

Chapter 9

Calculations from Chemical Equations

Advanced Chemistry

9.1 Introduction to Stoichiometry

Learning Objective	
Define stoichiometry and describe the strategy required to solve problems based on chemical equations.	<ul style="list-style-type: none">Stoichiometry is the area of chemistry that deals with the quantitative relationships among reactants and products in a chemical reaction.To solve a stoichiometry problem:<ul style="list-style-type: none">Convert the quantity of starting substance to moles (if it is not given in moles).Convert the moles of starting substance to moles of desired substance.Convert the moles of desired substance to the appropriate unit.
Key Terms	
Stoichiometry	The area of chemistry that deals with the quantitative relationships among reactants and products in a chemical reaction.
Molar mass	The mass of Avogadro's number of atoms or molecules. The sum of the atomic masses of all the atoms in an element, compound, or ion. The mass of a mole of any formula unit. It is also known as the molecular weight.
Mole ratio	A ratio between the number of moles of any two species involved in a chemical reaction; the mole ratio is used as a conversion factor in stoichiometric calculations.

9.2 Mole-mole Calculations

Learning Objective	
Solve problems in which the reactants and products are both in moles.	<ul style="list-style-type: none">Convert the moles of starting substance to moles of the desired substance using the mole ratio. The mole ratio can be obtained from the balanced chemical equation.

9.3 Mole-mass Calculations

Learning Objective	
Solve problems in which mass is given and the answer is to be determined in moles or the moles are given and mass is to be determined.	<ul style="list-style-type: none">Convert the moles of starting substance to moles of the desired substance.Convert the moles of desired substance to grams.

9.4 Mass-mass Calculations

Learning Objective	
Solve problems in which mass is given and the answer is to be determined as mass.	<ul style="list-style-type: none">Convert the quantity of starting substance to moles.Convert the moles of starting substance to moles of desired substance.Convert moles of desired substance to grams.

9.5 Limiting Reactant and Yield Calculations

Learning Objective	
Solve problems involving limiting reactant and yield.	<ul style="list-style-type: none">To identify the limiting reactant in a reaction:<ul style="list-style-type: none">Calculate the amount of product formed from each reactant.Determine the limiting reactant by selecting the one that gives the least amount of product.To determine the actual amount of product formed in a limiting reactant situation:<ul style="list-style-type: none">Use the result calculated that is the least amount of product.To determine the amount of the other reactants required to react with the limiting reactant:<ul style="list-style-type: none">Calculate the amount of the other reactants required to react with the limiting reactant.Subtract this amount from the original

	<p>amount of the other reactant to find the amount of excess reactant (unreacted).</p> <ul style="list-style-type: none"> • The theoretical yield of a chemical reaction is the calculated amount of product from a given amount of reactant (the limiting reactant). • The actual yield is the amount of product actually obtained experimentally. • The percent yield is $\frac{\text{actual yield}}{\text{theoretical yield}} \times 100 = \text{percent yield}$
Key Terms	
Limiting reactant	A reactant that limits the amount of product formed because it is present in insufficient amount compared with the other reactants.
Theoretical yield	The maximum amount of product that can be produced according to a balanced equation.
Actual yield	The amount of product actually produced in an chemical reaction (compared with the theoretical yield).
Percent yield	The ratio of the actual yield to the theoretical yield multiplied by 100.