CULINARY MATH

LINDA BLOCKER + JULIA HILL

FOURTH EDITION

WILEY

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This book is dedicated to:

My husband, Dr. Seth Blocker, and my children, Rachel and Benjamin Blocker
My parents, Arnold and Roslyn Weiss
The memory of my grandparents: Robert and Freda Weiss and Jean Friedlander
—LINDA A. BLOCKER

The memory of my niece, Elizabeth Willis Minter
—JULIA H. HILL

We would also like to dedicate this book to the students who found success in this math, perhaps for the first time!

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Preface

We are thrilled to bring you the fourth edition of *Culinary Math.* After decades of teaching this material, we are both excited to create a textbook that offers students an opportunity to find real success with the math that is required for in today's food-service industry. Many people are very talented at making delicious food; however, that skill might not be enough. The math behind the menu items that are served in the most successful restaurants must also be mastered in order to make a profit. The purpose of this book is to guide you in understanding and appropriately using the math of the food-service industry.

This edition has been improved and enriched to meet the needs of future food-service professionals. In this edition, we have updated and improved the practice problems, clarified content, and added new photography. Our most exciting addition to the forth edition of *Culinary Math* is your opportunity to go to the book companion site, where you can practice food costing (Chapter 11, page 131) on an Excel food cost form. We felt it was necessary to recognize the increasing use of computers in the food-service industry, particularly with food costing, and offer you a chance to become familiar with it while studying culinary math.

Organization of the Book

This textbook is designed to help you master the topics of culinary math. Once you have worked through the chapters in this text, you should feel confident costing out recipes, converting recipe sizes, and working with kitchen ratios. Each individual chapter is designed to move toward these goals one step at a time. These chapters build on one another, so it is important to be comfortable with the material covered in earlier chapters to be successful with the later material. Chapter 1 (page 1) reviews the basic math necessary to be able to successfully master the math in the remaining chapters. Chapter 2 (page 24) covers the units of measure used in most of the professional kitchens in the United States, and Chapter 3 (page 38) is dedicated

to the metric system. It is very important to commit these units of measure and their conversions to memory to be able to work efficiently in the kitchen.

Chapters 4 and 5 (pages 46 and 57, respectively) cover converting units of measure within weight and volume, and Chapter 6 (page 66) discusses converting between weight and volume measures. Chapter 7 (page 80) presents the concept of yield percent and how it is calculated. Chapter 8 (page 96) addresses how to use yield percent to determine how much of a product is usable and how to order the correct amount of a product for a particular need. Chapters 9 and 10 (pages 106 and 118, respectively) examine how to calculate the cost and the edible portion cost, and Chapter 11 (page 131) combines these concepts in recipe costing. Chapter 12 (page 152) addresses when yield percent is ignored in ordering and costing. These situations are exceptions to the rules covered in Chapter 7 through 11. How to identify these unique circumstances and formulate the math to find the solutions is covered. Chapter 13 (page 161) deals with beverage calculations and costing. Chapter 14 (page 172) deals with changing the yield of a recipe. Chapters 15 (page 192) introduces kitchen ratios, which are ratios that are specific to the food-service industry.

Organization of Each Chapter

Each chapter begins with a short vignette describing a situation that might be encountered in the food-service industry, which connects the math in the chapter with a real-world application. The chapter objectives make you aware of the material to be covered in the chapter so that you can be sure you have met these objectives. Each chapter includes a lesson and one or more example problems designed to show a method for solving a given problem. The procedures that are demonstrated reflect tried-and-true methods that have been presented successfully for more than 15 years; however, there are usually several ways to solve a problem, and if you perform different calculations but your solution matches the answer in the book, then you are probably on the right track. At the end of each chapter there are practice problems for you to do on your own.

