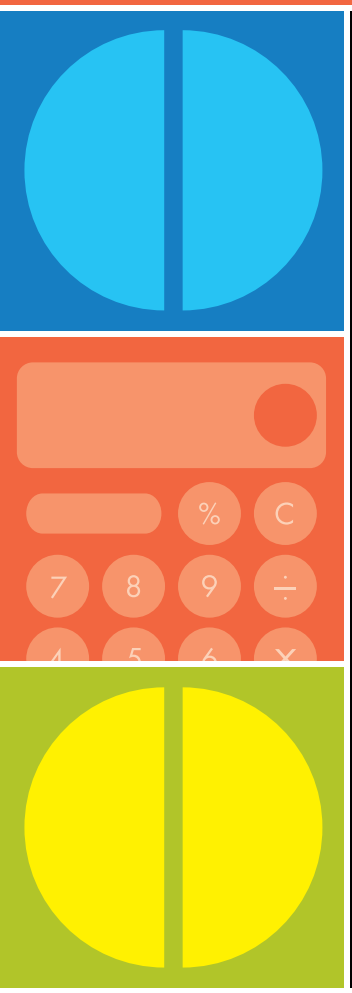
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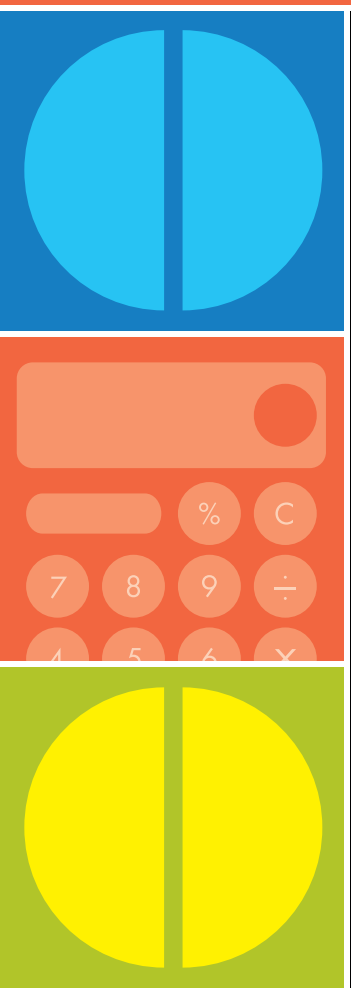


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PHARMACY TECHNICIAN EDUCATION SERIES



PHARMACEUTICAL CALCULATIONS *for the* PHARMACY TECHNICIAN

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This textbook is dedicated to my dad, the best math instructor I or any kid growing up in North Dakota ever had and the role model I use today as an instructor. He gave me the foundation and tools I needed for this project as well as many other lifelong accomplishments.

I dedicate this book to my family—my husband, children, and grandchildren, who provide me with examples of God's love on a daily basis.

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A Note About This Text

Pharmaceutical Calculations for the Pharmacy Technician is a text that embodies a shift between eras. Previously, on-the-job training of technicians was considered acceptable, but the recent realization of those in the field is that pharmacy technicians must be educated professionals. The changing role of the pharmacist and the emergence of a new definition of pharmaceutical care dictate that competent professionals be prepared to assume most of the dispensing functions previously performed by pharmacists. The conceptual organizational approach of this text is to educate the technician as a professional and to assist in the development of the professional judgment required for the technician's practice.

Current texts emphasize the mechanics of performing functions under the direct supervision of a pharmacist. This concept of direct supervision is beginning to change and will continue to evolve as pharmacists assume responsibility for greater numbers of technicians. Technicians need the tools to make important professional decisions and the confidence to trust their decisions, while retaining the ability to discern when pharmacist consultation is needed. *Pharmaceutical Calculations for the Pharmacy Technician* is meant to provide technician students with the confidence-based knowledge required for their practice today and in the future.

In *Pharmaceutical Calculations for the Pharmacy Technician,* Barbara Lacher, a respected educator in the pharmacy technician field, presents the subject matter in a detailed manner at the appropriate level for pharmacy technician students. This book is an up-to-date, comprehensive calculations text that will prepare technician students for their expanded role in pharmacy practice.

