Master dosage calculations with the best-selling book! This market-leader from Gloria Pickar includes a comprehensive math review, full-color drug labels, and critical thinking assessments. Basic and advanced calculations are thoroughly covered, including intravenous and those specific to the pediatric patient.

NEW TO THIS EDITION:
- New chapter 9: Preventing Medication Errors highlights the newest regulations on medication abbreviations, new medication administration technologies, and safe medication practices
- Expanded chapter on other calculation methods covers dimensional analysis and ratio-proportion, making this text a comprehensive resource for dosage calculations content
- All new student practice software provides hundreds of additional practice questions, as well as tutorials and animations to aid in comprehension of difficult concepts
- Only approved Joint Commission and ISMP abbreviations are included, to ensure safe and current use of standardized terminology

FEATURES:
- Real drug labels and life-size syringes bring the content to life and simulate a clinical environment
- The original three-step method, (1) Convert, (2) Think, (3) Calculate, trains the learner to approach calculations logically, increasing confidence and reducing medication errors
- Critical Thinking Skills can be developed through real-world clinical scenarios that demonstrate the importance of safe medication administration
- Hundreds of examples, practice problems, review sets, and self tests ensure complete mastery of dosage calculations

ALSO AVAILABLE FROM DELMAR, CENGAGE LEARNING:
  George R. Spratto and Adrienne L. Woods
  1-4283-0531-9
- 3-2-1 Calc!, Comprehensive Dosage Calculations Online
  Aresa M. Cater and Gloria D. Pickar
  1-4018-3326-8 (online individual purchase)
  1-4180-6671-0 (institutional purchase)
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Introduction

Dosage Calculations, eighth edition, offers a clear and concise method of calculating drug dosages. The text is directed to students and professionals who want to increase their comfort level with mathematics and also to faculty members who prefer the popular formula method for calculating dosages. Along with the companion text, Dosage Calculations: A Ratio-Proportion Approach, second edition, the content has been classroom tested and reviewed by well over 900,000 faculty and students, who report that it has helped allay math anxiety and promote confidence in their ability to perform accurate calculations. As one reviewer noted, “I have looked at others [texts], and I don’t feel they can compare.”

The only math prerequisite is the ability to do basic arithmetic. For those who need a review, Chapters 1 and 2 offer an overview of basic arithmetic calculations with extensive exercises for practice. The student is encouraged to use a three-step method for calculating dosages.

1. Convert measurements to the same system and same size units.
2. Consider what dosage is reasonable.
3. Calculate using the formula method \( \frac{D}{H} \times Q \) (desired over have times quantity).

Dosage Calculations, eighth edition, is based on feedback from users of the previous editions and users of other dosage calculations texts. The new edition also responds to changes in the health care field and includes the introduction of new drugs, replacement of outdated drugs, and discussion of new or refined methods of administering medications. The importance of avoiding medication errors is highlighted by the incorporation of applied critical thinking skills based on patient care situations and a new chapter on preventing medication errors.

Organization of Content

The text is organized in a natural progression of basic to more complex information. Learners gain self-confidence as they master content in small increments with ample review and reinforcement. Many learners claim that while using this text, they did not fear math for the very first time.

The seventeen chapters are divided into four sections. Section 1 includes a mathematics diagnostic evaluation and a mathematics review in Chapters 1 and 2. The Mathematics Diagnostic Evaluation allows learners to determine their computational strengths and weaknesses to guide them through the review of the Section 1 chapters. Chapters 1 and 2 provide a review of basic arithmetic procedures, with numerous examples and practice problems to ensure that students can apply the procedures.

Section 2 includes Chapters 3 through 9. This section provides essential information that is the foundation for accurate dosage calculations and safe medication administration, including medicine orders, labels, and equipment. Chapters 3 and 4 introduce the three systems of measurement (metric, apothecary, and household) and outline conversion from one system of measurement to another. The metric system of measurement is emphasized because of its standardization in the health care field. The apothecary system continues to be included for recognition purposes, and the household system is included because of its implications for care at home. International, or 24-hour, time and Fahrenheit and Celsius temperature conversions are presented in Chapter 5.

In Chapter 6, users learn to recognize and select appropriate equipment for the administration of medications based on the drug, dosage, and method of administration. Emphasis is placed on interpreting syringe calibrations to ensure that the dosage to be administered is accurate. All photos and drawings have been enhanced for improved clarity with updates for state-of-the-art technology.

Chapter 7 presents the common abbreviations used in health care so that learners can become proficient in interpreting medical orders. Additionally, the content on computerized medication administration records has been updated and expanded.

It is essential that learners be able to read medication labels to calculate dosages accurately. This ability is devel-
Chapters 14 and 15 introduce the concepts of solutions. Users learn the calculations associated with diluting solutions and reconstituting injectable drugs. This chapter provides a segue to intravenous calculations by fully describing the preparation of solutions. With the expanding role of the nurse and other health care workers in the home setting, clinical calculations for home care, such as nutritional feedings, are also emphasized.

The new Chapter 13 introduces the ratio-proportion and dimensional analysis methods of calculating dosages. Ample Review Sets and Practice Problems provide the opportunity to apply these methods, giving the learner an opportunity to sample other calculation methods and choose the one preferred.

Chapter 14 covers the calculation of pediatric and adult dosages and concentrates on the body weight method. Emphasis is placed on verifying safe dosages and applying concepts across the life span.

Advanced clinical calculations applicable to both adults and children are presented in Section 4. Intravenous administration calculations are presented in Chapters 15 through 17. Coverage reflects the greater application of IVs in drug therapy. Shortcut calculation methods are presented and explained fully. More electronic infusion devices are included. Heparin and saline locks, types of IV solutions, IV monitoring, IV administration records, and IV push drugs are included in Chapter 15. Pediatric IV calculations are presented in Chapter 16, and obstetric, hepatic, and critical care IV calculations are covered in Chapter 17. Ample problems help students master the necessary calculations.

Procedures in the text are introduced using Rule boxes and several Examples. Key concepts are summarized and highlighted in Quick Review boxes before each set of Review Problems to give learners an opportunity to review major concepts prior to working through the problems. Math Tips provide memory joggers to assist learners in accurately solving problems. Learning is reinforced by Practice Problems that conclude each chapter. The importance of calculation accuracy and patient safety is emphasized by patient scenarios that require careful and accurate consideration. Critical Thinking Skills scenarios have also been added to chapter Practice Problems to further emphasize accuracy and safety.

Information to be memorized is identified in Remember boxes, and Caution boxes alert learners to critical procedures.

Section Self-Evaluations found at the end of each section provide learners with an opportunity to test their mastery of chapter objectives prior to proceeding to the next section. Two Posttests at the conclusion of the text serve to evaluate the learner’s overall skill in dosage calculations. The first Posttest covers essential skills commonly tested by employers, and the second serves as a comprehensive examination. Both are presented in a case study format to simulate actual clinical calculations.

An Answer Key at the back of the text provides all answers and selected solutions to problems in the Review Sets, Practice Problems, Section Self-Evaluations, and Posttests.

Features of the Eighth Edition

- Content is divided into four main sections to help learners better organize their studies.
- Measurable objectives at the beginning of each chapter emphasize the content to be learned.
- More than 2,050 problems are included for learners to practice their skills and reinforce their learning reflect current drugs and protocols.
- More Critical Thinking Skills are applied to real-life patient care situations to emphasize the importance of accurate dosage calculations and the avoidance of medication errors.
Full color is used to make the text user friendly. Chapter elements, such as Rules, Math Tips, Cautions, Remember boxes, Quick Reviews, and Examples, are color-coded for easy recognition and use. Color also highlights Review Sets and Practice Problems.

All syringes and measuring devices are drawn to full size to provide accurate scale renderings to help learners master the measurement and reading of dosages.

An amber color has been added to selected syringe drawings throughout the text to simulate a specific amount of medication, as indicated in the example or problem. Because the color used may not correspond to the actual color of the medications named, it must not be used as a reference for identifying medications.

Photos and drug labels are presented in full color; color is used to highlight and enhance the visual presentation of content to improve readability. Special attention is given to visual clarity with some labels enlarged to ensure legibility.

The Math Review brings learners up to the required level of basic math competence.

SI conventional metric system notation is used (apothecary and household system of measurement are deemphasized but are still included).

Rule boxes draw the learner’s attention to pertinent instructions.

Remember boxes highlight information to be memorized.

Quick Review boxes summarize critical information throughout the chapters before Review Sets are solved.

Caution boxes alert learners to critical information.

Math Tips serve to point out math shortcuts and reminders.

Content is presented from simple to complex concepts in small increments followed by Review Sets and chapter Practice Problems to assess understanding and skills and to reinforce learning.

Many problems are included involving the interpretation of syringe scales to ensure that the proper dosage is administered. Once the dosage is calculated, the learner is directed to draw an arrow on a syringe at the proper value. Syringe photos and illustrations have been updated.

Many more labels of current and commonly prescribed medications are included to help users learn how to select the proper information required to determine correct dosage. There are over 375 labels included.

More solved Examples are included to demonstrate the $\frac{D}{H} \times Q = X$, ratio-proportion, or dimensional analysis methods of calculating dosages.

For the first time, dimensional analysis is included as an alternative dosage calculation method. Ratio-proportion is also included and has been expanded by popular demand, giving learners and instructors a choice of which method they prefer to use.

IV equipment and calculations have been expanded.

Clear instructions are included for calculating IV medications administered in milligram per kilogram per minute.

Clinical situations are simulated using actual medication labels, syringes, physician order forms, and medication administration records.

Case study format of Posttests simulate actual clinical calculations and scenarios.

An Essential Skills Evaluation simulates exams commonly administered by employers for new hires. A Comprehensive Skills Evaluation assesses the learner’s overall comprehension in preparation for a level or program assessment.

The index facilitates learner and instructor access to content and skills.

New to the Eighth Edition

Abbreviations, examples, and problems strictly adhere to The Joint Commission’s Official “Do Not Use” List.

An entirely new chapter (Chapter 9) is devoted to preventing medication errors and discussing the critical nature of dosage calculations and medication administration.

Dimensional analysis is thoroughly presented and demonstrated as a dosage calculation method.

New labels are added throughout the book to reflect current drugs on the market.

New questions are added throughout to reflect current drugs and protocols.

Photographs of state-of-the-art equipment are replaced and updated.

The number of Critical Thinking Skills scenarios has doubled.
Online course formats are available in Blackboard and WebCT so that students can access their Dosage Calculations course content, practice activities, communications, and assessments through the Internet.

An exciting new Student Practice Software CD-ROM is included in the book, offering a glossary review, chapter tutorials, and hundreds of practice problems.

Resources

Electronic Classroom Manager
(ISBN 1-4180-8048-9)

The Electronic Classroom Manager (ECM) to Accompany Dosage Calculations, eighth edition, contains a variety of tools to help instructors successfully prepare lectures and teach within this subject area. The following components in the ECM are all free to adopters of Dosage Calculations, eighth edition:

- An Instructor's Manual allows you to locate solutions for the Review Sets, Practice Problems, Section Evaluations, and Posttests from the book. It also includes additional teaching strategies and activities.

- The Computerized Test Bank includes approximately 500 additional questions not found in the book for further assessment. The software also allows for the creation of test items and full tests, as well as coding for difficulty level.

- PowerPoint Slides offer a depiction of administration tools and include calculation tips helpful to classroom lecture of dosage calculations.

- An Image Library is an invaluable digital resource of dozens of figures, labels, and syringes from the text. With the Image Library, you can search for, copy, and save images to easily paste into Microsoft PowerPoint presentations or other learning tools.

WebTutor Advantage on WebCT
(ISBN 1-4180-8049-7) and Blackboard
(ISBN 1-4180-8050-0)

WebTutor Advantage (both WebCT and Blackboard formats) accompany this new edition of Dosage Calculations. These online supplemental courses offer must-have classroom management tools such as chats and calendars, as well as additional content resources, including class notes, web links, PowerPoints, animations, video, student quizzes, frequently asked questions, a glossary, and more.
Online Companion (ISBN 1-4180-8051-9)

A new online companion is available to adopters of the text. This resource includes valuable instructor tools to facilitate lecture preparation and test administration.

Tutorial Software

Engaging Student Practice Software is available FREE to each user of Dosage Calculations, eighth edition. The CD-ROM packaged within the book features:

- A bank of several hundred questions that support and reinforce the content presented in Dosage Calculations, eighth edition.
- A user-friendly menu structure to immediately access the program's items.
- Practice Problems, Pretest, and Posttest that operate within a tutorial mode, which allows two tries before the correct answer is provided.
- Interactive exercises that ask you to fill a medicine cup or draw back a syringe to the correctly calculated dose.
- A comprehensive glossary of terms and drug names with definitions and pronunciations.
- Drop-down calculator available at a click of a button, as used on the NCLEX-RN™ examination.
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Professor Tremel expertly contributed to the research, updating, and expansion of the eighth edition, including reorganization of Chapter 13. Dr. Beers contributed content for Chapter 9, and Professor Testa contributed dimensional analysis content for Chapter 13.

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Gloria D. Pickar, EdD, RN
Amy Pickar Abernethy, MD
The accurate calculation of drug dosages is an essential skill in health care. Paracelsus (1493–1591), often referred to as the father of pharmacology, recognized that the difference between a poison, narcotic, hallucinogen, and medicine is dosage. Serious harm to the patient can result from a mathematical error during the calculation and subsequent administration of a drug dosage. It is the responsibility of those administering drugs to precisely and efficiently carry out medical orders.

Learning to calculate drug dosages need not be a difficult or burdensome process. *Dosage Calculations*, eighth edition, provides an uncomplicated, easy-to-learn, easy-to-recall three-step method of dosage calculations. Once you master this method, you will be able to consistently compute dosages with accuracy, ease, and confidence.

The text is a self-study guide that is divided into four main sections. The only mathematical prerequisite is the basic ability to add, subtract, multiply, and divide whole numbers. A review of fractions, decimals, percents, ratios, and proportions is included. You are encouraged to work at your own pace and seek assistance from a qualified instructor as needed.

Each procedure in the text is introduced by several *Examples*. Key concepts are summarized and highlighted before the *Practice Problems*. This gives you an opportunity to review the concepts before working the problems. Ample *Review* and *Practice Problems* are given to reinforce your skill and confidence.

Before calculating the dosage, you are asked to consider the reasonableness of the computation. More often than not, the correct amount can be estimated in your head. Many errors can be avoided if you approach dosage calculation in this logical fashion. The mathematical computation can then be used to double-check your thinking. Answers to all problems and step-by-step solutions to select problems are included at the back of the text.

Many photos and drawings are included to demonstrate key concepts and equipment. Drug labels and measuring devices (for example, syringes) are included to give a simulated “hands-on” experience outside of the clinical setting or laboratory. *Critical Thinking Skills* emphasize the importance of dosage calculation accuracy, and medication scenarios provide opportunities to analyze and prevent errors.

This text has helped hundreds of thousands of learners just like you to feel at ease about math and to master dosage calculations. I am interested in your feedback. Please write to me to share your reactions and success stories.

Gloria D. Pickar, EdD, RN
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*Dedicated to Eloby Prentis Rish ("Poppa," 1915–) for demonstrating the art of caring in every way.*
Using This Book

- Concepts are presented from simple to complex, in small increments, followed by a quick review and solved examples. Review Sets and Practice Problems provide opportunities for you to reinforce your learning.

- All syringes are drawn to full size to provide accurate scale renderings to help you master the reading of injectable dosages.

- Photos and drug labels are presented in full color; color is used to highlight and enhance the visual presentation of content and to improve readability. Actual size labels help prepare you to read and interpret content in its true-life format.

- Math Tip boxes provide you with clues to essential computations.

- Caution boxes alert you to critical information and safety concerns.

---

**Math Tip**

Try this to remember the order of six of the metric units—kilo-, hecto-, deca-, (BASE), deci-, centi-, and milli—“King Henry Died from a Disease Called Mumps.”

<table>
<thead>
<tr>
<th>gram</th>
<th>liter</th>
<th>meter</th>
</tr>
</thead>
<tbody>
<tr>
<td>kilo</td>
<td>hecto</td>
<td>deca</td>
</tr>
<tr>
<td>K</td>
<td>H</td>
<td>D</td>
</tr>
</tbody>
</table>

“King Henry Died from a Disease Called Mumps.”

---

**Caution**

You may see gram abbreviated as Gm or gm, liter as lowercase l, or milliliter as ml. These abbreviations are considered obsolete and too easily misinterpreted. You should only use the standardized SI abbreviations. Use g for gram, l for liter, and ml for milliliter. Further, the unit of measurement cubic centimeter, abbreviated cc, has been used interchangeably with ml. The use of cc for ml is now prohibited by many health care organizations because cc can be mistaken for zeros (00) or units (U). The abbreviation U is also now prohibited.
**Rule** boxes highlight and draw your attention to pertinent instructions.

**Remember** boxes highlight information that you should memorize.

**Quick Review** boxes summarize critical information that you will need to know and understand to safely prepare and administer medications.

**Illustrations** simulate critical dosage calculation and dose preparation skills.
Critical Thinking Skills are applied to real-life patient care situations for you, emphasizing the importance of accurate dosage calculations and the avoidance of medication errors. As an added benefit, critical thinking scenarios allowing you to present your own prevention strategy are included in end-of-chapter tests.

ERROR 1
Not placing a zero before a decimal point in medication orders.

Possible Scenario
An emergency room physician wrote an order for the bronchodilator terbutaline for a patient with asthma. The order was written as follows.

Incorrectly Written
Terbutaline .5 mg subcutaneously now, repeat dose in 30 minutes if no improvement

Suppose the nurse, not noticing the faint decimal point, administered 5 mg of terbutaline subcutaneously instead of 0.5 mg. The patient would receive ten times the dose intended by the physician.

Potential Outcome
Within minutes of receiving the injection the patient would likely complain of headache and develop tachycardia, nausea, and vomiting. The patient’s hospital stay would be lengthened because of the need to recover from the overdose.

Prevention
This type of medication error is avoided by remembering the rule to place a 0 in front of a decimal to avoid confusion regarding the dosage: 0.5 mg. Further, remember to question orders that are unclear or seem impractical.

Correctly Written
Terbutaline 0.5 mg subcutaneously now, repeat dose in 30 minutes if no improvement

CRITICAL THINKING SKILLS

Review Sets are sprinkled throughout the chapters to encourage you to stop and check your understanding of material just presented.

