

# General Chemistry 1

## Quarter 1, Lesson 14

### LIMITING AND EXCESS REAGENTS

#### Objectives:

- Define the concept of limiting and excess reactants.
- Determine the limiting and excess reactants using mole ratios from balanced chemical equations.

When a chemical reaction is carried out in a flask, the amount of reactants are not always present in the exact proportion stoichiometrically determined from the balanced equation. To make sure that the more expensive reagent is completely used up and converted to the desired product, chemists usually add the cheaper reagent in excess quantity. The reagent that has completely reacted and used up in a reaction is called the **limiting reagent**. The **excess reagent** is the reactant that is present in quantity higher than what is required to react with the limiting reagent.

**Sample Problem 1.** Let's use the chemical equation below:



Ammonia,  $NH_3$ , is synthesized from the reaction of  $H_2$  and  $N_2$  gases. Suppose 6 moles of  $H_2$  was initially mixed with 4 moles of  $N_2$  gas at high pressure. To determine which of the 2 reactants is the limiting reagent, the amount of  $NH_3$  produced must be computed given the number of moles of  $H_2$  and  $N_2$  and the mole-mole factor from the balanced equation.

$$\begin{aligned} \text{moles } NH_3 &= \cancel{\# \text{ moles of } H_2} \times \frac{2 \text{ moles } NH_3}{\cancel{3 \text{ moles } H_2}} \\ \text{moles } NH_3 &= 6 \cancel{\text{ moles of } H_2} \times \frac{2 \text{ moles } NH_3}{\cancel{3 \text{ moles } H_2}} \\ \text{moles } NH_3 &= 4 \text{ moles} \end{aligned}$$

$$\begin{aligned} \text{moles } NH_3 &= \cancel{\text{moles of } N_2} \times \frac{2 \text{ moles } NH_3}{\cancel{1 \text{ mole } N_2}} \\ \text{moles } NH_3 &= 4 \cancel{\text{ moles of } N_2} \times \frac{2 \text{ moles } NH_3}{\cancel{1 \text{ mole } N_2}} \\ \text{moles } NH_3 &= 8 \text{ moles} \end{aligned}$$

From the computed values we determined that if 6 moles of  $H_2$  completely reacts with  $N_2$ , it can produce 4 moles of  $NH_3$  while 4 moles of  $N_2$  can produce 8 moles of  $NH_3$  when fully used up. Since there is less amount of  $NH_3$  produced with 6 moles of  $H_2$  than 4 moles of  $N_2$ ,  $H_2$  gas is the limiting reagent while the  $N_2$  gas is the reagent in excess. To determine how much of the 4 moles of  $N_2$  is in excess, we will use the mole-mole factor of  $N_2$  and  $H_2$ .

$$\begin{aligned} \text{moles } N_2 &= 6 \cancel{\text{ moles of } H_2} \times \frac{1 \text{ mole } N_2}{\cancel{3 \text{ moles } H_2}} \\ \text{moles } N_2 &= 2 \text{ moles} \end{aligned}$$

The number of moles of  $N_2$  required to fully react to 6 moles of  $H_2$  is only 2 moles. Thus, the initial 4 moles of  $N_2$  has an excess of 2 moles.

$$\text{excess } N_2 = 2 \text{ moles} - 2 \text{ moles} = 2 \text{ moles}$$

**Sample Problem 2.** The combustion of ethane produces carbon dioxide and water shown in the reaction below:



1. How many moles of  $CO_2$  are produced with 56.2 moles  $C_2H_6$  and 73.4 moles of  $O_2$ ?  
Solution:

$$\begin{aligned} \text{moles } CO_2 &= 56.2 \cancel{\text{ moles of } C_2H_6} \times \frac{4 \text{ moles } CO_2}{\cancel{2 \text{ moles } C_2H_6}} \\ \text{moles } CO_2 &= 112.4 \text{ moles} \end{aligned}$$

$$\begin{aligned} \text{moles } CO_2 &= 73.4 \cancel{\text{ moles of } O_2} \times \frac{4 \text{ moles } CO_2}{\cancel{7 \text{ moles } O_2}} \\ \text{moles } CO_2 &= 41.9 \text{ moles} \end{aligned}$$

2. Which reagent is the limiting reagent? Which is the excess reagent?  
*The Limiting reagent is  $O_2$  while the excess reagent is  $C_2H_6$ .*
3. How many moles of  $C_2H_6$  are in excess?