Mary E. Mohr

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Preface

This text was written with one goal in mind: to create a calculations textbook specifically for pharmacy technicians that covers all practice sites. This book addresses not only calculations that technicians will encounter in retail, but those necessary for compounding, intravenous administration, industry, and areas in which the technician may be called upon more frequently because of the shortage of other pharmacy professionals. This text is intended for use in an introductory pharmacy technician calculations course. In the in-depth practice courses that follow, the technician will be able to apply the fundamentals taught in this book.

Organizational Philosophy

Pharmaceutical Calculations, by Howard C. Ansel and Mitchell J. Stoklosa, which has been used widely in colleges of pharmacy for years, was a starting point for this text. This book includes only chapters that cover a technician's area of practice and provides much more material of immediate helpfulness and relevance to the technician.

The text begins with a review and progresses to dosing calculations necessary for the technician student to master in any practice area. Calculations used in specialized practice sites, such as home health and compounding practices, are contained in the concluding chapters.

Chapter 1, "Fundamentals of Calculations," provides an important review of basic arithmetic and algebraic operations, including Arabic and Roman numerals, fractions, decimals, and the concepts of ratio-proportion. Mastery of this chapter serves as a foundation for the entire course.

Chapter 2, "Systems of Measure," also covers foundational concepts, including not only the metric system but other measuring systems, such as the household system. The technician student must master all concepts and operations involving the metric system.

Chapter 3, "Interpretation of the Prescription or Medication Order," briefly reviews prescription and medication orders, along with abbreviations. (This is not an operations text and therefore does not go into detail regarding the elements of prescription or medication orders; it is expected that the technician students will cover this material in other courses.)

Chapter 4, "Equipment Used in Measuring," covers percentage of error, which is important for compounding of extemporaneous products and dosing of liquid medications. (Calibration and utilization are not covered in this text; the technician student will learn these subjects in other courses.)

Chapter 5, "Understanding Drug Labels," exposes the technician student to reading and understanding the elements of a typical drug label for oral solid, liquid, and parenteral dosage forms.

Chapter 6, "Calculations of Oral Doses," offers examples of use of ratio-proportion, formula, and dimensional analysis. Most pharmacy technicians are required to perform these types of calculations on a daily basis, so they must become habitual.

Chapter 7, "Calculations for Pediatric Doses," covers calculations using body surface area and milligram per kilogram recommendations. These are also types of calculations that pharmacy technicians must master because they are required to perform them on a daily basis.

Chapter 8, "Reducing and Enlarging Formulas," covers making more or less of a medicinal product than the recipe calls for. (This chapter could easily be skipped in a training program whose focus is retail or community practice.)

Chapter 9, "Percentage, Ratio Strength, and Other Expressions of Concentration," is the introductory chapter for concentration of products. This chapter covers the definition and gives examples of the three basic types of preparations: weight-in-volume, weight-in-weight, and volume-in-volume.

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The concepts in this chapter are used in the preparation of intravenous solutions, parenteral products, and many topical creams and ointments.

Chapter 10, "Dilution and Concentration," uses the concepts mastered in Chapter 9 by demonstrating how pharmaceutical products can be made more concentrated or diluted using a diluent or a stock solution.

Chapter 11, "Some Calculations Involving Units, Micrograms per Milliliter, and Other Measures of Potency," discusses units and micrograms per milligram as measures of potency. Insulin is covered in this chapter. Although diabetic patients undergo education about their disease state and about the pharmaceutical preparations they use prior to coming to the pharmacy, the pharmacy technician must properly calculate insulin doses for injection and for intravenous use.

Chapter 12, "Reconstituted Solutions and Intravenous Admixtures," covers mixing of oral and parenteral powders and labeling of these products. It also discusses how to change the concentration of products with the addition of different amounts of diluent. Total parenteral nutrition is the last topic covered in this chapter.