Review Set 43
Use the formula method to determine the BSA. Round to 2 decimal places.
1. A child measures 36 inches tall and weighs 40 lb _______ m²
2. An adult measures 190 cm tall and weighs 105 kg _______ m²
3. A child measures 94 cm tall and weighs 18 kg _______ m²
4. A teenager measures 153 cm tall and weighs 46 kg _______ m²
5. An adult measures 175 cm tall and weighs 85 kg _______ m²
6. A child measures 41 inches tall and weighs 76 lb _______ m²
7. An adult measures 62 inches tall and weighs 140 lb _______ m²
8. A child measures 28 inches tall and weighs 18 lb _______ m²
9. A teenager measures 160 cm tall and weighs 64 kg _______ m²
10. A child measures 65 cm tall and weighs 15 kg _______ m²
11. A child measures 55 inches tall and weighs 70 lb _______ m²
12. A child measures 92 cm tall and weighs 24 kg _______ m²

Find the BSA on the West Nomogram (Figure 16-1) for a child of normal height and weight.
13. 4 lb _______ m²
14. 42 lb _______ m²
15. 17 lb _______ m²

Find the BSA on the West Nomogram (Figure 16-1) for children with the following height and weight.
16. 41 inches and 32 lb _______ m²
17. 21 inches and 8 lb _______ m²
18. 140 cm and 30 kg _______ m²
19. 80 cm and 11 kg _______ m²
20. 106 cm and 25 kg _______ m²

After completing these problems, see pages 544–545 to check your answers.
Practice Problems round out each chapter. This is your opportunity to put your skills to the test, to identify your areas of strength, and also to acknowledge those areas in which you need additional study.

Student Practice Software CD-ROM is your built-in learning tutor. As you study each chapter, be sure to also work with the in-book CD. This valuable resource will help you verify your understanding of key rules and calculations.

Online Resources are available at your fingertips. Visit the Online Companion and WebTutor Advantage components for valuable course content, exercises, skills checklists, class notes, web links, and case studies.
Mathematics Review

Mathematics Diagnostic Evaluation

1 Fractions and Decimals

2 Ratios, Percents, Simple Equations, and Ratio-Proportion

Section 1 Self-Evaluation
MATHEMATICS DIAGNOSTIC EVALUATION

As a prerequisite objective, *Dosage Calculations* takes into account that you can add, subtract, multiply, and divide whole numbers. You should have a working knowledge of fractions, decimals, ratios, percents, and basic problem solving as well. This text reviews these important mathematical operations, which support all dosage calculations in health care.

Set aside 1 1/2 hours in a quiet place to complete the 50 items in the following diagnostic evaluation. You will need scratch paper and a pencil to work the problems.

Use your results to determine your computational strengths and weaknesses to guide your review. A minimum score of 86 is recommended as an indicator of readiness for dosage calculations. If you achieve that score, you may proceed to Chapter 3. However, note any problems that you answered incorrectly, and use the related review materials in Chapters 1 and 2 to refresh your skills.

This mathematics diagnostic evaluation and the review that follows are provided to enhance your confidence and proficiency in arithmetic skills, thereby helping you to avoid careless mistakes when you perform dosage calculations.

Good luck!

Directions:

1. Carry answers to three decimal places and round to two places.
   (Examples: 5.175 = 5.18; 5.174 = 5.17)

2. Express fractions in lowest terms.
   (Example: \( \frac{6}{10} = \frac{3}{5} \))

Mathematics Diagnostic Evaluation

1. \( 1.517 + 0.63 = \)
2. Express the value of \( 0.7 + 0.035 + 20.006 \) rounded to two decimal places.
3. \( 9.5 + 17.06 + 32 + 41.11 + 0.99 = \)
4. \( \$19.69 + \$304.03 = \)
5. \( 93.2 - 47.09 = \)
6. \( 1.005 - 250.5 = \)
7. Express the value of \( 17.156 - 0.25 \) rounded to two decimal places.
8. \( 509 \times 38.3 = \)
9. \( \$4.12 \times 42 = \)
10. \( 17.16 \times 23.5 = \)
11. \( 972 \div 27 = \)
12. \( 2.5 \div 0.001 = \)
13. Express the value of \( \frac{1}{4} + \frac{3}{8} \) as a fraction reduced to lowest terms.
14. Express \( \frac{500}{240} \) as a decimal.
15. Express 0.8 as a fraction.
16. Express \( \frac{2}{3} \) as a percent.
17. Express 0.004 as a percent.
18. Express 5% as a decimal.
19. Express \( \frac{33\frac{1}{3}}{50} \) as a ratio in lowest terms.
20. Express 1:50 as a decimal.
21. \( \frac{1}{2} + \frac{3}{4} = \)
22. \( \frac{2}{3} + 4\frac{7}{8} = \)
23. \( \frac{5}{6} - \frac{2}{9} = \)
24. Express the value of \( \frac{1}{100} \times 60 \) as a fraction.
25. Express the value of \( 4\frac{1}{4} \times 3\frac{1}{2} \) as a mixed number.
26. Identify the fraction with the greatest value: \( \frac{1}{150}, \frac{1}{200}, \frac{1}{100} \).
27. Identify the decimal with the least value: 0.009, 0.19, 0.9.
28. \( 0.06 \)
29. \( 0.02 + 0.16 = \)
30. Express the value of \( \frac{3}{12 + 3} \times 0.25 \) as a decimal.
31. 8% of 50 =
32. \( \frac{1}{2} \) of 18 =
33. 0.9% of 24 =

Find the value of X. Express your answer as a decimal.
34. \( \frac{1.1000}{\frac{1}{100}} \times 250 = X \)
35. \( \frac{300}{150} \times 2 = X \)
36. \( \frac{2.5}{\frac{5}{1.5}} = X \)
37. \( \frac{1,000,000}{250,000} \times X = 12 \)
38. \( \frac{0.51}{17} \times X = 150 \)
39. \( X = (82.4 - 52)\frac{3}{5} \)
40. \( \frac{150}{\frac{1}{300}} \times 1.2 = X \)
41. Express 2:10 as a fraction in lowest terms.
42. Express 2% as a ratio in lowest terms.
43. If five equal medication containers contain a total of 25 tablets, how many tablets are in each container?
44. A person is receiving 0.5 milligrams of a medication four times a day. What is the total amount of milligrams of medication given each day?
45. If 1 kilogram equals 2.2 pounds, how many kilograms does a 66-pound child weigh?
46. If 1 kilogram equals 2.2 pounds, how many pounds are in 1.5 kilograms? (Express your answer as a decimal.)
47. If 1 centimeter equals \( \frac{3}{8} \) inch, how many centimeters are in \( 2\frac{1}{2} \) inches? (Express your answer as a decimal.)
48. If 2.5 centimeters equal 1 inch, how long in centimeters is a 3-inch wound?

49. This diagnostic test has a total of 50 problems. If you incorrectly answer 5 problems, what percentage will you have answered correctly?

50. For every 5 female student nurses in a nursing class, there is 1 male student nurse. What is the ratio of female to male student nurses?

After completing these problems, see page 487 to check your answers. Give yourself 2 points for each correct answer.

   Perfect score = 100          My score = 

   Minimum readiness score = 86 (43 correct)
Fractions and Decimals

OBJECTIVES
Upon mastery of Chapter 1, you will be able to perform basic mathematical computations that involve fractions and decimals. Specifically, you will be able to:

■ Compare the values of fractions and decimals.
■ Convert between mixed numbers and improper fractions, and between reduced and equivalent forms of fractions.
■ Add, subtract, multiply, and divide fractions and decimals.
■ Round a decimal to a given place value.
■ Read and write out the value of decimal numbers.

Health care professionals need to understand fractions and decimals to be able to interpret and act on medical orders, read prescriptions, and understand patient records and information in health care literature. The most common system of measurement used in the prescription, dosage calculation, and administration of medications is the metric system. Metric measure is based on decimals. You will see fractions used in apothecary and household measures in dosage calculations. The method of solving dosage problems in this book relies on expressing relationships in fractional form. Therefore, proficiency with fractions and decimals will add to your success with a variety of medical applications.

FRACTIONS
A fraction indicates a portion of a whole number. There are two types of fractions: common fractions, such as $\frac{1}{2}$ (usually referred to simply as fractions) and decimal fractions, such as 0.5 (usually referred to simply as decimals).
A fraction is an expression of division, with one number placed over another number (\(\frac{1}{4}, \frac{2}{3}, \frac{4}{5}\)). The bottom number, or denominator, indicates the total number of equal-sized parts into which the whole is divided. The top number, or numerator, indicates how many of those parts are considered. The fraction may also be read as the numerator divided by the denominator.

**EXAMPLE**

\[
\begin{array}{c}
\text{1} \\
\text{4}
\end{array}
\]

The whole is divided into four equal parts (denominator), and one part (numerator) is considered.

\[
\frac{1}{4} = 1 \text{ part of 4 parts, or } \frac{1}{4} \text{ of the whole.}
\]

The fraction \(\frac{1}{4}\) may also be read as \(1 \text{ divided by } 4\).

**MATH TIP**
The denominator begins with \(d\) and is down below the line in a fraction.

---

**Types of Fractions**

There are four types of fractions: proper, improper, mixed numbers, and complex.

**Proper Fractions**

*Proper fractions* are fractions in which the value of the numerator is less than the value of the denominator. The value of the proper fraction is less than 1.

**RULE**

Whenever the numerator is less than the denominator, the value of the fraction must be less than 1.

**EXAMPLE**

\[
\begin{array}{c}
\text{5} \\
\text{8}
\end{array}
\]

is less than 1

**Improper Fractions**

*Improper fractions* are fractions in which the value of the numerator is greater than or equal to the value of the denominator. The value of the improper fraction is greater than or equal to 1.

**RULE**

Whenever the numerator is greater than the denominator, the value of the fraction must be greater than 1.

**EXAMPLE**

\[
\begin{array}{c}
\text{8} \\
\text{5}
\end{array}
\]

is greater than 1
**RULE**

Whenever the numerator and denominator are equal, the value of the improper fraction is always equal to 1; a nonzero number divided by itself is equal to 1.

**EXAMPLE**

\[
\frac{5}{5} = 1
\]

**Mixed Numbers**

When a whole number and a proper fraction are combined, the result is referred to as a *mixed number*. The value of the mixed number is always greater than 1.

**EXAMPLE**

\[
1 \frac{5}{8} = 1 + \frac{5}{8}
\]

**Complex Fractions**

*Complex fractions* include fractions in which the numerator, the denominator, or both contain a fraction, decimal, or mixed number. The value may be less than, greater than, or equal to 1.

**EXAMPLES**

\[
\frac{5}{8} \text{ is greater than } 1 \quad \frac{5}{2} \text{ is less than } 1 \quad \frac{1\frac{5}{8}}{\frac{1}{5}} \text{ is greater than } 1 \quad \frac{\frac{1}{2}}{\frac{2}{4}} = 1
\]

To perform dosage calculations that involve fractions, you must be able to convert among these different types of fractions and reduce them to lowest terms. You must also be able to add, subtract, multiply, and divide fractions. Review these simple rules of working with fractions. Continue to practice until the concepts are crystal clear and automatic.

**Equivalent Fractions**

The value of a fraction can be expressed in several ways. This is called *finding an equivalent fraction*. In finding an equivalent fraction, both terms of the fraction (numerator and denominator) are either multiplied or divided by the same nonzero number.

**MATH TIP**

In an equivalent fraction, the form of the fraction is changed, but the value of the fraction remains the same.

**EXAMPLES**

\[
\frac{2}{4} = \frac{2 \div 2}{4 \div 2} = \frac{1}{2} \quad \frac{1}{3} = \frac{1 \times 3}{3 \times 3} = \frac{3}{9}
\]

**Reducing Fractions to Lowest Terms**

When calculating dosages, it is usually easier to work with fractions using the smallest possible numbers. Finding these equivalent fractions is called *reducing the fraction to the lowest terms* or *simplifying the fraction*. 
RULE
To reduce a fraction to lowest terms, divide both the numerator and denominator by the largest nonzero whole number that will go evenly into both the numerator and the denominator.

EXAMPLE ■
Reduce $\frac{6}{12}$ to lowest terms.

$6$ is the largest number that will divide evenly into both $6$ (numerator) and $12$ (denominator).

\[
\frac{6}{12} = \frac{6 \div 6}{12 \div 6} = \frac{1}{2}
\]

Sometimes this reduction can be done in several steps. Always check a fraction to see if it can be reduced further.

EXAMPLE ■

\[
\frac{5,000}{20,000} = \frac{5,000 \div 1,000}{20,000 \div 1,000} = \frac{5}{20}
\]

(not in lowest terms)

\[
\frac{5}{20} = \frac{5 \div 5}{20 \div 5} = \frac{1}{4}
\]

(in lowest terms)

MATH TIP
If both the numerator and denominator cannot be divided evenly by a nonzero number other than $1$, then the fraction is already in lowest terms.

Enlarging Fractions

RULE
To find an equivalent fraction in which both terms are larger, multiply both the numerator and the denominator by the same nonzero number.

EXAMPLE ■

Enlarge $\frac{3}{5}$ to the equivalent fraction in tenths.

\[
\frac{3}{5} = \frac{3 \times 2}{5 \times 2} = \frac{6}{10}
\]

Conversion

It is important to be able to convert among different types of fractions. Conversion allows you to perform various calculations with greater ease and permits you to express answers in simplest terms.

Converting Mixed Numbers to Improper Fractions

RULE
To change or convert a mixed number to an improper fraction with the same denominator, multiply the whole number by the denominator and add the numerator. Place that value in the numerator, and use the denominator of the fraction part of the mixed number.
Converting Improper Fractions to Mixed Numbers

**EXAMPLE**

\[
\frac{5}{8} = \frac{(2 \times 8) + 5}{8} = \frac{16 + 5}{8} = \frac{21}{8}
\]

**RULE**

To change or convert an improper fraction to an equivalent mixed number or whole number, divide the numerator by the denominator. Any remainder becomes the numerator of a proper fraction that should be reduced to lowest terms.

**EXAMPLES**

\[
\frac{8}{5} = 8 \div 5 = 1 \frac{3}{5}
\]

\[
\frac{10}{4} = 10 \div 4 = 2 \frac{2}{4} = 2 \frac{1}{2}
\]

Comparing Fractions

In calculating some drug dosages, it is helpful to know when the value of one fraction is greater or less than another. The relative sizes of fractions can be determined by comparing the numerators when the denominators are the same or comparing the denominators if the numerators are the same.

**RULE**

If the denominators are both the same, the fraction with the smaller numerator has the lesser value.

**EXAMPLE**

Compare \(\frac{2}{5}\) and \(\frac{3}{5}\)

Denominators are both 5

Numerators: 2 is less than 3

\(\frac{2}{5}\) has a lesser value

**RULE**

If the numerators are the same, the fraction with the smaller denominator has the greater value.

**EXAMPLE**

Compare \(\frac{1}{2}\) and \(\frac{1}{4}\)

Numerators are both 1

Denominators: 2 is less than 4

\(\frac{1}{2}\) has a greater value

Note: A smaller denominator means it has been divided into fewer pieces, so each one is larger.
QUICK REVIEW

- Proper fraction: numerator is less than denominator; value is less than 1. Example: $\frac{1}{2}$
- Improper fraction: numerator is greater than denominator; value is greater than 1. Example: $\frac{4}{3}$
  
  Or numerator = denominator; value = 1. Example: $\frac{5}{5}$
- Mixed number: whole number + a fraction; value is greater than 1. Example: $1 \frac{1}{2}$
- Complex fraction: numerator and/or denominator are composed of a fraction, decimal, or mixed number; value is less than, greater than, or $\neq 1$.
  
  Example:

- Any nonzero number divided by itself = 1. Example: $\frac{3}{3} = 1$
- To reduce a fraction to lowest terms, divide both terms by the largest nonzero whole number that will divide both the numerator and denominator evenly. Value remains the same.
  
  Example: $\frac{6}{10} = \frac{6 \div 2}{10 \div 2} = \frac{3}{5}$
- To enlarge a fraction, multiply both terms by the same nonzero number. Value remains the same.
  
  Example: $\frac{1}{12} = \frac{1 \times 2}{12 \times 2} = \frac{2}{24}$
- To convert a mixed number to an improper fraction, multiply the whole number by the denominator and add the numerator; use original denominator in the fractional part.
  
  Example: $\frac{1 \frac{1}{3}}{\frac{(3 \times 1) + 1}{3}} = \frac{3 + 1}{3} = \frac{4}{3}$
- To convert an improper fraction to a mixed number, divide the numerator by the denominator. Express any remainder as a proper fraction reduced to lowest terms.
  
  Example: $\frac{21}{9} = 21 \div 9 = 2 \frac{3}{9} = 2 \frac{1}{3}$
- When numerators are equal, the fraction with the smaller denominator is greater.
  
  Example: $\frac{1}{2}$ is greater than $\frac{1}{3}$
- When denominators are equal, the fraction with the larger numerator is greater.
  
  Example: $\frac{2}{3}$ is greater than $\frac{1}{3}$

Review Set 1

1. Circle the improper fraction(s).

   \[
   \frac{2}{3} \quad \frac{3}{4} \quad \frac{6}{5} \quad \frac{7}{15} \quad \frac{16}{17} \quad \frac{9}{2} \quad \frac{2}{3}
   \]

2. Circle the complex fraction(s).

   \[
   \frac{4}{5} \quad \frac{3}{7} \quad \frac{2}{8} \quad \frac{9}{8} \quad \frac{8}{9} \quad \frac{100}{150}
   \]

3. Circle the proper fraction(s).

   \[
   \frac{1}{4} \quad \frac{1}{14} \quad \frac{14}{1} \quad \frac{14}{14} \quad \frac{144}{14}
   \]

4. Circle the mixed number(s) reduced to the lowest terms.

   \[
   \frac{3\frac{4}{8}}{2\frac{3}} \quad \frac{2\frac{3}{9}}{1\frac{3}} \quad \frac{1\frac{1}{4}}{5\frac{7}{8}}
   \]
5. Circle the pair(s) of equivalent fractions.

\[
\frac{3}{4} = \frac{6}{8} \quad \frac{1}{5} = \frac{2}{10} \quad \frac{3}{9} = \frac{1}{3} \quad \frac{3}{4} = \frac{4}{3} \quad 1\frac{4}{9} = 1\frac{2}{\cancel{3}}
\]

Change the following mixed numbers to improper fractions.

6. \(6\frac{1}{2} = \) \(\) 
7. \(1\frac{1}{5} = \) \(\) 
8. \(10\frac{2}{3} = \) \(\)

Change the following improper fractions to whole numbers or mixed numbers; reduce to lowest terms.

9. \(7\frac{5}{6} = \) \(\) 
10. \(102\frac{3}{4} = \) \(\) 
11. \(\frac{24}{12} = \) \(\) 
12. \(\frac{8}{8} = \) \(\) 
13. \(\frac{30}{9} = \) \(\)

Enlarge the following fractions to the number of parts indicated.

14. \(2\frac{5}{8} = \) \(\) 
15. \(4\frac{4}{16} = \) \(\) 
16. \(\frac{3}{4}\) to eighths \(\) 
17. \(\frac{1}{4}\) to sixteenths \(\) 
18. \(\frac{2}{3}\) to twelfths \(\)

Circle the correct answer.

