

# 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.

$$\text{moles } NH_3 = \cancel{\# \text{ moles of } H_2} \times \frac{2 \text{ moles } NH_3}{\cancel{3 \text{ moles } H_2}}$$

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

$$\text{moles } NH_3 = \cancel{\text{moles of } N_2} \times \frac{2 \text{ moles } NH_3}{\cancel{1 \text{ mole } N_2}}$$

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

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

**Ian Guch**



## **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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Chemistry in Action features and conceptual questions checks brings together the understanding of chemistry and relates chemistry to things health professionals experience on a regular basis     Holt Chemistry Ralph Thomas Myers,2004

Foundations of Physical Science Tom Hsu PH.D.,2002     *Chemical Principles* Peter Atkins,Loretta Jones,2007-08

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**Prentice Hall Chemistry**, 2000 *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

*Limiting Reactant and Percent Yield*, 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

**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

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