Chapter 13, "Intravenous Rate of Flow Calculations," covers the flow rate of intravenous products, common intravenous products, and components of those products. Pharmacy technicians working in sterile product preparation must have a good foundation in intravenous products and administering those products to the patient, and this chapter gives the technician student that foundation.

Chapter 14, "Contemporary Compounding," covers calculations in a growing area of pharmaceutical care. The number of compounding pharmacies is increasing throughout the country, and technicians play a vital role in these practices. This chapter covers compounding using manufactured dosage forms and chemical products. The mastery of this chapter is critical for a technician in a compounding practice and many community and hospital practices as well.

Appendix A provides answers for all the review sets in the book, including detailed explanations of how to arrive at those answers. Appendix B contains solutions for critical thinking problems that have answers. (Solutions to the practice problems in each chapter are available to the instructor only.) In addition, a glossary at the end of the book is a valuable resource for the technician student.

This text was written to provide the technician student with the tools necessary to practice in any type of setting. Instructors can customize their approach to the material by assigning chapters that address only areas that they would like to cover.

Chapter Structure

Each chapter of *Pharmaceutical Calculations for the Pharmacy Technician* contains the following elements:

- Objectives: This list of competencies at the beginning of each chapter should be mastered upon the completion of the review and practice problems in that chapter.
- Key terms: The student must know the basic vocabulary to attain a full understanding of the material. Key terms, which appear at the beginning of the chapter and are highlighted in color throughout the text, are defined in the margins and in the glossary.
- Examples: Examples of concepts are shown in the ratio-proportion method. When appropriate, an alternative calculation using dimensional analysis appears, showing students another way to solve the problem.
- Rules: These boxes highlight important rules in each chapter.
- Critical thinking: These boxes provide additional application for the calculations and highlight different practice settings. Answers to the critical thinking problems that have solutions appear in Appendix B.
- Formulas: These important equations stand out in boldface colored type for easy reference.

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- Review sets: These sets of problems follow small sections of information, giving the technician student additional practice to master the concepts. Solutions for these problems, found in Appendix A, give the student step-by-step explanations for problem solving.
- Practice problems: Each chapter concludes with a set of practice problems that reinforces the concepts covered in that chapter. Answers to these problems are available to the instructor only.

Technician students will be most successful in this calculations course if they have mastered beginning algebra. The text uses primarily the ratio-proportion method of problem solving, which the average technician student can easily understand. When relevant, solutions are shown using dimensional analysis for students wishing to use that method of problem solving.

In summary, this textbook is a comprehensive calculations text aimed at the pharmacy technician student, encompassing all areas of pharmacy practice from the very basic to the most complicated. A multitude of problems and many of their solutions have been included, guiding the technician student to mastery of the concepts contained in the text.

Instructor and Student Resources

Teaching materials to accompany *Pharmaceutical Calculations for the Pharmacy Technician* are available to faculty upon request. For more information, please contact your local Jones & Bartlett Learning representative. Supplemental materials include:

- An Instructor's Manual that contains lecture outlines, suggested student activities, and answers to the practice problems found in the text
- A set of PowerPoint slides for each chapter
- A Test Bank that includes questions based on the content of each chapter
- An image bank of all the images and tables in the text
- Worksheets with questions based on the content of each chapter

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Acknowledgments

Pharmaceutical Calculations, 11th edition, by Dr. Howard C. Ansel (Professor and Dean Emeritus, College of Pharmacy, University of Georgia, Athens, Georgia) and Dr. Mitchell J. Stoklosa (Professor Emeritus, Massachusetts College of Pharmacy and Health Sciences, Boston, Massachusetts), was the starting point for this text. My thanks to Drs. Ansel and Stoklosa for allowing me to use their material, which they have continually updated and compiled over the years, and which has stood the test of time as a mainstay textbook of colleges of pharmacy throughout the country. I appreciate their enduring dedication to pharmacy education, as it continues now for the role of the pharmacy technician.