21. Which is larger? \(\frac{1}{150}\) or \(\frac{1}{100}\) 
22. Which is smaller? \(\frac{1}{1,000}\) or \(\frac{1}{10,000}\) 
23. Which is larger? \(\frac{2}{9}\) or \(\frac{5}{9}\) 
24. Which is smaller? \(\frac{3}{10}\) or \(\frac{5}{10}\)

25. A patient is supposed to drink a 10 fluid ounce bottle of magnesium citrate prior to his X-ray study. He has been able to drink 6 fluid ounces. What portion of the liquid remains? (Express your answer as a fraction reduced to lowest terms.)

26. If 1 medicine bottle contains 12 doses, how many full and fractional bottles of medicine are required for 18 doses? (Express your answer as a fraction reduced to lowest terms.)

27. A respiratory therapy class consists of 3 men and 57 women. What fraction of the students in the class are men? (Express your answer as a fraction reduced to lowest terms.)

28. A nursing student answers 18 out of 20 questions correctly on a test. Write a proper fraction (reduced to lowest terms) to represent the portion of the test questions that were answered correctly.

29. A typical dose of Children’s Tylenol contains 160 milligrams of medication per teaspoonful. Each 80 milligrams is what part of a typical dose?
30. In question 29, how many teaspoons of Tylenol would you need to give an 80 milligram dose?

After completing these problems, see pages 487–488 to check your answers.
If you answered question 30 correctly, you can already calculate dosages!

**Addition and Subtraction of Fractions**

To add or subtract fractions, all the denominators must be the same. You can determine the least common denominator by finding the smallest whole number into which all denominators will divide evenly. Once the least common denominator is determined, convert the fractions to equivalent fractions with the least common denominator. This operation involves *enlarging the fractions*, which we examined in the last section. Let’s look at an example of this important operation.

**EXAMPLE**

Find the equivalent fractions with the least common denominator for \( \frac{3}{8} \) and \( \frac{1}{3} \).

1. Find the smallest whole number into which the denominators 8 and 3 will divide evenly. The least common denominator is 24.

2. Convert the fractions to equivalent fractions with 24 as the denominator.

\[
\frac{3}{8} = \frac{3 \times 3}{8 \times 3} = \frac{9}{24} \quad \frac{1}{3} = \frac{1 \times 8}{3 \times 8} = \frac{8}{24}
\]

You have enlarged \( \frac{3}{8} \) to \( \frac{9}{24} \) and \( \frac{1}{3} \) to \( \frac{8}{24} \). Now both fractions have the same denominator. Finding the least common denominator is the first step in adding or subtracting fractions.

**RULE**

To add or subtract fractions:

1. Convert all fractions to equivalent fractions with the least common denominator.

2. Add or subtract the numerators, place that value in the numerator, and use the least common denominator as the denominator.

3. Convert to a mixed number and/or reduce the fraction to lowest terms, if possible.

**MATH TIP**

To add or subtract fractions, no calculations are performed on the denominators once they are all converted to equivalent fractions with the least common denominators. Perform the mathematical operation (addition or subtraction) on the *numerators* only, and use the least common denominator as the denominator of the answer. Never add or subtract denominators.

**Adding Fractions**

**EXAMPLE 1**

\[
\frac{3}{4} + \frac{1}{4} + \frac{2}{4}
\]

1. Find the least common denominator. This step is not necessary in this example because the fractions already have the same denominator.

2. Add the numerators and use the common denominator: \( \frac{3 + 1 + 2}{4} = \frac{6}{4} \)

3. Convert to a mixed number and reduce to lowest terms: \( \frac{6}{4} = 1 \frac{1}{2} \)
EXAMPLE 2 ■
$$\frac{1}{3} + \frac{3}{4} + \frac{1}{6}$$

1. Find the least common denominator: 12. The number 12 is the smallest number that 3, 4, and 6 will all equally divide into.

Convert to equivalent fractions in twelfths. This is the same as enlarging the fractions.
$$\frac{1}{3} = \frac{1 \times 4}{3 \times 4} = \frac{4}{12}$$
$$\frac{3}{4} = \frac{3 \times 3}{4 \times 3} = \frac{9}{12}$$
$$\frac{1}{6} = \frac{1 \times 2}{6 \times 2} = \frac{2}{12}$$

2. Add the numerators, and use the common denominator:
$$\frac{4 + 9 + 2}{12} = \frac{15}{12}$$

3. Convert to a mixed number, and reduce to lowest terms:
$$\frac{15}{12} = 1 \frac{3}{12} = 1 \frac{1}{4}$$

Subtracting Fractions

EXAMPLE 1 ■
$$\frac{15}{18} - \frac{8}{18}$$

1. Find the least common denominator. This is not necessary in this example because the denominators are the same.

2. Subtract the numerators, and use the common denominator:
$$\frac{15 - 8}{18} = \frac{7}{18}$$

3. Reduce to lowest terms. This is not necessary here because no further reduction is possible.

EXAMPLE 2 ■
$$1 \frac{1}{10} - \frac{3}{5}$$

1. Find the least common denominator: 10. The number 10 is the smallest number that both 10 and 5 will equally divide into.

Convert to equivalent fractions in tenths:
$$\frac{11}{10} = \frac{11}{10}$$
$$\frac{3}{5} = \frac{3 \times 2}{5 \times 2} = \frac{6}{10}$$

2. Subtract the numerators, and use the common denominator:
$$\frac{11 - 6}{10} = \frac{5}{10}$$

3. Reduce to lowest terms:
$$\frac{5}{10} = \frac{1}{2}$$

Let’s review one more time how to add and subtract fractions.

QUICK REVIEW

To add or subtract fractions:
- Convert to equivalent fractions with the least common denominator.
- Add or subtract the numerators; place that value in the numerator. Use the least common denominator as the denominator of the answer.
- Convert the answer to a mixed number and/or reduce to lowest terms, if possible.
Add, and reduce the answers to lowest terms.

1. \( \frac{7}{5} + \frac{2}{3} = \) ________
2. \( \frac{3}{4} + \frac{2}{3} = \) ________
3. \( \frac{4}{3} + \frac{5}{24} + \frac{7}{2} = \) ________
4. \( \frac{3}{4} + \frac{1}{8} + \frac{1}{6} = \) ________
5. \( 12\frac{1}{2} + 20\frac{1}{3} = \) ________
6. \( \frac{1}{4} + 5\frac{1}{3} = \) ________

Subtract, and reduce the answers to lowest terms.

7. \( \frac{1}{7} + \frac{2}{3} + \frac{11}{21} = \) ________
8. \( \frac{4}{9} + \frac{5}{8} + 4\frac{2}{3} = \) ________
9. \( 34\frac{1}{2} + 8\frac{1}{2} = \) ________
10. \( 12\frac{1}{17} + 5\frac{2}{7} = \) ________
11. \( \frac{6}{5} + 1\frac{1}{3} = \) ________
12. \( 1\frac{1}{4} + \frac{5}{33} = \) ________
13. \( \frac{3}{4} - \frac{1}{4} = \) ________
14. \( 8\frac{1}{12} - 3\frac{1}{4} = \) ________
15. \( \frac{1}{8} - \frac{1}{12} = \) ________
16. \( 100 - 36\frac{1}{3} = \) ________
17. \( 355\frac{1}{5} - 55\frac{2}{5} = \) ________
18. \( \frac{1}{3} - \frac{1}{6} = \) ________
19. \( 2\frac{3}{5} - 1\frac{1}{5} = \) ________
20. \( 14\frac{3}{16} - 7\frac{1}{8} = \) ________
21. \( 25 - 17\frac{7}{9} = \) ________
22. \( 4\frac{7}{10} - 3\frac{9}{20} = \) ________
23. \( 48\frac{6}{11} - 24 = \) ________
24. \( 1\frac{2}{3} - \frac{1}{12} = \) ________

25. A patient weighs 50 pounds on admission and 48 pounds on day 3 of his hospital stay. Write a fraction, reduced to lowest terms, to express the fraction of his original weight that he has lost.

26. A patient is on strict recording of fluid intake and output, including measurement of liquid medications. A nursing student gave the patient \( \frac{1}{4} \) fluid ounce of medication at 8 AM and \( \frac{1}{3} \) fluid ounce of medication at noon. What is the total amount of medication the patient consumed?

27. An infant has grown \( \frac{1}{2} \) inch during his first month of life, \( \frac{1}{4} \) inch during his second month, and \( \frac{3}{8} \) inch during his third month. How much did he grow during his first 3 months? ________

28. The required margins for your term paper are 1\( \frac{1}{2} \) inches at the top and bottom of a paper that has 11 inches of vertical length. How long is the vertical area available for typed information? ________

29. A stock clerk finds that there are 34\( \frac{1}{2} \) pints of hydrogen peroxide on the shelf. If the fully stocked shelf held 56 pints of hydrogen peroxide, how many pints were used?

30. Your 1-year-old patient weighs 20\( \frac{1}{2} \) pounds. At birth, she weighed 7\( \frac{1}{4} \) pounds. How much weight has she gained in 1 year? ________

After completing these problems, see page 488 to check your answers.
Multiplication of Fractions

To multiply fractions, multiply numerators (for the numerator of the answer) and multiply denominators (for the denominator of the answer) to arrive at the product or result.

When possible, cancellation of terms simplifies and shortens the process of multiplication of fractions. Cancellation (like reducing to lowest terms) is based on the fact that the division of both the numerator and denominator by the same nonzero whole number does not change the value of the resulting number. In fact, it makes the calculation simpler because you are working with smaller numbers.

EXAMPLE ■

\[
\frac{1}{3} \times \frac{250}{500} \quad (\text{numerator and denominator of } \frac{250}{500} \text{ are both divisible by 250})
\]

\[
= \frac{1}{3} \times \frac{1}{2} = \frac{1}{6}
\]

Also, a numerator and a denominator of any of the fractions involved in the multiplication may be cancelled when they can be divided by the same number. This is called cross-cancellation.

EXAMPLE ■

\[
\frac{1}{8} \times \frac{8}{9} = \frac{1}{1} \times \frac{8}{9} = \frac{1}{9}
\]

RULE

To multiply fractions:

1. Cancel terms, if possible.

2. Multiply numerators for the numerator of the answer, and multiply denominators for the denominator of the answer.

3. Reduce the result (product) to lowest terms, if possible.

EXAMPLE 1 ■

\[
\frac{3}{4} \times \frac{2}{6}
\]

1. Cancel terms: Divide 2 and 6 by 2

\[
\frac{3}{4} \times \frac{1}{3} = \frac{1}{4} \times \frac{1}{3}
\]

Divide 3 and 3 by 3

\[
\frac{1}{4} \times \frac{1}{1} = \frac{1}{4}
\]

2. Multiply numerators and denominators

\[
\frac{1}{4} \times \frac{1}{1} = \frac{1}{4}
\]

3. Reduce to lowest terms. This is not necessary here because no further reduction is possible.
EXAMPLE 2 ■
\[
\frac{15}{30} \times \frac{2}{5}
\]

1. Cancel terms: Divide 15 and 30 by 15
\[
\frac{15/15}{30/15} \times \frac{2}{5} = \frac{1}{2} \times \frac{2}{5}
\]

Divide 2 and 2 by 2
\[
\frac{1}{1} \times \frac{2}{5} = \frac{1}{1} \times \frac{1}{5}
\]

2. Multiply numerators and denominators:
\[
\frac{1}{1} \times \frac{1}{5} = \frac{1}{5}
\]

3. Reduce to lowest terms. This is not necessary here because no further reduction is possible.

MATH TIP
When multiplying a fraction by a nonzero whole number, first convert the whole number to a fraction with a denominator of 1; the value of the number remains the same.

EXAMPLE 3 ■
\[
\frac{2}{3} \times 4
\]

1. No terms to cancel. (You cannot cancel 2 and 4 because both are numerators. To do so would change the value.) Convert the whole number to a fraction.
\[
\frac{2}{3} \times 4 = \frac{2}{3} \times \frac{4}{1}
\]

2. Multiply numerators and denominators:
\[
\frac{2}{3} \times \frac{4}{1} = \frac{8}{3}
\]

3. Convert to a mixed number.
\[
\frac{8}{3} = 8 \div 3 = 2\frac{2}{3}
\]

MATH TIP
To multiply mixed numbers, first convert them to improper fractions, and then multiply.

EXAMPLE 4 ■
\[
\frac{3\frac{1}{2}}{4\frac{1}{3}}
\]

1. Convert:
\[
3\frac{1}{2} = \frac{7}{2}
\]
\[
4\frac{1}{3} = \frac{13}{3}
\]
Therefore,
\[
\frac{3\frac{1}{2}}{4\frac{1}{3}} = \frac{7}{2} \times \frac{13}{3}
\]

2. Cancel: not necessary. No numbers can be cancelled.
3. Multiply: \( \frac{7}{2} \times \frac{13}{3} = \frac{91}{6} \)

4. Convert to a mixed number: \( \frac{91}{6} = 15 \frac{1}{6} \)

**Division of Fractions**

The division of fractions uses three terms: *dividend*, *divisor*, and *quotient*. The *dividend* is the fraction being divided or the first number. The *divisor*, the number to the right of the division sign, is the fraction the dividend is divided by. The *quotient* is the result of the division. To divide fractions, the divisor is inverted, and the operation is changed to multiplication. Once inverted, the calculation is the same as for multiplication of fractions.

**EXAMPLE**

\[
\frac{1}{4} \div \frac{2}{7} = \frac{1}{4} \times \frac{7}{2} = \frac{7}{8}
\]

**RULE**

To divide fractions:

1. Invert the terms of the divisor, change \( \div \) to \( \times \).
2. Cancel terms, if possible.
3. Multiply the resulting fractions.
4. Convert the result (quotient) to a mixed number, and/or reduce to lowest terms, if possible.

**EXAMPLE 1**

\( \frac{3}{4} \div \frac{1}{3} \)

1. Invert divisor, and change \( \div \) to \( \times \): \( \frac{3}{4} \div \frac{1}{3} = \frac{3}{4} \times \frac{3}{1} \)
2. Cancel: not necessary. No numbers can be cancelled.
3. Multiply: \( \frac{3}{4} \times \frac{3}{1} = \frac{9}{4} \)
4. Convert to mixed number: \( \frac{9}{4} = 2 \frac{1}{4} \)

**EXAMPLE 2**

\( \frac{2}{3} \div 4 \)

1. Invert divisor, and change \( \div \) to \( \times \): \( \frac{2}{3} \div 4 = \frac{2}{3} \times \frac{1}{4} \)
2. Cancel terms: \( \frac{2}{3} \times \frac{1}{4} = \frac{1}{3} \times \frac{1}{2} \)
3. Multiply: \( \frac{1}{3} \times \frac{1}{2} = \frac{1}{6} \)
4. Reduce: not necessary; already reduced to lowest terms.

**MATH TIP**

To divide mixed numbers, first convert them to improper fractions.
EXAMPLE 3 ■

1 1/2 ÷ 3/4

1. Convert: 3/2 ÷ 3/4

2. Invert divisor, and change ÷ to ×: 3/2 × 4/3

3. Cancel: 3/2 × 2/1 = 1 × 2/1

4. Multiply: 1 × 2 = 2

5. Simplify: 2/1 = 2

MATH TIP

Multiplying complex fractions also involves the division of fractions.

In the next example the divisor is the same as the denominator, so you will invert the denominator and multiply. Multiplying complex fractions can be confusing—take your time and study this carefully.

EXAMPLE 4 ■

1 150/100 ÷ 2

1. Convert: Express 2 as a fraction. 1 150/100 ÷ 2/1

2. Rewrite complex fraction as division: 1 150/100 ÷ 100/1 × 2/1

3. Invert divisor and change ÷ to ×: 1 150/100 × 100/1 ÷ 2/1

4. Cancel: 1 150/3 × 2 1/1 × 2 = 1 × 2 × 2 / 1

5. Multiply: 1 × 2 = 4/3

6. Convert to mixed number: 4/3 = 1 1/3

This example appears difficult at first but when solved logically, one step at a time, it is just like the others.

QUICK REVIEW

- To multiply fractions, cancel terms, multiply numerators, and multiply denominators.
- To divide fractions, invert the divisor, cancel terms, and multiply.
- Convert results to a mixed number and/or reduce to lowest terms, if possible.
### Review Set 3

Multiply, and reduce the answers to lowest terms.

1. \( \frac{3}{10} \times \frac{1}{12} = \) 
2. \( \frac{12}{25} \times \frac{3}{5} = \) 
3. \( \frac{5}{8} \times \frac{11}{6} = \) 
4. \( \frac{1}{100} \times 3 = \) 
5. \( \frac{1}{4} \times \frac{3}{2} = \) 
6. \( \frac{15}{100} \times 2\frac{1}{2} = \)

7. \( \frac{30}{75} \times 2 = \)
8. \( 9\frac{4}{5} \times \frac{2}{3} = \)
9. \( \frac{3}{4} \times \frac{2}{3} = \)
10. \( 4\frac{2}{3} \times 5\frac{1}{24} = \)
11. \( \frac{3}{4} \times \frac{1}{8} = \)
12. \( 12\frac{1}{2} \times 20\frac{1}{3} = \)

Divide, and reduce the answers to lowest terms.

13. \( \frac{3}{4} \div \frac{1}{4} = \)
14. \( 6\frac{1}{12} \div 3\frac{1}{4} = \)
15. \( \frac{1}{8} \div \frac{7}{12} = \)
16. \( \frac{1}{33} \div \frac{1}{3} = \)
17. \( 5\frac{1}{4} \div 10\frac{1}{2} = \)
18. \( \frac{1}{60} \div \frac{1}{2} = \)
19. \( 2\frac{1}{2} \div \frac{3}{4} = \)
20. \( \frac{20}{1\frac{1}{3}} = \)
21. \( \frac{1}{150} \div \frac{1}{50} = \)
22. \( \frac{7}{8} \div 4\frac{1}{2} = \)
23. \( \frac{3}{5} \div \frac{4}{1\frac{1}{9}} = \)

**24.** The nurse is maintaining calorie counts (or counting calories) for a patient who is not eating well. The patient ate \( \frac{3}{4} \) of a large apple. If one large apple contains 80 calories, how many calories were consumed? 

**25.** How many seconds are there in \( 9\frac{1}{3} \) minutes?

**26.** A bottle of Children’s Tylenol contains 20 teaspoons of liquid. If each dose for a 2-year-old child is \( \frac{1}{2} \) teaspoon, how many doses for a 2 year old are available in this bottle? 

**27.** You need to take \( 1\frac{1}{2} \) tablets of medication 3 times per day for 7 days. Over the 7 days, how many tablets will you take? 

**28.** The nurse aide observes that the patient’s water pitcher is \( \frac{1}{2} \) full. If the patient drank 850 milliliters of water, how many milliliters does the pitcher hold? (Hint: The 850 milliliters does not represent \( \frac{1}{2} \) of the pitcher.)
29. A pharmacist weighs a tube of antibiotic eye ointment and documents that it weighs \( \frac{7}{10} \) of an ounce. How much would 75 tubes weigh?