How Best to Use the Practice Problems

All of the work that you do for the practice problems should be shown so that errors may be easily identified and corrected. When all the work is done on your calculator, there is no way to backtrack and find errors, which can be a very effective learning tool. Knowing how and why to make the calculations is as important as coming up with the right answer. The correct answers for the odd-numbered problems are provided for you in the back of the book so that you can check your calculations and gauge your understanding of the concepts presented in the chapter. For additional practice in recipe costing beyond the practice problems, you can access an interactive Excel food cost form online at the book companion site.

The applied math of the culinary field is both challenging and rewarding. Do not forget to use common sense when reading through the chapters, studying the examples, and doing the practice problems.

Additional Resources

An **Instructor's Manual** and a set of **PowerPoint Slides** to accompany the textbook are available to qualified adopters for download at www.wiley.com/college/cia.

The **Test Bank** has been specifically formatted for **Respondus**, an easy-to-use software program for creating and managing exams that can be printed to paper or published directly to Blackboard, WebCT, Desire2Learn, eCollege, ANGEL, and other eLearning systems. Instructors who adopt ***Culinary Math, Fourth Edition*** can download the Test Bank for free. Additional Wiley resources also can be uploaded into your LMS coursed at no charge.

A **Book Companion Website** provides readers with additional resources as well as enabling instructors to download the electronic files for the **Instructor's Manual**, **Power Point slides**, and **Test Bank**.

Videos have been created to enhance your learning to meet specific chapter objectives. You will be able to work on a practice problems along with the videos to ensure your understanding of the steps for solving the problems.

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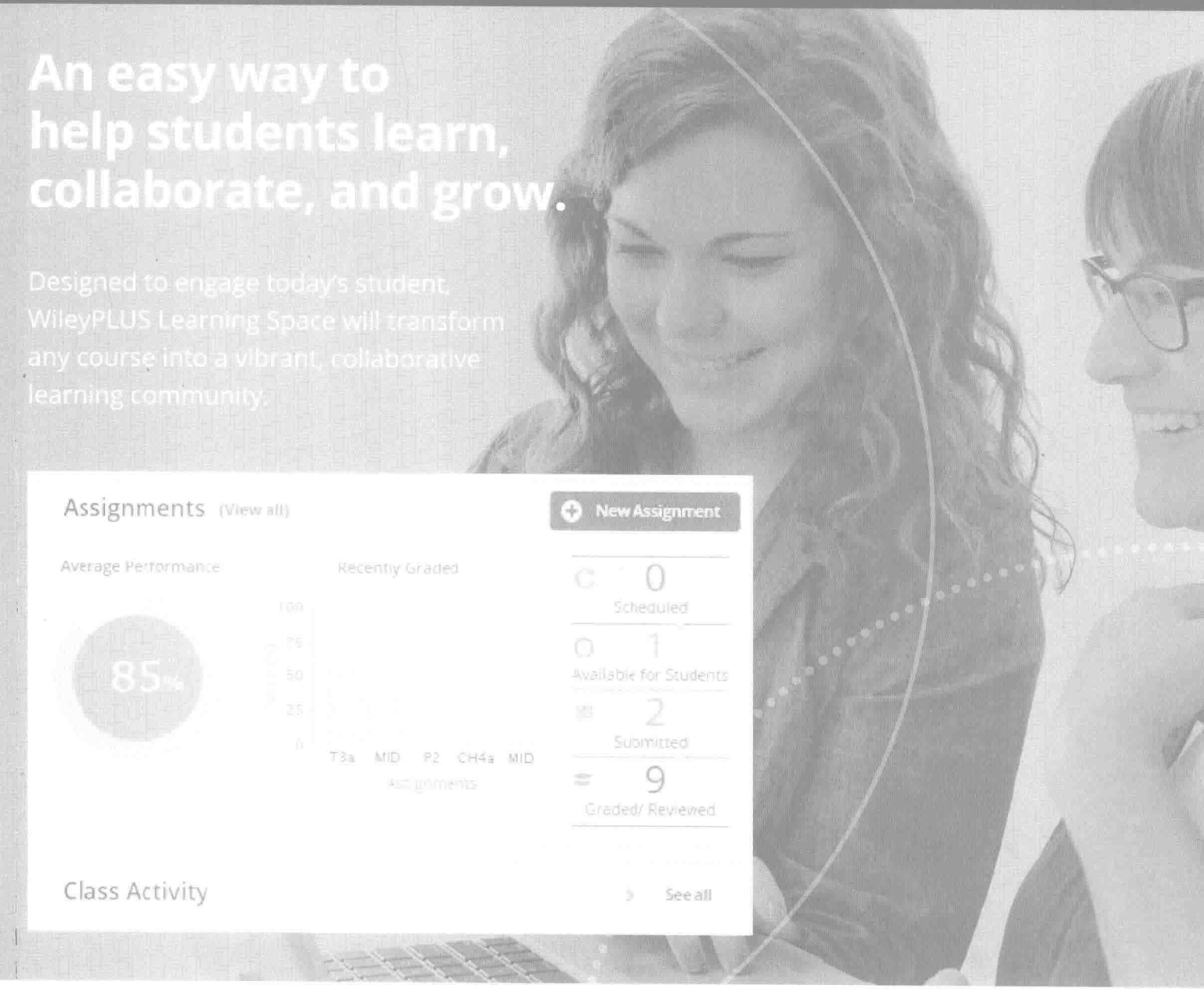