Special thanks to Sandi Tschritter, who wrote the quiz and test questions for the student and instructor resources, and to Doug Scribner, who (in addition to reviewing the book) checked all of the problems and provided suggestions for illustrations. I also thank Robert Beardsley and Fred Abramson of the University of Maryland School of Pharmacy, and Shirish A. Patil of the University of Maryland Medical System, for their substantial assistance in obtaining the photos that appear in this book.

I thank my colleagues in technician education; their encouragement in this process is greatly appreciated. Thanks also to David Troy for his encouragement and support in this process, and Meredith Brittain for her continuous help throughout the project. Thanks must be extended to my students over the years, both past and present, from whom I have learned so much. Last but not least, I thank my husband, Gary. Without his love, patience, and support, I would have never completed the project.

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User's Guide

For today's practicing pharmacy technician, a thorough understanding of pharmaceutical calculations is more important than ever. Pharmaceutical Calculations for the Pharmacy Technician *not only provides the conceptual knowledge you'll need as a pharmacy technician but also teaches you how to apply it in a variety of practice settings. This User's Guide introduces you to the features and tools of this innovative textbook. Each feature is specifically designed to enhance your learning experience, preparing you for a successful career as a pharmacy technician.*

Chapter Opener Features

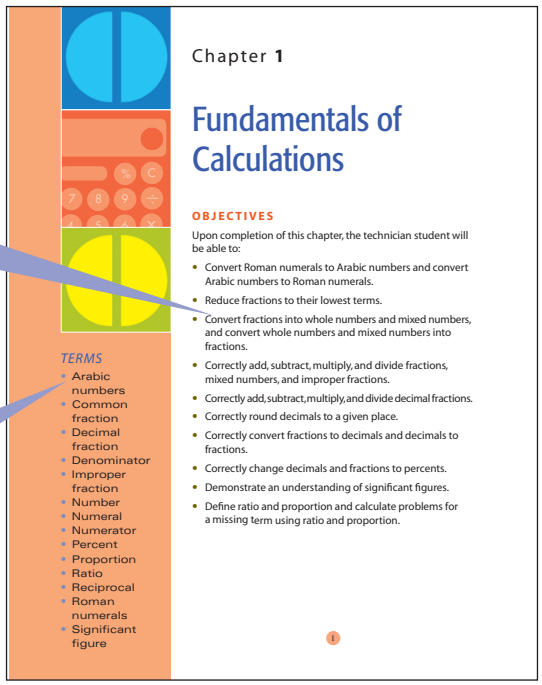
The features that open each chapter are an introduction to guide you through the remainder of the lesson.

Objectives

Lists the most important concepts to focus on as you work through the chapter.

Key Terms

Previews the most important terms in the chapter. These terms are highlighted in color throughout the text and are defined in the margins and in the glossary.



Chapter **1**

Fundamentals of Calculations

OBJECTIVES

Upon completion of this chapter, the technician student will be able to:

- Convert Roman numerals to Arabic numbers and convert Arabic numbers to Roman numerals.
- Reduce fractions to their lowest terms.
- Convert fractions into whole numbers and mixed numbers, and convert whole numbers and mixed numbers into fractions.
- Correctly add, subtract, multiply, and divide fractions, mixed numbers, and improper fractions.
- Correctly add, subtract, multiply, and divide decimal fractions.
- Correctly round decimals to a given place.
- Correctly convert fractions to decimals and decimals to fractions.
- Correctly change decimals and fractions to percents.
- Demonstrate an understanding of significant figures.
- Define ratio and proportion and calculate problems for a missing term using ratio and proportion.

TERMS

- Arabic numbers
- Common fraction
- Decimal fraction
- Denominator
- Improper fraction
- Number
- Numeral
- Numerator
- Percent
- Proportion
- Ratio
- Reciprocal
- Roman numerals
- Significant figure