30. A patient is taking a liquid antacid from a 16 fluid ounce bottle. If the patient takes \( \frac{1}{2} \) fluid ounce every 4 hours while awake beginning at 7 AM and ending with a final dose at 11 PM, how many full days would this bottle last? (Hint: First, draw a clock.)

After completing these problems, see pages 488–489 to check your answers.

**DECIMALS**

**Decimal Fractions and Decimal Numbers**

Decimal fractions are fractions with a denominator of 10, 100, 1,000, or any power of 10. At first glance, they appear to be whole numbers because of the way they are written. But the numeric value of a decimal fraction is always less than 1.

**EXAMPLES**

\[
\begin{align*}
0.1 &= \frac{1}{10} \\
0.01 &= \frac{1}{100} \\
0.001 &= \frac{1}{1,000}
\end{align*}
\]

Decimal numbers are numeric values that include a whole number, a decimal point, and a decimal fraction.

**EXAMPLES**

4.67 and 23.956

Generally, decimal fractions and decimal numbers are referred to simply as decimals.

Nurses and other health care professionals must have an understanding of decimals to be competent at dosage calculations. Medication orders and other measurements in health care primarily use metric measure, which is based on the decimal system. Decimals are a special shorthand for designating fractional values. They are simpler to read and faster to use when performing mathematical computations.

**MATH TIP**

When dealing with decimals, think of the decimal point as the center that separates whole and fractional amounts. The position of the numbers in relation to the decimal point indicates the place value of the numbers.
MATH TIP
The words for all decimal fractions end in \textit{th(s)}.

**EXAMPLES**
- \(0.001 = \) one thousand\textit{th}
- \(0.02 = \) two hundred\textit{ths}
- \(0.7 = \) seven tenths

**RULE**
The decimal number is read by stating the whole number first, the decimal point as \textit{and}, and then the decimal fraction by naming the value of the last decimal place.

**EXAMPLE**
Look carefully at the decimal number 4.125. The last decimal place is thousandths. Therefore, the number is read as four and one hundred twenty-five thousandths.

**EXAMPLES**
The number 6.2 is read as six and two tenths.
The number 10.03 is read as ten and three hundredths.

MATH TIP
Given a decimal fraction (whose value is less than 1), the decimal number is read alone, without stating the zero. However, the zero is written to emphasize the decimal point. In fact, since 2005 this is a requirement by the accrediting body for health care organizations, The Joint Commission (2005), when writing decimal fractions in medical notation.

**EXAMPLE**
0.125 is read as one hundred twenty-five thousandths.

A set of rules governs the decimal system of notation.

**RULE**
The whole number value is controlled by its position to the left of the decimal point.

**EXAMPLES**
- \(10.1 = \) ten and one tenth. The whole number is 10.
- \(1.01 = \) one and one hundredth. The whole number is 1.

Notice that the decimal point’s position completely changes the numeric value.
RULE
The decimal fraction value is controlled by its position to the right of the decimal point.

EXAMPLES ■
25.1 = twenty-five and one tenth. The decimal fraction is one tenth.
25.01 = twenty-five and one hundredth. The decimal fraction is one hundredth.

MATH TIP
Each decimal place is counted off as a power of 10 to tell you which denominator is expected.

EXAMPLE 1 ■
437.5 = four hundred thirty-seven and five tenths \((437 \frac{5}{10})\)
One decimal place indicates tenths.

EXAMPLE 2 ■
43.75 = forty-three and seventy-five hundredths \((43 \frac{75}{100})\)
Two decimal places indicate hundredths.

EXAMPLE 3 ■
4.375 = four and three hundred seventy-five thousandths \((4 \frac{375}{1000})\)
Three decimal places indicate thousandths.

RULE
Zeros added after the last digit of a decimal fraction do not change its value, except when a zero is required to demonstrate the level of precision of the value being reported, such as for laboratory results.

EXAMPLE ■
0.25 = 0.250
Twenty-five hundredths equals two hundred fifty thousandths.

CAUTION
When writing decimals, eliminate unnecessary zeros at the end of the number to avoid confusion. As of May 2005, The Joint Commission forbids the use of trailing zeros for medication orders or other medication-related documentation and cautions that, in such cases, the decimal point may be missed when an unnecessary zero is written. This is part of The Joint Commission’s Official “Do Not Use” List (2005) for medical notation, which will be discussed again in Chapters 3 and 9.

Because the last zero does not change the value of the decimal, it is not necessary. The preferred notation is 0.25 rather than 0.250. For example, the required notation is 0.25 rather than 0.250 and 10 not 10.0, which can be misinterpreted as 250 and 100, respectively, if the decimal point is not clear.

RULE
Zeros added before or after the decimal point of a decimal number may change its value.
EXAMPLES

0.125 ≠ (is not equal to) 0.0125
1.025 ≠ 10.025

However, 0.6 = 0.6 and 12 = 12.0, but you should write 0.6 (with a leading decimal) and 12 (without a trailing zero).

Comparing Decimals

It is important to be able to compare decimal amounts, noting which has a greater or lesser value.

CAUTION

A common error in comparing decimals is to overlook the decimal place values and misinterpret higher numbers for greater amounts and lower numbers for lesser amounts.

MATH TIP

You can accurately compare decimal amounts by aligning the decimal points and adding zeros so that the numbers to be compared have the same number of decimal places. Remember that adding zeros at the end of a decimal fraction for the purposes of comparison does not change the original value.

EXAMPLE 1

Compare 0.125, 0.05, and 0.2 to find which decimal fraction is largest.

Align decimal points and add zeros.

0.125 = \( \frac{125}{1,000} \) or one hundred twenty-five thousandths

0.050 = \( \frac{50}{1,000} \) or fifty thousandths

0.200 = \( \frac{200}{1,000} \) or two hundred thousandths

Now it is easy to see that 0.2 is the greatest amount and 0.05 is the least. But at first glance, you might have been tricked into thinking that 0.2 was the least amount and 0.125 was the greatest amount. This kind of error can have dire consequences in dosage calculations and health care.

EXAMPLE 2

Suppose 0.5 microgram of a drug has been ordered. The recommended maximum dosage of the drug is 0.25 microgram, and the minimum recommended dosage is 0.125 microgram. Comparing decimals, you can see that the ordered dosage is not within the recommended range.

0.125 microgram (recommended minimum dosage)

0.250 microgram (recommended maximum dosage)

0.500 microgram (ordered dosage)

Now you can see that 0.5 microgram is outside the allowable limits of the recommended dosage range of 0.125 to 0.25 microgram for this medication. In fact, it is twice the recommended maximum dosage.

CAUTION

It is important to eliminate possible confusion and avoid errors in dosage calculation. To avoid overlooking a decimal point in a decimal fraction and thereby reading the numeric value as a whole number, always place a zero to the left of the decimal point to emphasize that the number...
has a value less than 1. This is another of The Joint Commission’s requirements. The Joint Commission’s Official “Do Not Use” List (2005) prohibits writing a decimal fraction that is less than 1 without a leading zero. This important concept will be emphasized again in Chapters 3 and 9.

**EXAMPLES**

0.425, 0.01, or 0.005

**Conversion between Fractions and Decimals**

For dosage calculations, you may need to convert decimals to fractions and vice versa.

**RULE**

To convert a fraction to a decimal, divide the numerator by the denominator.

**MATH TIP**

Make sure the numerator is inside the division sign and the denominator is outside. You will avoid reversing the numerator and the denominator in division if you write down the number you read first and put the division sign around that number, with the second number written outside the division sign. This will work regardless of whether is is written as a fraction or as a division problem (such as $\frac{1}{2}$ or $1 \div 2$).

**EXAMPLE 1**

Convert $\frac{1}{4}$ to a decimal.

\[
\frac{1}{4} = 0.25
\]

**EXAMPLE 2**

Convert $\frac{2}{5}$ to a decimal.

\[
\frac{2}{5} = 0.4
\]

**RULE**

To convert a decimal to a fraction:

1. Express the decimal number as a whole number in the numerator of the fraction.
2. Express the denominator of the fraction as the number 1 followed by as many zeros as there are places to the right of the decimal point.
3. Reduce the resulting fraction to lowest terms.

**EXAMPLE 1**

Convert 0.125 to a fraction.

1. Numerator: 125
2. Denominator: 1 followed by 3 zeros = 1,000
3. Reduce: $\frac{125}{1,000} = \frac{1}{8}$
EXAMPLE 2
Convert 0.65 to a fraction.
1. Numerator: 65
2. Denominator: 1 followed by 2 zeros = 100
3. Reduce: \( \frac{65}{100} = \frac{13}{20} \)

**MATH TIP**
State the complete name of the decimal, and write the fraction that has the same name, such as 0.65 = “sixty-five hundredths” = \( \frac{65}{100} \).

**QUICK REVIEW**
- In a decimal number, whole number values are to the left of the decimal point and fractional values are to the right.
- Zeros added to a decimal fraction before the decimal point of a decimal number less than 1 or at the end of the decimal fraction do not change the value (except when a zero is required to demonstrate the level of precision of the reported value). Example: .5 = 0.5 = 0.50. However, using the leading zero is the only acceptable notation (such as 0.5).
- In a decimal number, zeros added before or after the decimal point may change the value.
  Example: 1.5 ≠ 1.05 and 1.5 ≠ 10.5.
- To avoid overlooking the decimal point in a decimal fraction, always place a zero to the left of the decimal point.
  Example: .5 ← Avoid writing a decimal fraction this way; it could be mistaken for the whole number 5.
  Example: 0.5 ← This is the required method of writing a decimal fraction with a value less than 1.
- The number of places in a decimal fraction indicates the power of 10.
  Examples:
  0.5 = five tenths
  0.05 = five hundredths
  0.005 = five thousandths
- Compare decimals by aligning decimal points and adding zeros at the end.
  Example:
  Compare 0.5, 0.05, and 0.005.
  0.500 = five hundred thousandths (greatest)
  0.050 = fifty thousandths
  0.005 = five thousandths (least)
- To convert a fraction to a decimal, divide the numerator by the denominator.
- To convert a decimal to a fraction, express the decimal number as a whole number in the numerator and the denominator as the correct power of 10. Reduce the fraction to lowest terms.
  Example:
  \[ \frac{0.04}{100} = \frac{4}{100} = \frac{1}{25} \]
Complete the following table of equivalent fractions and decimals. Reduce fractions to lowest terms.

<table>
<thead>
<tr>
<th>Fraction</th>
<th>Decimal</th>
<th>The decimal number is read as:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. (\frac{1}{5})</td>
<td>_______</td>
<td>_________________</td>
</tr>
<tr>
<td>2. _______</td>
<td>_______</td>
<td>eighty-five hundredths</td>
</tr>
<tr>
<td>3. _______</td>
<td>1.05</td>
<td>___________________</td>
</tr>
<tr>
<td>4. _______</td>
<td>0.006</td>
<td>___________________</td>
</tr>
<tr>
<td>5. (10\frac{3}{200})</td>
<td>_______</td>
<td>___________________</td>
</tr>
<tr>
<td>6. _______</td>
<td>1.9</td>
<td>___________________</td>
</tr>
<tr>
<td>7. _______</td>
<td>_______</td>
<td>five and one tenth</td>
</tr>
<tr>
<td>8. (\frac{4}{5})</td>
<td>_______</td>
<td>___________________</td>
</tr>
<tr>
<td>9. _______</td>
<td>250.5</td>
<td>___________________</td>
</tr>
<tr>
<td>10. (33\frac{3}{100})</td>
<td>_______</td>
<td>___________________</td>
</tr>
<tr>
<td>11. _______</td>
<td>0.95</td>
<td>___________________</td>
</tr>
<tr>
<td>12. (2\frac{3}{4})</td>
<td>_______</td>
<td>___________________</td>
</tr>
<tr>
<td>13. _______</td>
<td>_______</td>
<td>seven and five thousandths</td>
</tr>
<tr>
<td>14. (\frac{21}{250})</td>
<td>_______</td>
<td>___________________</td>
</tr>
<tr>
<td>15. _______</td>
<td>12.125</td>
<td>___________________</td>
</tr>
<tr>
<td>16. _______</td>
<td>20.09</td>
<td>___________________</td>
</tr>
<tr>
<td>17. _______</td>
<td>_______</td>
<td>twenty-two and twenty-two thousandths</td>
</tr>
<tr>
<td>18. _______</td>
<td>0.15</td>
<td>___________________</td>
</tr>
<tr>
<td>19. (1,000\frac{1}{200})</td>
<td>_______</td>
<td>___________________</td>
</tr>
<tr>
<td>20. _______</td>
<td>_______</td>
<td>four thousand eighty-five and seventy-five thousandths</td>
</tr>
</tbody>
</table>

21. Change 0.017 to a four-place decimal. ____________________________

22. Change 0.2500 to a two-place decimal. ____________________________

23. Convert \(\frac{75}{100}\) to a decimal. ____________________________

24. Convert 0.045 to a fraction reduced to lowest terms. ____________________________

Circle the correct answer.

25. Which is largest? 0.012 0.12 0.021

26. Which is smallest? 0.635 0.6 0.063

27. True or false? 0.375 = 0.0375

28. True or false? 2.2 grams = 2.02 grams

29. True or false? 6.5 ounces = 6.500 ounces
30. For a certain medication, the safe dosage should be greater than or equal to 0.5 gram but less than or equal to 2 grams. Circle each dosage that falls within this range.

0.8 gram  0.25 gram  2.5 grams  1.25 grams

After completing these problems, see page 489 to check your answers.

**Addition and Subtraction of Decimals**

The addition and subtraction of decimals is similar to addition and subtraction of whole numbers. There are two simple but essential rules that are different. Health care professionals must use these two rules to perform accurate dosage calculations for some medications.

**RULE**

To add and subtract decimals, line up the decimal points.

**CAUTION**

In final answers, eliminate unnecessary zeros at the end of a decimal to avoid confusion.

**EXAMPLE 1**

\[
\begin{align*}
1.25 + 1.75 &= 3.00 = 3 \\
+ 1.75 & \\
3.00 &= 3
\end{align*}
\]

**EXAMPLE 3**

\[
\begin{align*}
3.54 + 1.26 &= 4.80 = 4.8 \\
+ 1.26 & \\
4.80 &= 4.8
\end{align*}
\]

**EXAMPLE 2**

\[
\begin{align*}
1.25 - 0.13 &= 1.12 \\
- 0.13 & \\
1.12 &
\end{align*}
\]

**EXAMPLE 4**

\[
\begin{align*}
2.54 - 1.04 &= 1.50 = 1.5 \\
- 1.04 & \\
1.50 &= 1.5
\end{align*}
\]

**RULE**

To add and subtract decimals, add zeros at the end of decimal fractions if necessary to make all decimal numbers of equal length.

**EXAMPLE 1**

\[
\begin{align*}
3.75 - 2.1 &= 1.65 \\
- 2.10 & \\
1.65 &
\end{align*}
\]

**EXAMPLE 2**

Add 0.9, 0.65, 0.27, 4.712

\[
\begin{align*}
0.900 \\
0.650 \\
0.270 \\
+ 4.712 \\
6.532
\end{align*}
\]
EXAMPLE 3

\[ 5.25 - 3.6 = 5.25 \]
\[ \quad - 3.60 \]
\[ \quad 1.65 \]

EXAMPLE 4

\[ 66.96 + 32 = 66.96 \]
\[ \quad + 32.00 \]
\[ \quad 98.96 \]

QUICK REVIEW

To add or subtract decimals, align the decimal points and add zeros at the end of the decimal fraction, making all decimals of equal length. Eliminate unnecessary zeros at the end in the final answer.

EXAMPLES

\[ 1.5 + 0.05 = 1.50 \]
\[ \quad + 0.05 \]
\[ \quad 1.55 \]
\[ 7.8 + 1.12 = 7.80 \]
\[ \quad + 1.12 \]
\[ \quad 8.92 \]

\[ 0.725 - 0.5 = 0.725 \]
\[ \quad - 0.500 \]
\[ \quad 0.225 \]
\[ 12.5 - 1.5 = 12.5 \]
\[ \quad - 1.5 \]
\[ \quad 11.0 = 11 \]

Review Set 5

Find the result of the following problems.

1. \[ 0.16 + 5.375 + 1.05 + 16 = \]
2. \[ 7.517 + 3.2 + 0.16 + 33.3 = \]
3. \[ 13.009 - 0.7 = \]
4. \[ 5.125 + 6.025 + 0.15 = \]
5. \[ 175.1 + 0.099 = \]
6. \[ 25.2 - 0.193 = \]
7. \[ 0.58 - 0.062 = \]
8. \[ $10.10 - $0.62 = \]
9. \[ $19 - $0.09 = \]
10. \[ $5.05 + $0.17 + $17.49 = \]
11. \[ 4 + 1.98 + 0.42 + 0.003 = \]
12. \[ 0.3 - 0.03 = \]
13. \[ 16.3 - 12.15 = \]
14. \[ 2.5 - 0.99 = \]
15. \[ 5 + 2.5 + 0.05 + 0.15 + 2.55 = \]
16. $0.03 + 0.16 + 2.327 = \underline{\quad} \\
17. $700 - 325.65 = \underline{\quad} \\
18. $645.32 - 40.9 = \underline{\quad} \\
19. $18 + 2.35 + 7.006 + 0.093 = \underline{\quad} \\
20. $13.529 + 10.09 = \underline{\quad} \\

21. A dietitian calculates the sodium in a patient’s breakfast: raisin bran cereal = 0.1 gram, 1 cup 2% milk = 0.125 gram, 6 ounces orange juice = 0.001 gram, 1 corn muffin = 0.35 gram, and butter = 0.121 gram. How many grams of sodium did the patient consume? \underline{\quad} \\

22. In a 24-hour period, an infant drank 3.6 ounces, 4.2 ounces, 3.9 ounces, 3.15 ounces, and 3.7 ounces of formula. How many ounces did the infant drink in 24 hours? \underline{\quad} \\

23. A patient has a hospital bill for $16,709.43. Her insurance company pays $14,651.37. What is her balance due? \underline{\quad} \\

24. A patient’s hemoglobin was 14.8 grams before surgery. During surgery, the hemoglobin dropped 4.5 grams. What was the hemoglobin value after it dropped? \underline{\quad} \\

25. A home health nurse accounts for her day of work. If she spent 3 hours and 20 minutes at the office, 40 minutes traveling, $3\frac{1}{2}$ hours caring for patients, 24 minutes for lunch, and 12 minutes on break, what is her total number of hours including all of her activities? Express your answer as a decimal. (Hint: First convert each time to hours and minutes.) \underline{\quad} \\

After completing these problems, see page 489 to check your answers.

### Multiplying Decimals

The procedure for multiplication of decimals is similar to that used for whole numbers. The only difference is the decimal point, which must be properly placed in the product or answer. Use the following simple rule.