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Contents

1 Math Basics

The understanding of numbers and how to correctly complete basic math operations with all forms of numbers is the foundation of culinary math. Food costing, recipe size conversion, recipe development, and cost control begin with the basic math concepts covered in this chapter. Errors in basic math calculations can become costly and time-consuming. It is necessary for your success to master these skills before tackling the math of the kitchen.

The primary goal of this chapter is to review basic math, including whole numbers, fractions, and decimals. After completing the basic review, the chapter covers percent and then word problems and their solutions. This chapter is designed to be a resource that may be used as a reference for the subsequent chapters.

OBJECTIVES

- Identify the place value of a whole number.
- Identify the types of fractions.
- Convert a whole number to a fraction.
- Convert an improper fraction to a mixed number.
- Convert a mixed number to an improper fraction.
- Solve fraction problems.
- Identify the first four place values to the right of the decimal point.
- Solve decimal problems.
- Convert fractions to decimals and decimals to fractions.
- Convert a percent to a decimal or fraction and a decimal or fraction to a percent.
- Round given numbers based on the situation.
- Solve word problems for the part, whole, or percent.

WHOLE NUMBERS

Whole numbers are the counting numbers and 0. They are 0, 1, 2, 3, 4, 5, and so on. The following chart identifies the place value of whole numbers.

WHOLE NUMBERS

Trillions			,	Billions			,	Millions			,	Thousands			,	Units		
hundreds	tens	ones		hundreds	tens	ones		hundreds	tens	ones		hundreds	tens	ones		hundreds	tens	ones

It is important to be familiar with place value when dealing with whole number operations.

FRACTIONS

Fractions are numeric symbols of the relationship between the part and the whole. They are composed of a numerator (the top number in a fraction) and a denominator (the bottom number in a fraction). Fractions are frequently used in the kitchen. Measuring cups, measuring spoons, and the volumes and weights of products ordered may be expressed in fractional quantities. Most ingredients in the recipes or formulas found in a kitchen or in a cookbook express quantities in fractional form. The fractions used in the kitchen are, for the most part, the more common fractions: $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$. A culinary recipe or formula would most likely never use a fraction such as $\frac{349}{940}$ cup of flour. However, when making calculations to increase or decrease a recipe's yield, you will be confronted with fractions that have to be converted to a measure that is more realistic in the kitchen.

A fraction may be thought of as all of the following:

- A part of a whole number: 3 out of 5 slices of pie could be presented as $\frac{3}{5}$. In this example, 3 is the part and 5 is the whole.
- An expression of a relationship between two numbers:

  $\frac{3}{7}$ 3 The *numerator*, or top number
  7 The *denominator*, or bottom number
- A division problem: The fraction $\frac{3}{7}$ can also be written as the division problem $3 \div 7$.