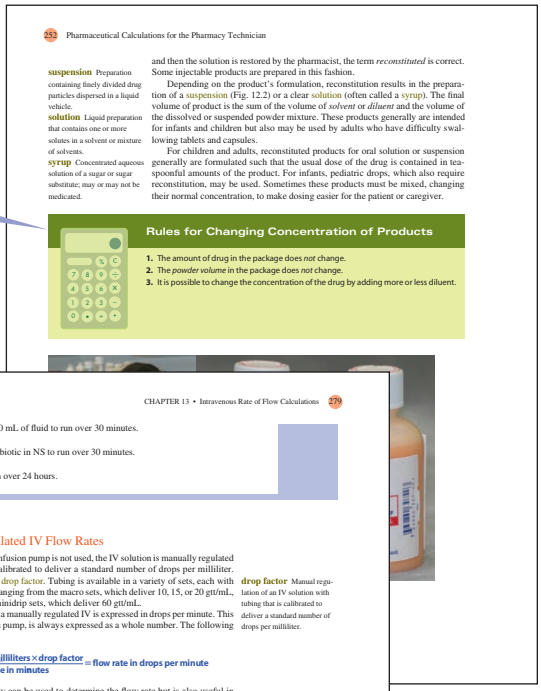
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Chapter Features

The following features appear throughout the body of the chapter. They are designed to hone critical thinking skills and judgment and promote comprehension and retention of key concepts.

Rules Boxes

Set forth the important rules that you need to remember in each chapter.


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suspension Preparation containing finely divided drug particles dispersed in a liquid vehicle.
solution Liquid preparation that contains one or more solutes in a solvent or mixture of solvents.
syrup Concentrated aqueous solution of a sugar or sugar substitute; may or may not be medicated.

and then the solution is restored by the pharmacist, the term *reconstituted* is correct. Some injectable products are prepared in this fashion.

Depending on the product's formulation, reconstitution results in the preparation of a suspension (Fig. 12.2) or a clear solution (often called a syrup). The final volume of product is the sum of the volume of *solvent* or *diluent* and the volume of the dissolved or suspended powder mixture. These products generally are intended for infants and children but also may be used by adults who have difficulty swallowing tablets and capsules.

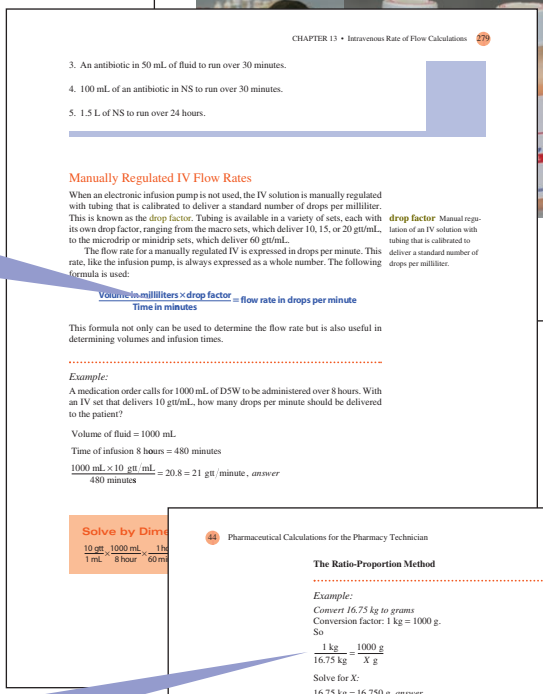
For children and adults, reconstituted products for oral solution or suspension generally are formulated such that the usual dose of the drug is contained in teaspoonful amounts of the product. For infants, pediatric drops, which also require reconstitution, may be used. Sometimes these products must be mixed, changing their normal concentration, to make dosing easier for the patient or caregiver.

Rules for Changing Concentration of Products

1. The amount of drug in the package does *not* change.
2. The *powder volume* in the package does *not* change.
3. It is possible to change the concentration of the drug by adding more or less diluent.

Formulas

Stand out in colored, boldface type for easy reference.


CHAPTER 13 • Intravenous Rate of Flow Calculations 279

3. An antibiotic in 50 mL of fluid to run over 30 minutes.
4. 100 mL of an antibiotic in NS to run over 30 minutes.
5. 1.5 L of NS to run over 24 hours.