**RULE**

To multiply decimals:

1. Multiply the decimals without concern for decimal point placement.
2. Count off the total number of decimal places in both of the decimals multiplied.
3. Move the decimal point in the product by moving it to the left the number of places counted.

**EXAMPLE 1**

$$1.5 \times 0.5 = 1.5 \text{ (1 decimal place)}$$

$$\times 0.5 \text{ (1 decimal place)}$$

$$0.75 \text{ (The decimal point is located 2 places to the left because a total of 2 decimal places are counted in the numbers that are multiplied.)}$$

**EXAMPLE 2**

$$1.72 \times 0.9 = 1.72 \text{ (2 decimal places)}$$

$$\times 0.9 \text{ (1 decimal place)}$$

$$1.548 \text{ (The decimal point is located 3 places to the left because a total of 3 decimal places are counted.)}$$
EXAMPLE 3

\[ 5.06 \times 1.3 = 5.06 \] (2 decimal places)
\[ \times 1.3 \] (1 decimal place)
\[ 1518 \]
\[ 506 \]
\[ 6.578 \] (The decimal point is located 3 places to the left because a total of 3 decimal places are counted.)

EXAMPLE 4

\[ 1.8 \times 0.05 = 1.8 \] (1 decimal place)
\[ \times 0.05 \] (2 decimal places)
\[ 0.090 \] (The decimal point is located 3 places to the left. Notice that a zero has to be inserted between the decimal point and the 9 to allow for enough decimal places.)
\[ 0.090 = 0.09 \] (Eliminate unnecessary zero.)

**RULE**

When multiplying a decimal by a power of 10, move the decimal point as many places to the right as there are zeros in the multiplier.

EXAMPLE 1

\[ 1.25 \times 10 \]
The multiplier 10 has 1 zero; move the decimal point 1 place to the right.
\[ 1.25 \times 10 = 12.5 \]

EXAMPLE 2

\[ 2.3 \times 100 \]
The multiplier 100 has 2 zeros; move the decimal point 2 places to the right. (Note: Add zeros as necessary to complete the operation.)
\[ 2.3 \times 100 = 230 \]

EXAMPLE 3

\[ 0.001 \times 1,000 \]
The multiplier 1,000 has 3 zeros; move the decimal point 3 places to the right.
\[ 0.001 \times 1,000 = 0.001 = 1 \]

**Dividing Decimals**

When dividing decimals, set up the problem the same as for the division of whole numbers. Follow the same procedure for dividing whole numbers after you apply the following rule.
**RULE**
To divide decimals:

1. Move the decimal point in the **divisor** (number divided by) and the **dividend** (number divided) the number of places needed to make the divisor a whole number.

2. Place the decimal point in the **quotient** (answer) above the new decimal point place in the dividend.

**EXAMPLE 1**

\[
\begin{array}{c|c}
\text{100.75} & \text{2.5} \\
\hline
\text{40.3} & \text{(quotient)} \\
\end{array}
\]

\[
\begin{array}{c|c}
\text{100.75} & \text{10} \\
\hline
\text{0.75} & \text{(dividend)} \\
\end{array}
\]

\[
\begin{array}{c|c}
\text{10} & \text{(divisor)} \\
\hline
\text{10} & \text{0.065} \\
\end{array}
\]

**EXAMPLE 2**

\[
\begin{array}{c|c}
\text{56.5} & \text{0.02} \\
\hline
\text{2.825} & \text{(quotient)} \\
\end{array}
\]

\[
\begin{array}{c|c}
\text{56.5} & \text{10} \\
\hline
\text{5} & \text{(dividend)} \\
\end{array}
\]

\[
\begin{array}{c|c}
\text{10} & \text{0} \\
\hline
\text{10} & \text{0} \\
\end{array}
\]

**MATH TIP**
Recall that adding a zero at the end of a decimal number does not change its value (56.5 = 56.50). Adding a zero was necessary in the last example to complete the operation.

**RULE**
When dividing a decimal by a power of 10, move the decimal point to the left as many places as there are zeros in the divisor.

**EXAMPLE 1**

\[
0.65 \div 10
\]

The divisor 10 has 1 zero; move the decimal point 1 place to the left.

\[
0.65 \div 10 = 0.065
\]

(Note: Place a zero to the left of the decimal point to avoid confusion and to emphasize that this is a decimal.)
EXAMPLE 2 ■

7.3 \div 100

The divisor 100 has 2 zeros; move the decimal point 2 places to the left.

7.3 \div 100 = 0.073

(Note: Add zeros as necessary to complete the operation.)

EXAMPLE 3 ■

0.5 \div 1,000

The divisor 1,000 has 3 zeros; move the decimal point 3 places to the left.

0.5 \div 1,000 = 0.0005

Rounding Decimals

For many dosage calculations, it will be necessary to compute decimal calculations to thousandths (three decimal places) and round back to hundredths (two places) for the final answer. For example, pediatric care and critical care require this degree of accuracy. At other times, you will need to round to tenths (one place). Let’s look closely at this important math skill.

RULE

To round a decimal to hundredths, drop the number in thousandths place, and

1. Do not change the number in hundredths place, if the number in thousandths place was 4 or less.
2. Increase the number in hundredths place by 1, if the number in thousandths place was 5 or more.

When rounding for dosage calculations, unnecessary zeros can be dropped. For example, 5.20 rounded to hundredths place should be written as 5.2 because the 0 is not needed to clarify the number.

EXAMPLES ■

<table>
<thead>
<tr>
<th>Tenths</th>
<th>Hundredths</th>
<th>Thousandths</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 . 1 2 3</td>
<td>= 0.12</td>
<td></td>
</tr>
<tr>
<td>1 . 7 4 4</td>
<td>= 1.74</td>
<td></td>
</tr>
<tr>
<td>5 . 3 2 5</td>
<td>= 5.33</td>
<td></td>
</tr>
<tr>
<td>0 . 6 6 6</td>
<td>= 0.67</td>
<td></td>
</tr>
<tr>
<td>0 . 3 0</td>
<td>= 0.3</td>
<td>(When this is rounded to hundredths, the final zero can be dropped. It is not needed to clarify the number.)</td>
</tr>
</tbody>
</table>
RULE

To round a decimal to tenths, drop the number in hundredths place, and
1. Do not change the number in tenths place, if the number in hundredths place was 4 or less.
2. Increase the number in tenths place by 1, if the number in hundredths place was 5 or more.

EXAMPLES

<table>
<thead>
<tr>
<th>Tenths</th>
<th>Hundredths</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.13</td>
<td></td>
</tr>
<tr>
<td>5.64</td>
<td></td>
</tr>
<tr>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>1.66</td>
<td></td>
</tr>
<tr>
<td>0.95</td>
<td></td>
</tr>
</tbody>
</table>

All rounded to tenths (1 place)

0.1
5.6
0.8
1.7
1.0

(Zero at the end of a decimal is unnecessary and should be dropped unless a zero is necessary to indicate precision, such as for lab values.)

QUICK REVIEW

- To multiply decimals, place the decimal point in the product to the left as many total decimal places as there are in the two decimals multiplied.
  
  Example: 
  
  \[ 0.25 \times 0.2 = 0.050 = 0.05 \] (Zero at the end of the decimal is unnecessary.)

- To divide decimals, move the decimal point in the divisor and dividend the number of decimal places that will make the divisor a whole number and align it in the quotient.
  
  Example: 
  
  \[
  \begin{array}{c|c|c}
  \underline{2.0} & \underline{1.2} & 24.0 \\
  \underline{2.4} & 24.0 & \end{array}
  \]

  \[ 24 \div 1.2 = 20 \]

- To multiply or divide decimals by a power of 10, move the decimal point to the right (to multiply) or to the left (to divide) the number of decimal places as there are zeros in the power of 10.
  
  Examples:
  
  \[ 5.06 \times 10 = 50.6 \]
  
  \[ 2.1 \div 100 = 0.021 \]

- When rounding decimals, add 1 to the place value considered if the next decimal place is 5 or greater.
  
  Examples:
  
  Rounded to hundredths: 3.054 = 3.05; 0.566 = 0.57.

  Rounded to tenths: 3.05 = 3.1; 0.54 = 0.5
Section 1 Mathematics Review

Review Set 6

Multiply, and round your answers to two decimal places.

1. \(1.16 \times 5.03 = \) __________
2. \(0.314 \times 7 = \) __________
3. \(1.71 \times 25 = \) __________
4. \(3.002 \times 0.05 = \) __________
5. \(16.1 \times 25.04 = \) __________

6. \(75.1 \times 1,000.01 = \) __________
7. \(16.03 \times 2.05 = \) __________
8. \(55.50 \times 0.05 = \) __________
9. \(23.2 \times 15.025 = \) __________
10. \(1.14 \times 0.014 = \) __________

Divide, and round your answers to two decimal places.

11. \(16 \div 0.04 = \) __________
12. \(25.3 \div 6.76 = \) __________
13. \(0.02 \div 0.004 = \) __________
14. \(45.5 \div 15.25 = \) __________
15. \(515 \div 0.125 = \) __________

16. \(73 \div 13.40 = \) __________
17. \(16.36 \div 0.06 = \) __________
18. \(0.375 \div 0.25 = \) __________
19. \(100.04 \div 0.002 = \) __________
20. \(45 \div 0.15 = \) __________

Multiply or divide by the power of 10 indicated. Draw an arrow to demonstrate movement of the decimal point. Do not round answers.

21. \(562.5 \times 100 = \) __________
22. \(16 \times 10 = \) __________
23. \(25 \div 1,000 = \) __________
24. \(32.005 \div 1,000 = \) __________
25. \(0.125 \div 100 = \) __________

26. \(23.25 \times 10 = \) __________
27. \(717.717 \div 10 = \) __________
28. \(83.16 \times 10 = \) __________
29. \(0.33 \times 100 = \) __________
30. \(14.106 \times 1,000 = \) __________

After completing these problems, see page 490 to check your answers.

PRACTICE PROBLEMS—CHAPTER 1

1. Convert 0.35 to a fraction in lowest terms. __________
2. Convert \(\frac{3}{8}\) to a decimal. __________

Find the least common denominator for the following pairs of fractions.

3. \(\frac{5}{7}, \frac{2}{3}\) __________
4. \(\frac{4}{5}, \frac{1}{11}\) __________

5. \(\frac{4}{9}, \frac{5}{6}\) __________
6. \(\frac{1}{3}, \frac{3}{5}\) __________

Perform the indicated operation, and reduce fractions to lowest terms.

7. \(1 \frac{2}{3} + \frac{9}{5} = \) __________
8. \(4 \frac{5}{12} + 3 \frac{1}{15} = \) __________

9. \(\frac{7}{9} - \frac{5}{18} = \) __________
10. \(5 \frac{1}{6} - 2 \frac{7}{8} = \) __________
### Chapter 1 Fractions and Decimals

#### Fractions

<table>
<thead>
<tr>
<th>Expression</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\frac{4}{9} \times \frac{7}{12}$</td>
<td>$\frac{13}{3}$</td>
</tr>
<tr>
<td>$1 \frac{1}{2} \times 6 \frac{3}{4}$</td>
<td>$\frac{1}{2}$</td>
</tr>
<tr>
<td>$\frac{1}{10} \div 1 \frac{7}{10}$</td>
<td>$\frac{1}{125} \times 1 \frac{25}{6}$</td>
</tr>
<tr>
<td>$\frac{3}{16} + \frac{3}{10}$</td>
<td>$\frac{7}{13}$</td>
</tr>
<tr>
<td>$\frac{4}{11} \div 1 \frac{2}{3}$</td>
<td>$\frac{20}{35} \times 3$</td>
</tr>
<tr>
<td>$\frac{9}{2} \div 1 \frac{2}{4}$</td>
<td>$2 \frac{1}{4} \times 7 \frac{1}{8}$</td>
</tr>
</tbody>
</table>

Perform the indicated operations, and round the answers to two decimal places.

<table>
<thead>
<tr>
<th>Expression</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>$11.33 + 29.16 + 19.78$</td>
<td>$5 + 2.5 + 0.05 + 0.15$</td>
</tr>
<tr>
<td>$93.712 - 26.97$</td>
<td>$1.71 \times 25$</td>
</tr>
<tr>
<td>$43.69 - 0.7083$</td>
<td>$45 \div 0.15$</td>
</tr>
<tr>
<td>$66.4 \times 72.8$</td>
<td>$3.2974 + 0.23$</td>
</tr>
<tr>
<td>$360 \times 0.53$</td>
<td>$51.21 \div 0.016$</td>
</tr>
<tr>
<td>$268.4 \div 14$</td>
<td>$0.74 \div 0.37$</td>
</tr>
<tr>
<td>$10.10 - 0.62$</td>
<td>$1.5 + 146.73 + 1.9 + 0.832$</td>
</tr>
</tbody>
</table>

Multiply or divide by the power of 10 indicated. Draw an arrow to demonstrate movement of the decimal point. Do not round answers.

<table>
<thead>
<tr>
<th>Expression</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>$9.716 \times 1,000$</td>
<td>$5.75 \times 1,000$</td>
</tr>
<tr>
<td>$50.25 \div 100$</td>
<td>$0.25 \div 10$</td>
</tr>
<tr>
<td>$0.25 \times 100$</td>
<td>$11.525 \times 10$</td>
</tr>
</tbody>
</table>

43. A 1-month-old infant drinks $3 \frac{1}{2}$ fluid ounces of formula every 4 hours day and night. How many fluid ounces will the infant drink in 1 week on this schedule?

44. There are 368 people employed at Riverview Clinic. If $\frac{3}{8}$ of the employees are nurses, $\frac{1}{4}$ are maintenance/cleaners, $\frac{1}{4}$ are technicians, and $\frac{1}{4}$ are all other employees, calculate the number of employees that each fraction represents.

45. True or false? A specific gravity of urine of $1 \frac{3}{2}$ falls within the normal range of 1.01 to 1.025 for an adult patient.

46. Last week a nurse earning $20.43 per hour gross pay worked 40 hours plus 6.5 hours overtime, which is paid at twice the hourly rate. What is the total regular and overtime gross pay for last week?
47. The instructional assistant is ordering supplies for the nursing skills laboratory. A single box of 12 urinary catheters costs $98.76. A case of 12 boxes of these catheters costs $975. Calculate the savings per catheter when a case is purchased.

48. If each ounce of a liquid laxative contains 0.065 gram of a drug, how many grams of the drug would be contained in 4.75 ounces? (Round answer to the nearest hundredth.)

49. A patient is to receive 1,200 milliliters of fluid in a 24-hour period. How many milliliters should the patient drink between the hours of 7:00 AM and 7:00 PM if he is to receive $\frac{2}{3}$ of the total amount during that time?

50. A baby weighed 3.7 kilograms at birth. The baby now weighs 6.65 kilograms. How many kilograms did the baby gain?

After completing these problems, see page 490 to check your answers.

**REFERENCE**

Ratios, Percents, Simple Equations, and Ratio-Proportion

OBJECTIVES
Upon mastery of Chapter 2, you will be able to perform basic mathematical computations that involve ratios, percents, simple equations, and proportions. Specifically, you will be able to:

- Interpret values expressed in ratios.
- Convert among fractions, decimals, ratios, and percents.
- Compare the size of fractions, decimals, ratios, and percents.
- Determine the value of X in simple equations.
- Set up proportions for solving problems.
- Cross-multiply to find the value of X in a proportion.
- Calculate the percentage of a quantity.

Health care professionals need to understand ratios and percents to be able to accurately interpret, prepare, and administer a variety of medications and treatments. Let’s take a look at each of these important ways of expressing ratios and percents and how they are related to fractions and decimals. It is important for you to be able to convert equivalent ratios, percents, decimals, and fractions quickly and accurately.
RATIOS AND PERCENTS

Ratios

Like a fraction, a ratio is used to indicate the relationship of one part of a quantity to the whole. The two quantities are written as a fraction or separated by a colon (:). The use of the colon is a traditional way to write the division sign within a ratio.

EXAMPLE

On an evening shift, if there are 5 nurses and 35 patients, what is the ratio of nurses to patients?
5 nurses to 35 patients = 5 nurses per 35 patients = \(\frac{5}{35} = \frac{1}{7}\). This is the same as a ratio of 5:35 or 1:7.

MATH TIP

The terms of a ratio are the numerator (always to the left of the colon) and the denominator (always to the right of the colon) of a fraction. Like fractions, ratios should be stated in lowest terms.

If you think back to the discussion of fractions and parts of a whole, it is easy to see that a ratio is actually the same as a fraction and its equivalent decimal. It is just a different way of expressing the same quantity. Recall from Chapter 1 that to convert a fraction to a decimal, you simply divide the numerator by the denominator.

EXAMPLE

Adrenalin 1:1,000 for injection = 1 part Adrenalin to 1,000 total parts of solution. It is a fact that 1:1,000 is the same as \(\frac{1}{1,000}\).

In some drug solutions, such as Adrenalin 1:1,000, the ratio is used to indicate the drug’s concentration. This will be covered in more detail later.

Percents

A type of ratio is a percent. Percent comes from the Latin phrase per centum, translated per hundred. This means per hundred parts or hundredth part.

MATH TIP

To remember the value of a given percent, replace the % symbol with “/” for per and “100” for cent. THINK: Percent (%) means \(\frac{1}{100}\) or per hundred.

EXAMPLE

\(3\% = 3\ \text{percent} = \frac{3}{100} = \frac{3}{100} = 0.03\)

Converting among Ratios, Percents, Fractions, and Decimals

When you understand the relationship of ratios, percents, fractions, and decimals, you can readily convert from one to the other. Let’s begin by converting a percent to a fraction.
RULE
To convert a percent to a fraction:
1. Delete the % sign.
2. Write the remaining number as the numerator.
3. Write 100 as the denominator.
4. Reduce the result to lowest terms.

EXAMPLE ■
5% = \frac{5}{100} = \frac{1}{20}

It is also easy to express a percent as a ratio.

RULE
To convert a percent to a ratio:
1. Delete the % sign.
2. Write the remaining number as the numerator.
3. Write 100 as the denominator.
4. Reduce the result to lowest terms.
5. Express the fraction as a ratio.

EXAMPLE ■
25% = \frac{25}{100} = \frac{1}{4} = 1:4

Because the denominator of a percent is always 100, it is easy to find the equivalent decimal. Recall that to divide by 100, you move the decimal point two places to the left, the number of places equal to the number of zeros in the denominator.

RULE
To convert a percent to a decimal:
1. Delete the % sign.
2. Divide the remaining number by 100, which is the same as moving the decimal point two places to the left.

EXAMPLE ■
25% = \frac{25}{100} = 25 ÷ 100 = 0.25

Conversely, it is easy to change a decimal to a percent.

RULE
To convert a decimal to a percent:
1. Multiply the decimal number by 100, which is the same as moving the decimal point two places to the right.
2. Add the % sign.
EXAMPLE ■

\[ 0.25 \times 100 = 0.25 \times 100 = 25\% \]

MATH TIP

When converting a decimal to a percent, always move the decimal point two places so that the resulting percent is the larger number.