TYPES OF FRACTIONS

A *proper (common) fraction* is a fraction in which the numerator is less than the denominator. For example:

$$\frac{1}{2} \quad \text{and} \quad \frac{3}{4}$$

An *improper fraction* is a fraction with a numerator that is greater than or equal to the denominator, such as:

$$\frac{28}{7}, \frac{140}{70}, \quad \text{and} \quad \frac{28}{28}$$

A *mixed number* is a number that contains both a whole number and a fraction, such as:

$$4\frac{3}{8}$$

A *lowest-term* fraction is the result of reducing a fraction so that the numerator and the denominator have no other common factors beside 1. For example:

$$\frac{14}{28} = \frac{14 \div 14}{28 \div 14} = \frac{1}{2}$$

The fraction $^{14}/_{28}$ is a proper fraction, but it is not in lowest terms. Both 14 and 28 share the following factors: 2, 7, and 14. If you divide both 14 and 28 by the largest factor, 14, the result is $^{1}/_{2}$, which is equivalent to $^{14}/_{28}$.

The result of reducing a fraction so that the numerator and the denominator no longer have any common factors is a fraction expressed in its lowest terms, or lowest-term fraction.

CONVERTING WHOLE NUMBERS TO FRACTIONS

To convert a whole number to a fraction, place the whole number over 1.

EXAMPLE 1.1: $5 \rightarrow \frac{5}{1}$

CONVERTING IMPROPER FRACTIONS TO MIXED NUMBERS

To convert an improper fraction to a mixed number, divide the numerator by the denominator. The quotient will be the whole number, and the remainder (if any) will be placed over the denominator of the original improper fraction to form the fractional part of the mixed number.

REMEMBER
When dividing, the numerator is the number being divided.

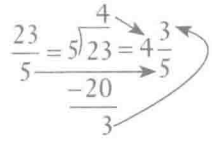
Numerator ÷ Denominator

or

Denominator⟌Numerator

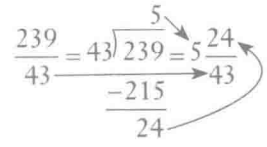
EXAMPLE 1.2:

Convert $^{23}/_{5}$ to a mixed number.



EXAMPLE 1.3:

Convert $^{239}/_{43}$ to a mixed number.



CONVERTING MIXED NUMBERS TO IMPROPER FRACTIONS

STEPS TO CONVERTING MIXED NUMBERS TO IMPROPER FRACTIONS

STEP 1. Multiply the whole number by the denominator.

STEP 2. Add the result to the numerator.

STEP 3. Place the resulting number over the original denominator.

EXAMPLE 1.4:

Convert $4\frac{2}{3}$ to an improper fraction.

STEP 1. Multiply 4 and 3. $4\frac{2}{3}$ $4 \times 3 = 12$

STEP 2. Add 2 to the result. $4\frac{2}{3}$ $12 + 2 = 14$

STEP 3. Use 14 from step 2 as the numerator and 3 as the denominator.

$$\frac{14}{3} = 4\frac{2}{3}$$

Note that the denominator is the same in both the improper fraction and the mixed number.

SOLVING PROBLEMS WITH FRACTIONS

ADDITION OF FRACTIONS

Fractions that are added to one another must have the same denominator, called the *common denominator.*

EXAMPLE 1.5:

$$\frac{1}{7}+\frac{2}{7}=\frac{3}{7}$$

7 is the common denominator.

EXAMPLE 1.6:

$$\text{Solve } \frac{1}{8}+\frac{5}{16}$$

To solve this example, you must find a common denominator.

