br₂ : 2 mol Al

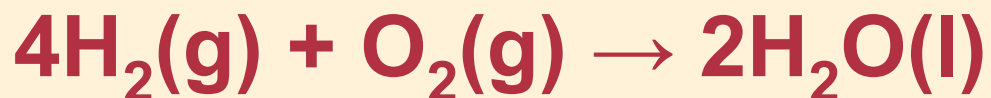
C. 2 mol AlBr₃ : 1 mol Br₂

D. 2 mol Br : 2 mol Al



Section Check

How many mole ratios can be written for the following reaction?



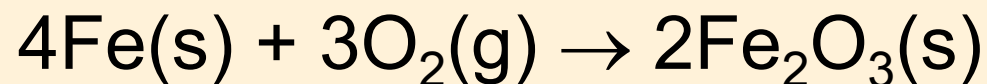
- A. 6
- B. 4
- C. 3
- D. 2



Stoichiometric Calculations

Using Stoichiometry

- All stoichiometric calculations begin with a balanced chemical equation.



Stoichiometric Calculations

Using Stoichiometry (cont.)

- Steps to solve mole-to-mole, mole-to-mass, and mass-to-mass stoichiometric problems
 1. Write a balanced chemical equation for the reaction.
 2. Determine where to start your calculations by noting the unit of the given substance.
 - If mass (in grams) of the given substance is the starting unit, you must convert to moles.
 - If amount (in moles) of the given substance is the starting unit, convert moles of the given substance to moles of the unknown.



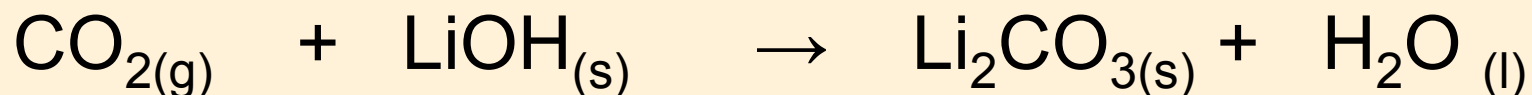
Using Stoichiometry (cont.)

3. The end point of the calculation depends on the desired unit of the unknown substance.
 - If the answer must be in moles, stop you are finished.
 - If the answer must be in grams, convert moles of unknown to grams of unknown using the molar mass as the conversion factor.



Using Stoichiometry (cont.)

- **Ex.** The carbon dioxide exhaled by astronauts can be removed from a spacecraft by reacting with lithium hydroxide as follows:



An average person exhales about 20 moles of CO_2 per day. How many moles of LiOH would be required to maintain 2 astronauts in a spacecraft for three days?



Using Stoichiometry (cont.)

1. Balance equation:



2. Determine moles of given substance:

20moles per person, 2 people = 40moles x 3 days = 120moles of CO_2

3. Convert moles of given substance to moles of unknown:

$$120 \text{ mol CO}_2 \times \frac{2 \text{ mol LiOH}}{1 \text{ mol CO}_2} = 240 \text{ mol of LiOH}$$



Section Check

A chemical reaction equation must be _____ in order to make stoichiometric calculations.

A. measured

B. controlled

C. balanced

D. produced



Section Check

How many moles of CO_2 will be produced in the following reaction if the initial amount of reactants was 0.50 moles?

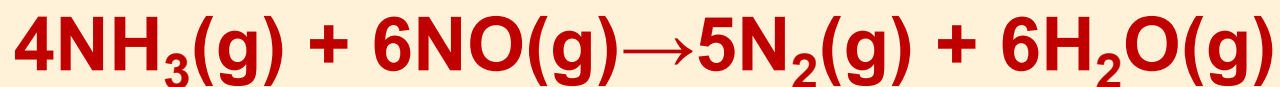


- A. 0.25
- B. 0.3
- C. 0.5
- D. 1.0



Practice Problem

How many moles of each reactant were there if 13.7 moles of $\text{N}_2(\text{g})$ is produced?



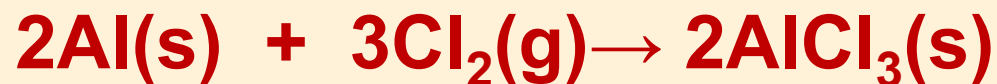
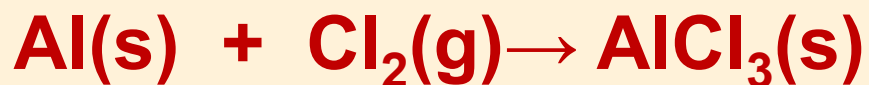
$$13.7 \text{ mol N}_2 \times \frac{4 \text{ mol NH}_3}{5 \text{ mol N}_2} = 10.96 \text{ mol NH}_3$$

$$13.7 \text{ mol N}_2 \times \frac{6 \text{ mol NO}}{5 \text{ mol N}_2} = 16.44 \text{ mol NO}$$



Practice Problem

When 80 grams of aluminum is reacted with excess chlorine gas, how many formula units of AlCl_3 are produced?



$$80 \text{ g Al} \times \frac{27 \text{ g Al}}{1 \text{ mol Al}} = 2.96 \text{ mol Al}$$

$$2.96 \text{ mol Al} \times \frac{2 \text{ mol AlCl}_3}{2 \text{ mol Al}} = 2.96 \text{ mol AlCl}_3$$