Now you know all the steps to change a ratio to the equivalent percent.

RULE

To convert a ratio to a percent:
1. Convert the ratio to a fraction.
2. Convert the fraction to a decimal.
3. Convert the decimal to a percent.

EXAMPLE ■

Convert 1:1,000 Adrenalin solution to the equivalent concentration expressed as a percent.

1. \( \frac{1}{1,000} \) (ratio converted to fraction)
2. \( \frac{1}{1,000} = 0.001 \) (fraction converted to decimal)
3. \( 0.001 = 0.1\% \) (decimal converted to percent)

Thus, 1:1,000 Adrenalin solution = 0.1\% Adrenalin solution.

Review the preceding example again slowly until it is clear. Ask your instructor for assistance as needed. If you go over this one step at a time, you can master these important calculations. You need never fear fractions, decimals, ratios, and percents again.

Comparing Percents and Ratios

Nurses and other health care professionals frequently administer solutions with the concentration expressed as a percent or ratio. Consider two intravenous (which means given directly into a person’s vein) solutions: one that is 0.9%; the other 5%. It is important to be clear that 0.9% is less than 5%. A 0.9% solution means that there are 0.9 parts of the solid per 100 total parts (0.9 parts is less than one whole part, so it is less than 1%). Compare this to the 5% solution, with 5 parts of the solid (or more than five times 0.9 parts) per 100 total parts. Therefore, the 5% solution is much more concentrated, or stronger, than the 0.9% solution. A misunderstanding of these numbers and the quantities they represent can have dire consequences.

Likewise, you may see a solution concentration expressed as \( \frac{1}{3}\% \) and another expressed as 0.45%. Convert these amounts to equivalent decimals to clarify values and compare concentrations.

EXAMPLES ■

\[ \frac{1}{3\%} = \frac{1}{3} \times \frac{100}{1} = \frac{1 \times 100}{300} = \frac{100}{300} = 0.0033 \]

\[ 0.45\% = \frac{0.45}{100} = 0.0045 \text{ (greater value, stronger concentration)} \]
MATH TIP

In the last set of examples, the line over the last 3 in the decimal fraction 0.003\(\overline{3}\) indicates that the number 3 repeats itself indefinitely.

Compare solution concentrations expressed as a ratio, such as 1:1,000 and 1:100.

EXAMPLES

1:1,000 = \(\frac{1}{1,000}\) = 0.001

1:100 = \(\frac{1}{100}\) = 0.01 or 0.010 (add zero for comparison), 1:100 is a stronger concentration

QUICK REVIEW

- Fractions, decimals, ratios, and percents are related equivalents.
  
  Example: 1:2 = \(\frac{1}{2}\) = 0.5 = 50%

- Like fractions, ratios should be reduced to lowest terms.
  
  Example: 2:4 = 1:2

- To express a ratio as a fraction, the number to the left of the colon becomes the numerator and the number to the right of the colon becomes the denominator. The colon in a ratio is equivalent to the division sign in a fraction.
  
  Example: 2:3 = \(\frac{2}{3}\)

- To change a ratio to a decimal, convert the ratio to a fraction and divide the numerator by the denominator.
  
  Example: 1:4 = \(\frac{1}{4}\) = 1 ÷ 4 = 0.25

- To change a percent to a fraction, drop the % sign and place the remaining number as the numerator over the denominator 100. Reduce the fraction to lowest terms. THINK: per (/) cent (100).
  
  Example: 75% = \(\frac{75}{100}\) = \(\frac{3}{4}\)

- To change a percent to a ratio, first convert the percent to a fraction in lowest terms. Then, place the numerator to the left of a colon and the denominator to the right of that colon.
  
  Example: 35% = \(\frac{35}{100}\) = \(\frac{7}{20}\) = 7:20

- To change a percent to a decimal, drop the % sign and divide by 100.
  
  Example: 4% = 0.04 = 0.04

- To change a decimal to a percent, multiply by 100, and add the % sign.
  
  Example: 0.5 = 0.50 = 50%

- To change a ratio to a percent, first convert the ratio to a fraction. Convert the resulting fraction to a decimal and then to a percent.
  
  Example: 1:2 = \(\frac{1}{2}\) = 1 ÷ 2 = 0.5 = 0.50 = 50%

Review Set 7

Change the following ratios to fractions that are reduced to lowest terms.

1. 3:150 = \(\frac{3}{150}\) = \(\frac{1}{50}\)

2. 6:10 = \(\frac{6}{10}\) = \(\frac{3}{5}\)

3. 0.05:0.15 = \(\frac{0.05}{0.15}\) = \(\frac{1}{3}\)
Section 1  Mathematics Review

Change the following ratios to decimals; round to two decimal places, if needed.

6. 20:40 = 
7. \( \frac{1}{1,000} : \frac{1}{150} = \)
8. 0.12:0.88 = 

Change the following ratios to percents; round to two decimal places, if needed.

9. 0.3:4.5 = 
10. 1\frac{1}{2}:6\frac{2}{9} = 

Change the following percents to fractions that are reduced to lowest terms.

11. 12:48 = 
12. 2:5 = 
13. 0.08:0.64 = 

Change the following percents to decimals; round to two decimal places, if needed.

14. 7:10 = 
15. 50:100 = 

Change the following percents to ratios that are reduced to lowest terms.

16. 45% = 
17. 60% = 
18. 0.5% = 

19. 1% = 
20. 66\frac{2}{3}% = 

Which of the following is largest? Circle your answer.

21. 2.94% = 
22. 4.5% = 
23. 6.32% = 
24. 33% = 
25. 0.9% = 
26. 16% = 
27. 25% = 
28. 50% = 
29. 45% = 
30. 6% = 

After completing these problems, see pages 490–491 to check your answers.

SOLVING SIMPLE EQUATIONS FOR X

You can set up and solve dosage calculations in different ways. One way is to use a simple equation form. The following examples demonstrate the various forms of this equation. Learn to express your answers in decimal form because decimals will be used most often in dosage calculations and administration. Round decimals to hundredths or to two places.

MATH TIP
The unknown quantity is represented by X.

EXAMPLE 1

\( \frac{100}{200} \times 1 = X \)
MATH TIP
You can drop the 1 because a number multiplied by 1 is the same number.

\[
\frac{100}{200} \times 1 = X \text{ is the same as } \frac{100}{200} = X.
\]

1. Reduce to lowest terms: \(\frac{100}{200} = \frac{\cancel{100}}{\cancel{200}} = \frac{1}{2} = X\)
2. Convert to decimal form: \(\frac{1}{2} = 0.5 = X\)
3. You have your answer. \(X = 0.5\)

EXAMPLE 2 ■
\(\frac{3}{5} \times 2 = X\)

MATH TIP
Dividing a number by 1 does not change its value.

1. Convert: Express 2 as a fraction: \(\frac{3}{5} \times \frac{2}{1} = X\)
2. Multiply fractions: \(\frac{3}{5} \times \frac{2}{1} = \frac{6}{5} = X\)
3. Convert to a mixed number: \(\frac{6}{5} = 1 \frac{1}{5} = X\)
4. Convert to decimal form: \(1 \frac{1}{5} = 1.2 = X\)
5. You have your answer. \(X = 1.2\)

EXAMPLE 3 ■
\(\frac{1}{6} \times \frac{1}{4} \times 5 = X\)

1. Convert: Express 5 as a fraction: \(\frac{1}{6} \times \frac{2}{1} = X\)
2. Divide fractions: \(\frac{1}{6} \div \frac{1}{4} \times \frac{5}{1} = X\)
3. Invert the divisor, and multiply: \(\frac{1}{6} \times \frac{4}{1} \times \frac{5}{1} = X\)
4. Cancel terms: \(\frac{1}{\cancel{6}} \times \frac{2}{\cancel{1}} \times \frac{\cancel{5}}{\cancel{1}} = \frac{2}{3} \times \frac{\cancel{2}}{\cancel{1}} \times \frac{\cancel{5}}{\cancel{1}} = \frac{10}{3} = X\)
5. Convert to a mixed number: \(\frac{10}{3} = 3 \frac{1}{3} = X\)
6. Convert to decimal form: \(3 \frac{1}{3} = 3.333 = X\)
7. Round to hundredths place: \(3.333 = 3.33 = X\)
8. It is easy, when you take it one step at a time. \(X = 3.33\)
EXAMPLE 4 

\[
\frac{10}{15} \times 2.2 = X
\]

1. Convert: Express 2.2 in fraction form: \( \frac{10}{15} \times \frac{2.2}{1} = X \)

2. Divide fractions: \( \frac{1}{2} \div \frac{1}{15} \times \frac{2.2}{1} = X \)

3. Invert the divisor, and multiply: \( \frac{1}{10} \times \frac{15}{1} \times \frac{2.2}{1} = X \)

4. Cancel terms: \( \frac{1}{2} \times \frac{18}{1} \times \frac{2.2}{1} = \frac{1}{2} \times \frac{3}{1} \times \frac{11}{1} = \frac{33}{1} = 33 = X \)

5. Multiply: \( \frac{1}{1} \times \frac{3}{1} \times \frac{11}{1} = \frac{33}{1} = 33 = X \)

6. That's it! \( X = 3.3 \)

EXAMPLE 5 

\[
\frac{0.125}{0.25} \times 1.5 = X
\]

1. Convert: Express 1.5 in fraction form: \( \frac{0.125}{0.25} \times \frac{1.5}{1} = X \)

2. Convert: Add zeros for easier comparison, making both decimals of equal length: \( \frac{0.125}{0.250} \times \frac{1.5}{1} = X \)

3. Cancel terms: \( \frac{0.125}{0.250} \times \frac{1.5}{1} = \frac{1}{2} \times \frac{1.5}{1} = X \)

4. Multiply: \( \frac{1}{2} \times \frac{1.5}{1} = \frac{1.5}{2} = X \)

5. Divide: \( \frac{1.5}{2} = 0.75 = X \)

6. You've got it! \( X = 0.75 \)

MATH TIP

It may be easier to work with whole numbers than decimals. If you had difficulty with Step 3, try multiplying the numerator and denominator by 1,000 to eliminate the decimal fractions.

\[
\frac{0.125}{0.250} \times \frac{1,000}{1,000} = \frac{125}{250} = \frac{1}{2}
\]

Example 5 can also be solved by computing with fractions instead of decimals.

Try this: \( \frac{0.125}{0.25} \times 1.5 = X \)

1. Convert: Express 1.5 in fraction form: \( \frac{0.125}{0.25} \times \frac{1.5}{1} = X \)

2. Convert: Add zeros for easier comparison, making both decimals of equal length:

\[
\frac{0.125}{0.250} \times \frac{1.5}{1.0} = X
\]
3. Cancel terms: \( \frac{\frac{1}{2}}{\frac{1}{2}} \times \frac{\frac{3}{2}}{\frac{3}{2}} = \frac{1}{2} \times \frac{3}{2} = X \) (It is easier to work with whole numbers.)

4. Multiply: \( \frac{1}{2} \times \frac{3}{2} = \frac{3}{4} = X \)

5. Convert: \( \frac{3}{4} \times 0.75 = X \)

6. You’ve got it again! \( X = 0.75 \)

Which way do you find easier?

**EXAMPLE 6**

\( \frac{3}{4} \times 45\% = X \)

1. Convert: Express 45\% as a fraction reduced to lowest terms: \( 45\% = \frac{45}{100} = \frac{9}{20} \)

2. Multiply fractions: \( \frac{3}{4} \times \frac{9}{20} = X \)

\( \frac{27}{80} = X \)

3. Divide: \( \frac{27}{80} = 0.337 = X \)

4. Round to hundredths place: \( 0.34 = X \)

5. You have your answer. \( X = 0.34 \)

**QUICK REVIEW**

- To solve simple equations, perform the mathematical operations indicated to find the value of the unknown \( X \).
- Express the result (value of \( X \)) in decimal form.

**Review Set 8**

Solve the following problems for \( X \). Express answers as decimals rounded to two places.

1. \( \frac{75}{125} \times 5 = X \)
2. \( \frac{3}{4} \times 2.2 = X \)
3. \( \frac{150}{300} \times 2.5 = X \)
4. \( \frac{40\%}{60\%} \times 8 = X \)
5. \( \frac{0.35}{2.5} \times 4 = X \)
6. \( \frac{0.15}{0.1} \times 1.2 = X \)
7. \( \frac{0.4}{2.5} \times 4 = X \)
8. \( \frac{1200000}{400000} \times 4.2 = X \)
9. \( \frac{2}{3} \times 10 = X \)
10. \( \frac{30}{50} \times 0.8 = X \)
11. \( \frac{200000}{300000} \times 1.5 = X \)
12. \( \frac{0.08}{0.1} \times 1.2 = X \)
13. \( \frac{7.5}{5} \times 3 = X \)
14. \( \frac{250000}{2000000} \times 7.5 = X \)
RATIO-PROPORTION: CROSS-MULTIPLYING TO SOLVE FOR X

A proportion is two ratios that are equal or an equation between two equal ratios.

**MATH TIP**
A proportion is written as two ratios separated by an equal sign, such as $5:10 = 10:20$. The two ratios in a proportion may also be separated by a double colon sign, such as $5:10::10:20$.

Some of the calculations you will perform will have the unknown $X$ as a different term in the equation. To determine the value of the unknown $X$, you must apply the rule for cross-multiplying used in a proportion.

**RULE**
In a proportion, the product of the means (the two inside numbers) equals the product of the extremes (the two outside numbers). Finding the product of the means and the extremes is called cross-multiplying.

**EXAMPLE**

<table>
<thead>
<tr>
<th>Extreme</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>$5:10$</td>
<td>$10:20$</td>
</tr>
</tbody>
</table>

$5 \times 20 = 10 \times 10$

$100 = 100$

Because ratios are the same as fractions, the same proportion can be expressed like this: $\frac{5}{10} = \frac{10}{20}$. The fractions are equivalent, or equal. The numerator of the first fraction and the denominator of the second fraction are the extremes, and the denominator of the first fraction and the numerator of the second fraction are the means.

**EXAMPLE**

<table>
<thead>
<tr>
<th>Extreme</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\frac{5}{10}$</td>
<td>$\frac{10}{20}$</td>
</tr>
</tbody>
</table>

Cross-multiply to find the equal products of the means and extremes.
RULE
If two fractions are equivalent, or equal, their cross-products are also equal.

EXAMPLE
\[
\frac{5}{10} = \frac{20}{40}
\]

\[
5 \times 20 = 10 \times 10
\]

\[
100 = 100
\]

When one of the quantities in a proportion is unknown, a letter, such as \(X\), may be substituted for this unknown quantity. You would solve the equation to find the value of \(X\). In addition to cross-multiplying, there is one more rule you need to know to solve for \(X\) in a proportion.

RULE
Dividing or multiplying each side (member) of an equation by the same nonzero number produces an equivalent equation.

MATH TIP
Dividing each side of an equation by the same nonzero number is the same as reducing or simplifying the equation. Multiplying each side by the same nonzero number enlarges the equation.

Let’s examine how to simplify an equation.

EXAMPLE
\[
25X = 100 \quad (25X \text{ means } 25 \times X)
\]

Simplify the equation to find \(X\). Divide both sides by 25, the number before \(X\). Reduce to lowest terms.

\[
\frac{25X}{25} = \frac{100}{25}
\]

\[
\frac{1X}{1} = \frac{4}{1} \quad \text{(Dividing or multiplying a number by 1 does not change its value. 1X is understood to be simply X.)}
\]

\[X = 4\]

Replace \(X\) with 4 in the same equation, and you can prove that the calculations are correct.

\[
25 \times 4 = 100
\]

Now you are ready to apply the concepts of cross-multiplying and simplifying an equation to solve for \(X\) in a proportion.
EXAMPLE 1 ■

\[ \frac{90}{2} = \frac{45}{X} \]

You have a proportion with an unknown quantity X in the denominator of the second fraction. Find the value of X.

1. Cross-multiply: \[ \frac{90}{2} \times \frac{X}{45} \]
2. Multiply terms: \[ 90 \times X = 2 \times 45 \]
   \[ 90X = 90 \] (90X means 90 \( \times \) X)
3. Simplify the equation: Divide both sides of the equation by the number before the unknown X. You are equally reducing the terms on both sides of the equation.
   \[ \frac{90X}{90} = \frac{90}{X} \]
   \[ X = 1 \]

Try another one. You will use a proportion to solve this equation.

EXAMPLE 2 ■

\[ \frac{80}{X} \times 60 = 20 \]

1. Convert: Express 60 as a fraction.
   \[ \frac{80}{X} \times \frac{60}{1} = 20 \]
2. Multiply fractions: \[ \frac{80}{X} \times \frac{60}{1} = 20 \]
   \[ \frac{4800}{X} = 20 \]
3. Convert: Express 20 as a fraction.
   \[ \frac{4800}{X} = \frac{20}{1} \]
   You now have a proportion.
4. Cross-multiply: \[ \frac{4800}{X} \times \frac{20}{1} \]
   \[ 20X = 4800 \]
5. Simplify: Divide both sides of the equation by the number before the unknown X.
   \[ \frac{20X}{20} = \frac{4800}{20} \]
   \[ X = 240 \]

EXAMPLE 3 ■

\[ \frac{X}{160} = \frac{2.5}{80} \]

1. Cross-multiply: \[ \frac{X}{160} \times \frac{2.5}{80} \]
   \[ 80 \times X = 2.5 \times 160 \]
   \[ 80X = 400 \]
2. Simplify: \( \frac{\frac{1}{10}}{\frac{5}{1}} = \frac{\frac{5}{10}}{\frac{1}{1}}\)
   
   \[ X = 5 \]

**EXAMPLE 4**

\[ \frac{40}{100} = \frac{X}{2} \]

1. Cross-multiply: \( \frac{40}{100} \times 2 = X \)

2. Multiply terms: \( 100 \times X = 40 \times 2 \)
   
   \[ 100X = 80 \]

3. Simplify the equation: \( \frac{100X}{100} = \frac{80}{100} \)
   
   \[ X = 0.8 \]

Calculations that result in an amount less than 1 should be expressed as a decimal. Most medications are ordered and supplied in metric measure. Metric measure is a decimal-based system.

**QUICK REVIEW**

- A proportion is an equation of two equal ratios. The ratios may be expressed as fractions.
- Example: \( 1:4 = X:8 \) or \( \frac{1}{4} = \frac{X}{8} \)

- In a proportion, the product of the means equals the product of the extremes.

  - Example: \( 1:4 \) = \( X:8 \) Therefore, \( 4 \times X = 1 \times 8 \)

- If two fractions are equal, their cross-products are equal. This operation is referred to as cross-multiplying.