# Limiting And Excess Reactants Answer Key

**Tom Hsu PH.D.**



### **Limiting And Excess Reactants Answer Key:**

*Mapping College Chemistry* Stephen DeMeo, 2019-03-01 This text is a chemistry problem solving resource appropriate for teachers and their students who are enrolled in high school Advanced Placement Chemistry or in a first year college General Chemistry course The book incorporates a chemistry problem solving plan one that uses an innovative graphic organizer strategy The strategy successfully evaluated with students combines problem solving processes with chemical concepts that will allow students to solve the most common and difficult problems encountered in the first year of chemistry Topical problem solving will focus on limiting reactant stoichiometry identifying types of chemical reactions equilibrium acid base equilibria and electrochemistry Why would this resource be of interest to chemistry students To be successful to get into a well known college medical school physical therapy or graduate program often requires that students get an A in your pre requisite Introductory General Chemistry course To make matters worse many college professors feel that only a few students should get A grades and therefore they give difficult exams that many students fail this is the weeding out process that every pre health student is apprehensive about To succeed in this competitive environment entails not just studying harder or longer it means re organizing textbook content so that it is meaningful to the student This is the first text of its kind to employ a reliable research based strategy that incorporates a decision based visual tool to solve chemistry textbook problems ones that can make or break a career

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**Foundations of Physical Science** Tom Hsu PH.D.,2002     **Chemical Principles** Peter Atkins,Loretta Jones,2007-08  
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*Study Guide to Accompany Basics for Chemistry* Martha Mackin, 1982-01-01 Study Guide to Accompany Basics for Chemistry is an 18 chapter text designed to be used with Basics for Chemistry textbook Each chapter contains Overview Topical Outline Skills and Common Mistakes which are all keyed to the textbook for easy cross reference The Overview section summarizes the content of the chapter and includes a comprehensive listing of terms a summary of general concepts and a list of numerical exercises while the Topical Outline provides the subtopic heads that carry the corresponding chapter and section numbers as they appear in the textbook The Fill in Multiple Choice are two sets of questions that include every concept and numerical exercise introduced in the chapter and the Skills section provides developed exercises to apply the new concepts in the chapter to particular examples The Common Mistakes section is designed to help avoid some of the errors that students make in their effort to learn chemistry while the Practical Test section includes matching and multiple choice questions that comprehensively cover almost every concept and numerical problem in the chapter After briefly dealing with an overview of chemistry this book goes on exploring the concept of matter energy measurement problem solving atom periodic table and chemical bonding These topics are followed by discussions on writing names and formulas of compounds chemical formulas and the mole chemical reactions calculations based on equations gases and the properties of a liquid The remaining chapters examine the solutions acids bases salts oxidation reduction reactions electrochemistry chemical kinetics and equilibrium and nuclear organic and biological chemistry This study guide will be of great value to chemistry teachers and students

**The Complete Idiot's Guide to Chemistry** Ian Guch, 2006 With topics such as stoichiometry chemical equilibria and thermodynamics it's no wonder so many students have a bad reaction to chemistry class Fortunately The Complete Idiot's Guide to Chemistry Second Edition gives readers an easy to understand formula for success when it comes to passing their chemistry class with flying colours Intended for both high school students who are required to take a college prep chemistry course and college students who need to take chemistry to meet their degree requirements this book gives readers a non intimidating easy to understand companion to their textbooks The book follows a standard math based chemistry curriculum covering the following topics Atomic structure and elements The periodic table Ionic and covalent compounds Chemical reactions Kinetics Acids and bases Electrochemistry Organic chemistry Nuclear chemistry

Stoichiometry Thermodynamics      Exploring Chemistry (Loose-Leaf) Matthew Johll, 2012-05-04 Matthew Johll's Exploring Chemistry covers the standard topics for the nonmajors course in the typical order but each chapter unfolds in the context of a single case study that helps students connect what they are learning to real life situations. For example, students work through the often difficult topics of molecular structure, gas laws, and organic chemistry by learning about the development of powerful new chemotherapy drugs, new technologies for screening airline passengers, and the creation of biodegradable biopolymers. It's the same case-driven approach that Johll uses in his acclaimed Investigating Chemistry, now in its Third Edition, but Exploring Chemistry goes beyond the other book's specific focus on examples from forensic science to use real life stories from cooking, athletics, genetics, green chemistry, and more.

### **Limiting Reactant and Percent**

Lifeliqe, 2019 This lesson plan covers analyzing chemical reactions in order to determine limiting reactants and excess reactants, including calculating the amount of excess reactant, calculate the theoretical yield of a reaction, and calculating the percent yield of a reaction.

*5 Steps to a 5: AP Chemistry 2024 Elite Student Edition* John T. Moore, Richard H. Langley, 2023-07-31 AP Teachers 1 Choice Ready to succeed in your AP course and ace your exam. Our 5 Steps to a 5 guides explain the tough stuff, offer tons of practice and explanations, and help you make the most efficient use of your study time. 5 Steps to a 5 AP Chemistry 2024 Elite Student Edition is more than a review guide; it's a system that has helped thousands of students walk into test day feeling prepared and confident. Everything You Need for a 5: 3 full-length practice tests that align with the latest College Board requirements. Hundreds of practice exercises with answer explanations. Comprehensive overview of all test topics. Proven strategies from seasoned AP educators. Why the Elite Edition: 200 pages of additional AP content, 5-minute daily activities to reinforce critical AP concepts. AP educators love this feature for bellringers in the classroom. Study on the Go: All instructional content in digital format for both computers and mobile devices. Interactive practice tests with answer explanations. A self-guided, personalized study plan with daily goals, powerful analytics, flashcards, games, and more. A Great In-class Supplement: 5 Steps is an ideal companion to your main AP text. Includes an AP Chemistry Teacher's Manual that offers excellent guidance to educators for better use of the 5 Steps resources.

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