Manually Regulated IV Flow Rates

When an electronic infusion pump is not used, the IV solution is manually regulated with tubing that is calibrated to deliver a standard number of drops per milliliter. This is known as the drop factor. Tubing is available in a variety of sets, each with its own drop factor, ranging from the macro sets, which deliver 10, 15, or 20 gtt/mL, to the microdrip or minidrip sets, which deliver 60 gtt/mL.

The flow rate for a manually regulated IV is expressed in drops per minute. This rate, like the infusion pump, is always expressed as a whole number. The following formula is used:

drop factor Manual regulation of an IV solution with tubing that is calibrated to deliver a standard number of drops per milliliter.

$$\frac{\text{Volume in milliliters} \times \text{drop factor}}{\text{Time in minutes}} = \text{flow rate in drops per minute}$$

This formula not only can be used to determine the flow rate but is also useful in determining volumes and infusion times.

Example:

A medication order calls for 1000 mL of D5W to be administered over 8 hours. With an IV set that delivers 10 gtt/mL, how many drops per minute should be delivered to the patient?

Volume of fluid = 1000 mL

Time of infusion 8 hours = 480 minutes

$$\frac{1000 \text{ mL} \times 10 \text{ gtt/mL}}{480 \text{ minutes}} = 20.8 = 21 \text{ gtt/minute}, \textit{ answer}$$

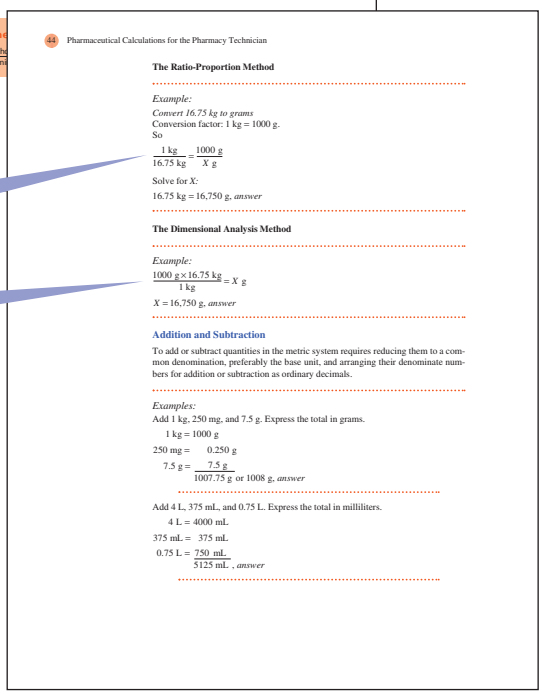
Solve by Dime

$$\frac{10 \text{ gtt}}{1 \text{ mL}} \times \frac{1000 \text{ mL}}{8 \text{ hour}} \times \frac{1 \text{ hr}}{60 \text{ mi}}$$

Examples

Demonstrate how to perform calculations using the ratio-proportion method.

The same calculations are often performed using dimensional analysis, providing you with an alternate method to solving the problem.


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The Ratio-Proportion Method

Example:
Convert 16.75 kg to grams
Conversion factor: 1 kg = 1000 g.
So

$$\frac{1 \text{ kg}}{16.75 \text{ kg}} = \frac{1000 \text{ g}}{X \text{ g}}$$

Solve for *X*:
16.75 kg = 16,750 g, *answer*

The Dimensional Analysis Method

Example:

$$\frac{1000 \text{ g} \times 16.75 \text{ kg}}{1 \text{ kg}} = X \text{ g}$$

X = 16,750 g, *answer*

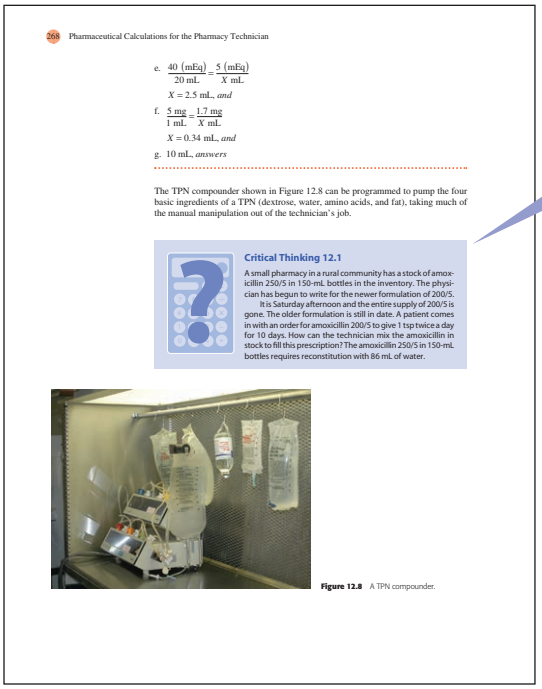
Addition and Subtraction

To add or subtract quantities in the metric system requires reducing them to a common denomination, preferably the base unit, and arranging their denominate numbers for addition or subtraction as ordinary decimals.

Examples:
Add 1 kg, 250 mg, and 7.5 g. Express the total in grams.
1 kg = 1000 g
250 mg = 0.250 g
7.5 g = 7.5 g
1007.75 g or 1008 g, *answer*

Add 4 L, 375 mL, and 0.75 L. Express the total in milliliters.
4 L = 4000 mL
375 mL = 375 mL
0.75 L = 750 mL
5125 mL, *answer*

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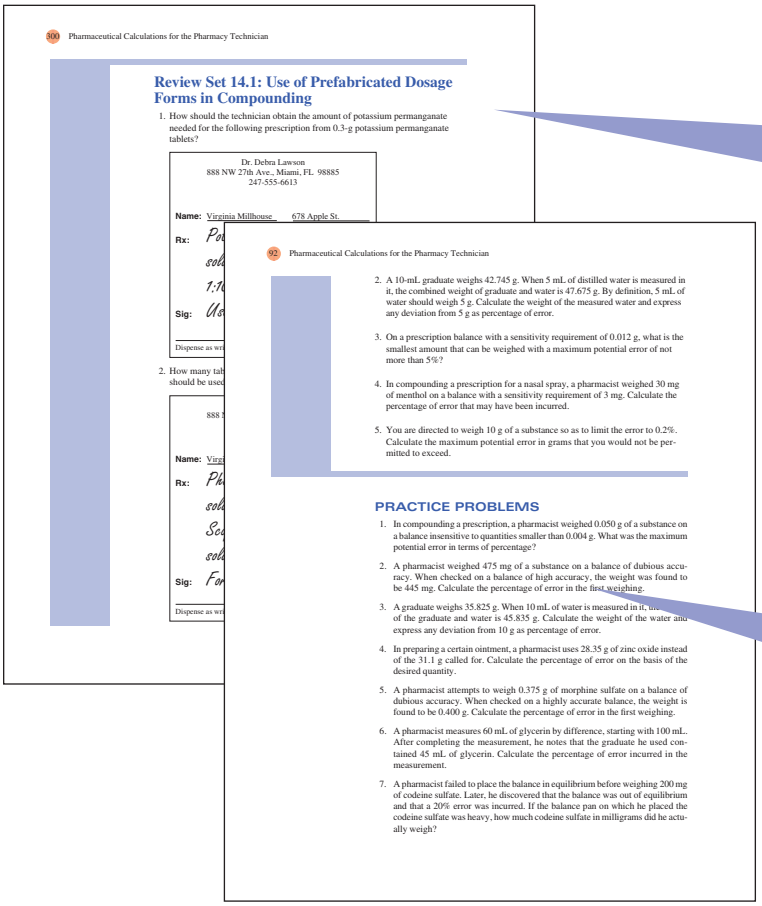


Critical Thinking Boxes

Ask you to solve problems that arise in different practice settings. Answers to the critical thinking problems that have solutions can be found in Appendix B.

Test Preparation Features

These features help you review chapter content and test yourself before exams.



Review Sets

Follow small sections of information, providing you with the opportunity to test your knowledge of key concepts that you have just learned. Solutions to these problems can be found in Appendix A.

Practice Problems

Appear at the end of each chapter to give you additional practice in performing pharmaceutical calculations.

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