  - Example: \( \frac{1}{4} \times \frac{X}{8} \) Therefore, \( 4 \times X = 1 \times 8 \) or \( 4X = 8 \)

- Dividing each side of an equation by the same number produces an equivalent equation. This operation is referred to as simplifying the equation.

  - Example: If \( 4X = 8 \), then \( \frac{4X}{4} = \frac{8}{4} \), and \( X = 2 \)

**Review Set 9**

Find the value of \( X \). Express answers as decimals rounded to two places.

1. \( \frac{1}{2} = \frac{125}{X} \)   
   
   \[ X = 250 \]

2. \( \frac{500}{2} = \frac{250}{X} \)   
   
   \[ X = 1 \]

3. \( \frac{500}{1} = \frac{280}{X} \)   
   
   \[ \frac{500}{1} \times \frac{1}{X} = \frac{280}{X} \]

4. \( \frac{0.5}{2} = \frac{250}{X} \)   
   
   \[ \frac{0.5}{2} \times \frac{1}{X} = \frac{250}{X} \]

5. \( \frac{75}{1.5} = \frac{35}{X} \)   
   
   \[ \frac{75}{1.5} \times \frac{1}{X} = \frac{35}{X} \]

6. \( \frac{40}{X} \times 12 = 60 \)   
   
   \[ \frac{40}{X} \times \frac{12}{1} = \frac{60}{1} \]

7. \( \frac{10}{X} \times 60 = 28 \)   
   
   \[ \frac{10}{X} \times \frac{60}{1} = \frac{28}{1} \]

8. \( \frac{2}{2000} \times X = 0.5 \)   
   
   \[ \frac{2}{2000} \times \frac{X}{1} = \frac{0.5}{1} \]
9. \( \frac{15}{500} \times X = 6 \)

10. \( \frac{5}{X} = \frac{10}{21} \)

11. \( \frac{250}{1} = \frac{750}{X} \)

12. \( \frac{80}{5} = \frac{10}{X} \)

13. \( \frac{5}{20} = \frac{X}{40} \)

14. \( \frac{1}{100} = \frac{1}{150} \times X \)

15. \( \frac{2.2}{X} = \frac{8.8}{5} \)

16. \( \frac{60}{15} = \frac{125}{X} \)

17. \( \frac{60}{10} = \frac{100}{X} \)

18. \( \frac{80}{X} \times 60 = 20 \)

19. \( \frac{X}{0.5} = \frac{6}{4} \)

20. \( \frac{5}{2.2} = \frac{X}{1} \)

21. \( \frac{1}{4} \times 15 = \frac{X}{60} \)

22. \( \frac{25\%}{30\%} = \frac{5}{X} \)

23. In any group of 100 nurses, you would expect to find 45 nurses who will specialize in a particular field of nursing. In a class of 240 graduating nurses, how many would you expect to specialize?

24. Low-fat cheese has 48 calories per ounce. A client who is having his caloric intake measured has eaten \( \frac{1}{2} \) ounce of low-fat cheese. How many calories has he eaten?

25. If a patient receives 450 milligrams of a medication given evenly over 5.5 hours, how many milligrams did the patient receive per hour?

After completing these problems, see page 492 to check your answers.

**FINDING THE PERCENTAGE OF A QUANTITY**

An important computation that health care professionals use for dosage calculations is to find a given percentage or part of a quantity. **Percentage** is a term that describes a part of a whole quantity. A **known percent** determines the part in question. Said another way, the percentage (or part in question) is equal to some known percent multiplied by the whole quantity.

**RULE**

Percentage (Part) = Percent \( \times \) Whole Quantity

To find a percentage or part of a whole quantity:

1. Change the percent to a decimal.
2. Multiply the decimal by the whole quantity.

**EXAMPLE**

A patient reports that he drank 75\% of his 8-ounce cup of coffee for breakfast. To record the amount he actually drank in his chart, you must determine what amount is 75\% of 8 ounces.

**MATH TIP**

In a mathematical expression, the word of means times and indicates that you should multiply.
To continue with the example:

Percentage (Part) = Percent × Whole Quantity

Let X represent the unknown.

1. Change 75% to a decimal: \( \frac{75}{100} = 0.75 \)
2. Multiply \( 0.75 \times 8 \) fluid ounces: \( X = 0.75 \times 8 \) fluid ounces = 6 fluid ounces

Therefore, 75% of 8 fluid ounces is 6 fluid ounces.

**QUICK REVIEW**

- **Percentage (Part) = Percent × Whole Quantity**
- Example: What is 12% of 48? \( X = 12\% \times 48 = 0.12 \times 48 = 5.76 \)

**Review Set 10**

Perform the indicated operation; round decimals to hundredths place.

1. What is 0.25% of 520? __________
2. What is 5% of 95? __________
3. What is 40% of 140? __________
4. What is 0.7% of 62? __________
5. What is 3% of 889? __________
6. What is 20% of 75? __________
7. What is 4% of 20? __________
8. What is 7% of 34? __________
9. What is 15% of 250? __________
10. What is 75% of 150? __________

11. A patient has an order for an anti-infective in the amount of 500 milligrams by mouth twice a day for 10 days to treat pneumonia. He received a bottle of 20 pills. How many pills has this patient taken if he has used 40% of the 20 pills? __________

12. The patient is on oral fluid restrictions of 1,200 milliliters for a 24-hour period. For breakfast and lunch he has consumed 60% of the total fluid allowance. How many milliliters has he had? __________

13. A patient’s hospital bill for surgery is $17,651.07. Her insurance company pays 80%. How much will the patient owe? __________

14. Table salt (sodium chloride) is 40% sodium by weight. If a box of salt weighs 18 ounces, how much sodium is in the box of salt? __________

15. A patient has an average daily intake of 3,500 calories. At breakfast she eats 20% of the total daily caloric allowance. How many calories did she ingest? __________

After completing these problems, see page 492 to check your answers.
Find the equivalent decimal, fraction, percent, and ratio forms. Reduce fractions and ratios to lowest terms; round decimals to hundredths and percents to the nearest whole number.

<table>
<thead>
<tr>
<th>Decimal</th>
<th>Fraction</th>
<th>Percent</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. _______</td>
<td>$\frac{2}{5}$</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>2. 0.05</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>3. _______</td>
<td>_______</td>
<td>17%</td>
<td>_______</td>
</tr>
<tr>
<td>4. _______</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>5. _______</td>
<td>_______</td>
<td>6%</td>
<td>_______</td>
</tr>
<tr>
<td>6. _______</td>
<td>$\frac{1}{6}$</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>7. _______</td>
<td>_______</td>
<td>50%</td>
<td>_______</td>
</tr>
<tr>
<td>8. _______</td>
<td>_______</td>
<td>_______</td>
<td>1:100</td>
</tr>
<tr>
<td>9. 0.09</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>10. _______</td>
<td>$\frac{3}{8}$</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>11. _______</td>
<td>_______</td>
<td>_______</td>
<td>2:3</td>
</tr>
<tr>
<td>12. _______</td>
<td>$\frac{1}{3}$</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>13. 0.52</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>14. _______</td>
<td>_______</td>
<td>_______</td>
<td>9:20</td>
</tr>
<tr>
<td>15. _______</td>
<td>$\frac{6}{7}$</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>16. _______</td>
<td>_______</td>
<td>_______</td>
<td>3:10</td>
</tr>
<tr>
<td>17. _______</td>
<td>$\frac{1}{50}$</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>18. 0.6</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>19. 0.04</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>20. _______</td>
<td>_______</td>
<td>10%</td>
<td>_______</td>
</tr>
</tbody>
</table>

Convert as indicated.

| 21. 1:25 to a decimal | _______ | 24. 17:34 to a fraction | _______ |
| 22. $\frac{10}{400}$ to a ratio | _______ | 25. 75% to a ratio | _______ |
| 23. 0.075 to a percent | _______ |

Perform the indicated operation. Round decimals to hundredths.

| 26. What is 35% of 750? | _______ | 28. What is 8.2% of 24? | _______ |
| 27. What is 7% of 52? | _______ |
Identify the strongest solution in each of the following groups:

29. 1:40  1:400  1:4

30. 1:10  1:200  1:50

Find the value of X in the following equations. Express your answers as decimals rounded to the nearest hundredth.

31. \( \frac{20}{400} = \frac{X}{1.680} \)  

32. \( \frac{75}{X} = \frac{1}{300} \times 4 \)  

33. \( \frac{X}{5} = \frac{3}{15} \)  

34. \( \frac{500}{250} = \frac{22}{X} \)  

35. \( \frac{0.6}{1.2} = \frac{X}{200} \)  

36. \( \frac{3}{9} = \frac{X}{117} \)  

37. \( \frac{8}{3} \times 2 = X \)  

38. \( \frac{X}{7} = \frac{12}{4} \)  

39. \( \frac{X}{8} = \frac{9}{0.6} \)  

40. \( \frac{0.4}{0.1} \times 22.5 = X \)  

41. A portion of meat totaling 125 grams contains 20% protein and 5% fat. How many grams each of protein and fat does the meat contain?  

42. The total points for a course in a nursing program is 308. A nursing student needs to achieve 75% of the total points to pass the semester. How many points are required to pass?  

43. To work off 90 calories, Angie must walk for 27 minutes. How many minutes would she need to walk to work off 200 calories?  

44. The doctor orders a record of the patient’s fluid intake and output. The patient drinks 25% of a bowl of broth. How many milliliters of intake will be recorded if the bowl holds 200 milliliters?  

45. The recommended daily allowance (RDA) of a particular vitamin is 60 milligrams. If a multivitamin tablet claims to provide 45% of the RDA, how many milligrams of the particular vitamin would a patient receive from the multivitamin tablet?  

46. A label on a dinner roll wrapper reads, “2.7 grams of fiber per \( \frac{3}{4} \) ounce serving.” If you eat \( \frac{1}{2} \) ounces of dinner rolls, how many grams of fiber will you consume?  

47. A patient received an intravenous medication at a rate of 6.75 milligrams per minute. After 42 minutes, how much medication had she received?  

48. A person weighed 130 pounds at his last doctor’s office visit. At this visit the patient has lost 5% of his weight. How many pounds has the patient lost?  

49. The cost of a certain medication is expected to decrease by 17% next year. If the cost is $12.56 now, how much would you expect it to cost at this time next year?  

50. A patient is to be started on 150 milligrams of a medication and then decreased by 10% of the original dose for each dose until he is receiving 75 milligrams. When he takes his 75 milligram dose, how many total doses will he have taken? HINT: Be sure to count his first (150 milligrams) and last (75 milligrams) doses.

After completing these problems, see pages 492–493 to check your answers.
SECTION 1 SELF-EVALUATION

Directions:

1. Round decimals to two places, as needed.
2. Express fractions in lowest terms.

Section 1 Mathematics Review for Dosage Calculations

Multiply or divide by the power of 10 indicated. Draw an arrow to demonstrate movement of the decimal point.

1. \(30.5 \div 10 = \)  

2. \(40.025 \times 100 = \)  

Identify the least common denominator for the following sets of numbers.

5. \( \frac{1}{6}, \frac{2}{3}, \frac{3}{4} \)  

6. \( \frac{2}{5}, \frac{3}{10}, \frac{3}{11} \)

Complete the operations indicated.

7. \(\frac{1}{4} + \frac{2}{3} = \)  

8. \(\frac{6}{7} - \frac{1}{9} = \)  

9. \(1\frac{3}{5} \times \frac{5}{8} = \)  

10. \(\frac{3}{8} \div \frac{3}{4} = \)  

11. \(13.2 + 32.55 + 0.029 = \)  

12. \(20\% \text{ of } 0.09 = \)  

Arrange in order from smallest to largest.

19. \(\frac{1}{3}, \frac{1}{2}, \frac{1}{6}, \frac{1}{10}, \frac{1}{5} \)  

20. \(\frac{3}{4}, \frac{7}{8}, \frac{5}{6}, \frac{2}{3}, \frac{9}{10} \)  

Convert as indicated.

25. \(1:100\) to a decimal  

26. \(\frac{6}{150} \) to a decimal  

27. \(0.009\) to a percent  

28. \(33\frac{1}{3}\% \) to a fraction
29. $\frac{5}{3}$ to a ratio
30. 0.05 to a fraction
31. $\frac{1}{2} \%$ to a ratio
32. 2:3 to a fraction

Find the value of X in the following equations. Express your answers as decimals; round to the nearest hundredth.

36. $\frac{0.35}{1.3} \times 4.5 = X$
37. $\frac{0.3}{2.6} = \frac{0.15}{X}$
38. $\frac{1,500,000}{500,000} \times X = 7.5$
39. $\frac{1}{6} \times 1 = X$
40. $\frac{1100}{14} \times 2,500 = X$

41. $\frac{0.25}{0.125} \times 2 = X$
42. $\frac{10\%}{\frac{1}{2}\%} \times 1,000 = X$
43. $\frac{100}{150} \times 2.2 = X$
44. $X:15 = 150:7.5$
45. $\frac{1,000,000}{600,000} \times 5 = X$

46. In a drug study, it was determined that 4\% of the participants developed the headache side effect. If there were 600 participants in the study, how many developed headaches?
47. You are employed in a health care clinic where each employee must work 25\% of 8 major holidays. How many holidays will you expect to work?
48. If the cost of 1 roll of gauze is $0.69, what is the cost of $3\frac{1}{2}$ rolls?
49. To prepare a nutritional formula from frozen concentrate, you mix 3 cans of water to every 1 can of concentrate. How many cans of water will you need to prepare formula from 4 cans of concentrate?
50. If 1 centimeter equals $\frac{3}{8}$ inch, how many centimeters is a laceration that measures 3 inches?

After completing these problems, see pages 493–494 to check your answers. Give yourself 2 points for each correct answer.

Perfect score = 100
My score = _________

Minimum mastery score = 86 (43 correct)

For more practice, go back to the beginning of this section and repeat the Mathematics Diagnostic Evaluation.
Measurement Systems, Drug Orders, and Drug Labels

3 Systems of Measurement
4 Conversions: Metric, Apothecary, and Household Systems
5 Conversions for Other Clinical Applications:
   Time and Temperature
6 Equipment Used in Dosage Measurement
7 Interpreting Drug Orders
8 Understanding Drug Labels
9 Preventing Medication Errors

Section 2 Self-Evaluation
Systems of Measurement

OBJECTIVES
Upon mastery of Chapter 3, you will be able to recognize and express the basic systems of measurement used to calculate dosages. To accomplish this you will also be able to:

■ Interpret and properly express metric, apothecary, and household notation.
■ Recall metric, apothecary, and household equivalents.
■ Explain the use of milliequivalent (mEq), international unit, unit, and milliunit in dosage calculation.

To administer the correct amount of the prescribed medication to the patient, you must have a thorough knowledge of the weights and measures used in the prescription and administration of medications. The three systems used by health professionals are the metric, the apothecary, and the household systems.

It is necessary for you to understand each system and how to convert from one system to another. All prescriptions should be written with the metric system, and all U.S. drug labels provide metric measurements. The household system uses measurements found in familiar containers such as teaspoons, cups, and quarts. It is helpful to understand the relationship between metric and household systems for home health care situations and discharge instructions. You may occasionally see prescriptions and medical notation using the apothecary system, usually written by physicians trained in this system. Until the metric system completely replaces the apothecary and household systems, health care professionals should be familiar with each system.

Three essential parameters of measurement are associated with the prescription and administration of drugs within each system of measurement: weight, volume, and length. Weight is the most utilized parameter. It is important as a dosage unit. Most drugs are ordered and supplied by the weight of the...
drug. Keep in mind that the metric weight units, such as gram and milligram, are the most accurate and are preferred for health care applications. Occasionally you will also use the apothecary unit of weight referred to as the grain.

Think of capacity, or how much a container holds, as you contemplate volume, which is the next most important parameter. Volume usually refers to liquids. Volume also adds two additional parameters to dosage calculations: quantity and concentration. The milliliter is the most common metric volume unit for dosage calculations. Much less frequently you will use household and apothecary measures, such as teaspoon and ounce.

Length is the least utilized parameter for dosage calculations, but linear measurement is still essential to learn for health care situations. A person’s height, the circumference of an infant’s head, body surface area, and the size of lacerations and tumors are examples of important length measurements. You are probably familiar with the household measurements of inches and feet. Typically in the health care setting, length is measured in millimeters and centimeters.

THE METRIC SYSTEM

The metric system was first adopted in 1799 in France. It is the most widely used system of measurement in the world today and is preferred for prescribing and administering medications.

The metric system is a decimal system, which means it is based on powers of 10. The base units (the primary units of measurement) of the metric system are gram for weight, liter for volume, and meter for length. In this system, prefixes are used to show which portion of the base unit is being considered. It is important that you learn the most commonly used prefixes.

REMEMBER
Metric Prefixes

- micro = one millionth or 0.000001 or \( \frac{1}{1,000,000} \) of the base unit
- milli = one thousandth or 0.001 or \( \frac{1}{1,000} \) of the base unit
- centi = one hundredth or 0.01 or \( \frac{1}{100} \) of the base unit
- deci = one tenth or 0.1 or \( \frac{1}{10} \) of the base unit
- kilo = one thousand or 1,000 times the base unit

Figure 3-1 demonstrates the relationship of metric units. Notice that the values of most of the common prefixes used in health care and the ones applied in this text are highlighted: kilo-, base, milli-, and micro-. These units are three places away from the next place. Often you can either multiply or divide by 1,000 to calculate an equivalent quantity. The only exception is centi-. Centi- is easy to remember, though, if you think of the relationship between one cent and one U.S. dollar as a clue to the

FIGURE 3-1  Relationship and value of metric units, with comparison of common metric units used in health care
relationship of centi- to the base, $\frac{1}{100}$. **Deci-** is one-tenth ($\frac{1}{10}$) of the base. See Chapter 1 to review the rules of multiplying and dividing decimals by a power of 10.

**MATH TIP**

Try this to remember the order of six of the metric units—kilo-, hecto-, deca-, (BASE), deci-, centi-, and milli-: “King Henry Died from a Disease Called Mumps.”

The international standardization of metric units was adopted throughout much of the world in 1960 with the International System of Units or SI (from the French *Système International*). The abbreviations of this system of metric notation are the most widely accepted. The metric units of measurement and the SI abbreviations most often used for dosage calculations and measurements of health status are given in the following units of weight, volume, and length. This text uses SI standardized abbreviations throughout. Learn and practice these notations.

**REMEMBER**

<table>
<thead>
<tr>
<th>SI METRIC SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit</strong></td>
</tr>
<tr>
<td>Weight</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Volume</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Length</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

**CAUTION**

You may see gram abbreviated as Gm or gm, liter as lowercase l, or milliliter as ml. These abbreviations are considered obsolete and too easily misinterpreted. You should only use the standardized SI abbreviations. Use g for gram, L for liter, and mL for milliliter. Further, the unit of measurement cubic centimeter, abbreviated cc, has been used interchangeably with mL. The use of cc for mL is now prohibited by many health care organizations because cc can be mistaken for zeros (00) or units (U). The abbreviation U is also now prohibited.