There are two ways to do this:

1. **MULTIPLY THE TWO DENOMINATORS TOGETHER:** To find the common denominator for ⅛ and 5/16, multiply the first denominator, 8, by the second denominator, 16: $(8 \times 16) = 128$. The numerator of each fraction must be multiplied by the same number as the denominator was multiplied by, so that the value of the fraction remains the same. In this example, multiply the 1 by 16 and multiply the 5 by 8. Thus:

$$\frac{1}{8}=\frac{1\times16}{8\times16}=\frac{16}{128}$$

$$\frac{5}{16}=\frac{5\times8}{16\times8}=\frac{40}{128}$$

$$\frac{16}{128}+\frac{40}{128}=\frac{56}{128}$$

This answer is not in lowest terms. In order to reduce it to lowest terms, divide the numerator and the denominator by the greatest common factor. In this example, divide 56 and 128 by 8. The answer in lowest terms is 7/16.

2. **DETERMINE IF ONE DENOMINATOR IS THE FACTOR OF THE OTHER:** Especially in recipes, it is not unusual for the denominator of one fraction to be evenly divisible by the denominator in the other fraction. In the following example, 16 can be divided

by 8, so 8 can be used as the common denominator. This method can save time but will work only when one of the denominators is a factor of the other:

$$\frac{1}{8}+\frac{5}{16}=\frac{(1\times 2)}{(8\times 2)}+\frac{5}{16}=\frac{2}{16}+\frac{5}{16}=\frac{7}{16}$$

You will notice in this approach that it is not necessary to reduce the answer. It is already in lowest terms.

SUBTRACTION OF FRACTIONS

Fractions that are subtracted from one another must also have a common denominator. The same methods used for converting denominators to common denominators when adding fractions can be used when subtracting fractions.

EXAMPLE 1.7:

$$\frac{3}{8}-\frac{1}{8}=\frac{2}{8}=\frac{1}{4}$$

EXAMPLE 1.8:

$$\frac{7}{8}-\frac{5}{9}=\frac{7\times 9}{8\times 9}-\frac{5\times 8}{9\times 8}=\frac{63}{72}-\frac{40}{72}=\frac{23}{72}$$

MULTIPLICATION OF FRACTIONS

The process of multiplying fractions simply requires that the numerators be multiplied together and the denominators be multiplied together; the results of the multiplied numerators are placed over the results of the multiplied denominators.

Any mixed numbers must first be converted to improper fractions before multiplying them.

$$\frac{\text{Numerator}\times\text{Numerator}}{\text{Denominator}\times\text{Denominator}}=\frac{\text{NN}}{\text{DD}}$$

EXAMPLE 1.9:

$$\frac{4}{7}\times\frac{3}{5}=\frac{12}{35}$$

EXAMPLE 1.10:

$$1\frac{1}{2}\times\frac{1}{5}\times\frac{1}{7}=\frac{3}{2}\times\frac{1}{5}\times\frac{1}{7}=\frac{3}{70}$$

DIVISION OF FRACTIONS

To divide fractions, first convert any mixed numbers to improper fractions. Next, invert the second fraction (the divisor) by placing the denominator on top of the numerator. Finally, change the division sign to a multiplication sign and complete the equation as a multiplication problem.

REMEMBER
A common denominator is not required when multiplying or dividing fractions.

EXAMPLE 1.11:

$$\frac{3}{4}\div1\frac{2}{3}=\frac{3}{4}\div\frac{5}{3}=\frac{3}{4}\times\frac{3}{5}=\frac{9}{20}$$

EXAMPLE 1.12:

$$\frac{7}{1}\div\frac{3}{4}=\frac{7}{1}\times\frac{4}{3}=\frac{28}{3}=9\frac{1}{3}$$

DECIMALS

Decimals are another common style of number that is often found in the food-service industry:

- Metric quantities are expressed in decimal form.
- Money is expressed in decimal form.
- Digital scales express weight in decimal form.
- Most calculators use decimal forms of numbers.

A *decimal number* is a number that uses a decimal point and place value to show values less than 1. Like the fraction, a decimal is the representation of a part of the whole. Decimals are expressed in powers of 10. A period (.), called a *decimal point*, is used to indicate the decimal form of the number.