**CAUTION**

The SI abbreviations for milligram (mg) and milliliter (mL) appear to be somewhat similar, but in fact mg is a weight unit and mL is a volume unit. Confusing these two units can have dire consequences in dosage calculations. Learn to clearly differentiate them now.
In addition to learning the metric units, their equivalent values, and their abbreviations, it is important to use the following rules of metric notation.

**RULES**
The following 10 critical rules will help to ensure that you accurately write and interpret metric notation.

1. The unit or abbreviation always follows the amount. Example: 5 g NOT g 5
2. Do not put a period after the unit abbreviation because it may be mistaken for the number 1 if poorly written. Example: mg NOT mg.
3. Do not add an s to make the unit plural because it may be misread for another unit. Example: mL NOT mls
4. Separate the amount from the unit so the number and unit of measure do not run together because the unit can be mistaken as zero or zeros, risking a 10-fold to 100-fold overdose. Example: 20 mg NOT 20mg
5. Place commas for amounts at or above 1,000. Example: 10,000 mcg NOT 10000 mcg
6. Decimals are used to designate fractional amounts. Example: 1.5 mL NOT 1½ mL
7. Use a leading zero to emphasize the decimal point for fractional amounts less than 1. Without the zero the amount may be interpreted as a whole number, resulting in serious overdosing. Example: 0.5 mg NOT .5 mg
8. Omit unnecessary or trailing zeros that can be misread as part of the amount if the decimal point is not seen. Example: 1.5 mg NOT 1.50 mg
9. Do not use the abbreviation μg for microgram because it might be mistaken for mg, which is 1,000 times the intended amount. Example: 150 mcg NOT 150 μg
10. Do not use the abbreviation cc for mL because the unit can be mistaken for zeros. Example: 500 mL NOT 500 cc

Always ask the writer to clarify if you are not sure of the abbreviation or notation used. Never guess!

The metric system is the most common and the only standardized system of measurement in health care. Take a few minutes to review these essential points.

**QUICK REVIEW**
- The metric base units are gram (g), liter (L), and meter (m).
- Subunits are designated by the appropriate prefix and the base unit (such as milligram) and standard abbreviations (such as mg).
- There are 10 critical rules for ensuring that units and amounts are accurately interpreted. Review them again now and learn to rigorously adhere to them.
- Never guess as to the meaning of metric notation. When in doubt about the exact amount or the abbreviation used, ask the writer to clarify.

**Review Set 11**
1. The system of measurement most commonly used for prescribing and administering medications is the ______________________ system.
2. Liter and milliliter are metric units that measure __________.
3. Gram and milligram are metric units that measure __________.
4. Meter and millimeter are metric units that measure __________.
5. 1 mg is ________ of a g.
6. There are ________ mL in a liter.
7. Which is the smallest—milligram or microgram? __________
8. Which is the largest—kilogram, gram, or milligram? __________
9. Which is the smallest—kilogram, gram, or milligram? __________
10. 1 liter = ________ mL
11. 1,000 mcg = ________ mg
12. 1 kg = ________ g
13. 1 cm = ________ mm
Select the correctly written metric notation.
14. .3 g, 0.3 Gm, .3 Gm, 0.3 g
15. $1 \frac{1}{3}$ ml, 1.33 mL, 1.33 ML, $1 \frac{1}{3}$ ML, 1.330 mL
16. 5 Kg, 5.0 kg, kg 05, 5 kg, 5 kG
17. 1.5 mm, $1 \frac{1}{2}$ mm, 1.5 Mm, 1.50 MM, $1 \frac{1}{2}$ MM
18. mg 10, 10 mG, 10.0 mg, 10 mg, 10 MG
Interpret these metric abbreviations.
19. mcg ____________________________ 23. mm ____________________________
20. mL ____________________________ 24. kg ____________________________
21. mg ____________________________ 25. cm ____________________________
22. g ____________________________
After completing these problems, see page 494 to check your answers.

THE APOTHECARY AND HOUSEHOLD SYSTEMS

The Joint Commission recommends that the metric system be used exclusively for the ordering, measuring, and reporting of medications. However, some apothecary notations—such as lowercase Roman numerals, ounces, and grains—are still in use. Likewise, the household system persists, and nurses and other health care providers need to be familiar with the equivalent measurements that patients or clients use at home.

The historic interconnection between the apothecary and household systems is interesting. The apothecary system was the first system of medication measurement used by pharmacists (apothecaries) and physicians. It originated in Greece and made its way to Europe via Rome and France. The English used it during the late 1600s, and the colonists brought it to America. A modified system of measurement for everyday use evolved; it is now recognized as the household system. Large liquid volumes were based on familiar trading measurements, such as pints, quarts, and gallons, which originated as apothecary measurements. Vessels to accommodate each measurement were made by craftspersons and widely circulated in colonial America.
Units of weight, such as the *grain, ounce*, and *pound*, also are rooted in the apothecary system. The grain originated as the standard weight of a single grain of wheat, which is approximately 60 milligrams. This one equivalency of weight (1 grain = 60 milligrams) is recognized in drug orders. After more than 100 years as the world’s most popular pill, aspirin may still be prescribed in grains.

**The Apothecary System**

Apothecary notation is unusual. Exercise caution when using this system. The apothecary system utilizes Roman numerals. The ability to interpret Roman numerals is therefore essential. The letters *I, V,* and *X* are the basic symbols of this system that you will use in dosage calculations. In medical notation, lowercase letters are typically used to designate Roman numerals (*i, v,* and *x*).

In addition to Roman numerals, apothecary notation also uses common fractions, special symbols, and units of measure that typically precede numeric values. The common units are *grain* and *ounce.*

**CAUTION**

In 2004, The Joint Commission (2005) first published its *Official “Do Not Use” List* for medical abbreviations and notation. This was followed later that year with another list of abbreviations, acronyms, and symbols recommended not to use (and for possible future inclusion on the official list), including apothecary ones. Although The Joint Commission does not prohibit the use of apothecary abbreviations at this time, it does discourage their use because they can be easily misinterpreted. This can be confusing because rules and guidelines are regularly updated to best ensure patient safety; but it is prudent for you to be familiar with notation that you may find in practice. It is important that all health care practitioners are diligent in their efforts to stay current with The Joint Commission’s and their local health care organizations’ requirements regarding medical abbreviations and notation and to rigorously follow those guidelines. You will learn more about medical abbreviations in Chapter 7, and you will find the Official “Do Not Use” list in Chapter 9, as we consider the prevention of medication errors.

The style of apothecary notation includes:

1. The unit or abbreviation typically precedes the amount. Example: gr v
2. Lowercase Roman numerals are often used to express whole numbers: *i, v,* and *x*
3. Fractions are used to designate amounts less than 1. Examples: gr $\frac{1}{2}$, gr $\frac{1}{4}$
4. You may see the symbol *ss* used to designate the fraction $\frac{1}{2}$. Because this symbol can be easily misinterpreted, it is provided here for recognition purposes only. We will not use this symbol.

**MATH TIP**

To decrease errors in interpretation of medical notation, a line may be drawn over the lowercase Roman numerals to distinguish them from other letters in a word or phrase. The lowercase *i* is dotted above, not below, the line.

**EXAMPLE**

$$3 = \text{iii or iii}$$
Learn the following common Roman numerals and their Arabic equivalents. These are the values that you may see.

<table>
<thead>
<tr>
<th>Arabic Number</th>
<th>Roman Numeral</th>
<th>Apothecary Notation</th>
<th>Arabic Number</th>
<th>Roman Numeral</th>
<th>Apothecary Notation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I</td>
<td>i, i</td>
<td>5</td>
<td>V</td>
<td>v, vv</td>
</tr>
<tr>
<td>2</td>
<td>II</td>
<td>ii, ii</td>
<td>10</td>
<td>X</td>
<td>x, x</td>
</tr>
<tr>
<td>3</td>
<td>III</td>
<td>iii, iii</td>
<td>15</td>
<td>XV</td>
<td>xv, xv</td>
</tr>
<tr>
<td>4</td>
<td>IV</td>
<td>iv, iv</td>
<td>20</td>
<td>XX</td>
<td>xx, xx</td>
</tr>
</tbody>
</table>

The essential apothecary unit of measurement to learn is given in the following Remember box. There are no essential equivalents of weight or length to learn for this system.

**REMEMBER**
The one apothecary unit you may still see in use is grain. It is abbreviated gr.

**CAUTION**
Notice that the abbreviations for the apothecary grain (gr) and the metric gram (g) can be confusing. The style indicating the abbreviation or symbol before the quantity in apothecary notation further distinguishes it from the metric system. If you are ever doubtful about the meaning that is intended, be sure to ask the writer for clarification.

**CAUTION**
The following apothecary units and symbols may appear on some syringes and medicine cups. Do not use these measurements, and be careful to differentiate them from acceptable units of measure.

- minim (m)
- fluid dram (f)
- fluid ounce (f)

**QUICK REVIEW**
In the apothecary system:
- A unit for dosage calculation is grain (gr).
- The quantity is often expressed in lowercase Roman numerals. Amounts greater than 10 may be expressed in Arabic numbers, except 15 (xv), 20 (xx), and 30 (xxx).
- Quantities of less than 1 are expressed as fractions.
- The abbreviation is typically written before the quantity, especially for grains.
- If you are unsure about the exact meaning of any medical notation, do not guess or assume. Ask the writer for clarification.
- Be sure to check with your health care facility regarding the acceptable use of apothecary notation.
The Household System

Household units are likely to be used by the patient at home where hospital measuring devices are not usually available. You should be familiar with the household system of measurement so that you can explain take-home prescriptions to your patient at the time of discharge. There is no standardized system of notation, but it is preferred to express the quantity in Arabic numbers and common fractions with the abbreviation following the amount. The common household units and abbreviations are given in the following table (Remember box).

CAUTION
Some units are used in both the apothecary and household systems (such as ounce, pint, and quart). The ounce household unit is used for both volume (fluid ounce) and weight (ounce). These similarities can be confusing. In apothecary, the amount technically follows the unit with Roman numerals used to designate the amount (such as oz ii). In the household system, the unit follows the amount (2 oz). However, either notation is acceptable.

REMEMBER

<table>
<thead>
<tr>
<th>HOUSEHOLD</th>
<th>Abbreviation</th>
<th>Equivalents</th>
</tr>
</thead>
<tbody>
<tr>
<td>drop</td>
<td>gtt</td>
<td></td>
</tr>
<tr>
<td>teaspoon</td>
<td>t (or tsp)</td>
<td>3 t = 1 T</td>
</tr>
<tr>
<td>tablespoon</td>
<td>T (or tbs)</td>
<td>1 T = 3 t</td>
</tr>
<tr>
<td>ounce (fluid)</td>
<td>fl oz</td>
<td>2 T = 1 fl oz</td>
</tr>
<tr>
<td>cup</td>
<td>cup</td>
<td>1 cup = 8 fl oz</td>
</tr>
<tr>
<td>pint</td>
<td>pt</td>
<td>1 pt = 2 cups = 16 fl oz</td>
</tr>
<tr>
<td>quart</td>
<td>qt</td>
<td>1 qt = 2 pt = 4 cups = 32 fl oz</td>
</tr>
<tr>
<td>ounce (weight)</td>
<td>oz</td>
<td>1 lb = 16 oz</td>
</tr>
<tr>
<td>pound</td>
<td>lb</td>
<td></td>
</tr>
</tbody>
</table>

Note: The drop (gtt) unit is given only for the purpose of recognition. There are no standard equivalents for drop to learn. The amount of each drop varies according to the diameter of the utensil used for measurement. (See Figure 6-2, calibrated dropper, and Figure 15-16, intravenous drip chambers.)

MATH TIP
Tablespoon is the larger unit, and the abbreviation is expressed with a capital or “large” T. Teaspoon is the smaller unit, and the abbreviation is expressed with a lowercase or “small” t.

CAUTION
Although some households may use metric measure, many do not. There can be a wide variation in household measuring devices, such as in tableware teaspoons, which can constitute a safety risk. Talking to your patients and their families about administering medications at home is an excellent teaching opportunity. Determine their familiarity with metric units, such as milliliters, and ask what kind of medicine measuring devices they use at home. It is best to advise your patients and their families to use the measuring devices packaged with the medication or provided by the pharmacy.
QUICK REVIEW
In the household system:
- The common units used in health care are teaspoon (t), tablespoon (T), ounce (oz), and pound (lb).
- The quantity is typically expressed in Arabic numbers with the unit abbreviation following the amount. Example: 5 t
- Quantities of less than 1 are preferably expressed as common fractions. Example: \( \frac{1}{2} \) cup
- When in doubt about the exact amount or the abbreviation used, do not guess or assume. Ask the writer to clarify.

OTHER COMMON DRUG MEASUREMENTS:
UNITS AND MILLEQUIVALENTS
Four other measurements may be used to indicate the quantity of medicine prescribed: international unit, unit, milliunit, and milliequivalent (mEq). The quantity is expressed in Arabic numbers with the unit of measure following. The international unit represents a unit of potency used to measure such things as vitamins and chemicals. The unit is a standardized amount needed to produce a desired effect. Medications such as penicillin, heparin, and insulin have their own meaning and numeric value related to the type of unit. One thousandth (\( \frac{1}{1000} \)) of a unit is a milliunit. The equivalent of 1 unit is 1,000 milliunits.

Oxytocin is a drug measured in milliunits. The milliequivalent (mEq) is one thousandth (\( \frac{1}{1000} \)) of an equivalent weight of a chemical. The mEq is the unit used when referring to the concentration of serum electrolytes, such as calcium, magnesium, potassium, and sodium.

CAUTION
The obsolete abbreviations U and IU are included on the Official “Do Not Use” List published by The Joint Commission (2005). The written words unit and international unit should be used instead. See Chapter 9 for the full list.

It is not necessary to learn conversions for the international unit, unit, or milliequivalent because medications prescribed in these measurements are also prepared and administered in the same system.

EXAMPLE 1
Heparin 800 units is ordered, and heparin 1,000 units per 1 mL is the stock drug. Because there is no standard equivalent for units, when a medication is ordered in units, such as heparin, the stock drug should be supplied in units.

EXAMPLE 2
Potassium chloride 10 mEq is ordered, and potassium chloride 20 mEq per 15 mL is the stock drug. Because there is no standard equivalent for mEq, when a medication is ordered in mEq, such as potassium chloride, the stock drug should be supplied in mEq.
EXAMPLE 3

Syntocinon 2 milliunits (0.002 international units) intravenous per minute is ordered and Syntocinon 10 international units per 1 mL to be added to 1,000 mL intravenous solution is available. Very small doses of a medication, such as oxytocin, may be ordered in milliunits. Remember the prefix milli means one thousandth. Sometimes converting from units to milliunits is necessary.

QUICK REVIEW

- The international unit, unit, milliunit, and milliequivalent (mEq) are special measured quantities expressed in Arabic numbers.
- No conversion is necessary for unit, international unit, and mEq because the ordered dosage and supply dosage are in the same system.
- 1 unit = 1,000 milliunits

**Review Set 12**

Interpret the following notations.

1. 20 gtt
2. 10 lb
3. 10 mEq

Express the following using medical notation.

6. four drops
7. thirty milliequivalents
8. five tablespoons
9. one-and-one-half teaspoons
10. ten grains

11. True or False? The household system of measurement is commonly used in hospital dosage calculations.

12. True or False? The drop is a standardized unit of measure.

13. True or False? Fluid ounce is equivalent to the ounce that measures weight.

14. Drugs such as heparin and insulin are commonly measured in ________.

15. 1 T = ________ t
16. 1 fl oz = ________ T
17. 16 oz = ________ lb
18. 2 T = ________ fl oz
19. 8 fl oz = ________ cup

20. The unit used to measure the concentration of serum electrolytes, such as calcium, magnesium, potassium, and sodium is the ________ and is abbreviated ________.

After completing these problems, see page 494 to check your answers.
The importance of the placement of the decimal point cannot be overemphasized. Let’s look at some examples of potential medication errors related to placement of the decimal point.

**ERROR 1**
Not placing a zero before a decimal point in medication orders.

**Possible Scenario**
An emergency room physician wrote an order for the bronchodilator terbutaline for a patient with asthma. The order was written as follows.

Incorrectly Written

Terbutaline .5 mg subcutaneously now, repeat dose in 30 minutes if no improvement

Suppose the nurse, not noticing the faint decimal point, administered 5 mg of terbutaline subcutaneously instead of 0.5 mg. The patient would receive ten times the dose intended by the physician.

**Potential Outcome**
Within minutes of receiving the injection the patient would likely complain of headache and develop tachycardia, nausea, and vomiting. The patient’s hospital stay would be lengthened because of the need to recover from the overdose.

**Prevention**
This type of medication error is avoided by remembering the rule to place a 0 in front of a decimal to avoid confusion regarding the dosage: 0.5 mg. Further, remember to question orders that are unclear or seem impractical.

Correctly Written

Terbutaline 0.5 mg subcutaneously now, repeat dose in 30 minutes if no improvement

**CRITICAL THINKING SKILLS**

Many medication errors occur by confusing mg and mL. Remember that mg is the weight of the medication, and mL is the volume of the medication preparation.

**ERROR 2**
Confusing mg and mL.

**Possible Scenario**
Suppose a physician ordered the steroid Prelone (prednisolone) 15 mg by mouth twice a day for a patient with cancer. Prelone syrup is supplied in a concentration of 15 mg in 5 mL. The pharmacist supplied a bottle of Prelone containing a total volume of 240 mL with 15 mg of Prelone in every 5 mL. The nurse, in a rush to give her medications on time, misread the order as 15 mL and gave the patient 15 mL of Prelone instead of 5 mL. Therefore, the patient received 45 mg of Prelone, or three times the correct dosage.

**Potential Outcome**
The patient could develop a number of complications related to a high dosage of steroids: gastrointestinal bleeding, hyperglycemia, hypertension, agitation, and severe mood disturbances, to name a few.

**Prevention**
The mg is the weight of a medication, and mL is the volume you prepare. Do not allow yourself to get rushed or distracted so that you confuse milligrams with milliliters. When you know you are distracted or stressed, have another nurse double-check the calculation of the dose.
### PRACTICE PROBLEMS—CHAPTER 3

Give the metric prefix for the following parts of the base units.

1. 0.001
   - **Answer:** milli

3. 0.01
   - **Answer:** centi

2. 0.000001
   - **Answer:** micro

4. 1.000
   - **Answer:** kilo

Identify the equivalent unit with a value of 1 that is indicated by the following amounts (such as 1 unit = 1,000 milliunits).

5. 0.001 gram
   - **Answer:** milligram

7. 0.001 milligram
   - **Answer:** micromilligram

6. 1,000 grams
   - **Answer:** kilogram

8. 0.01 meter
   - **Answer:** millimeter

Identify the metric base unit for the following.

9. length
   - **Answer:** meter

11. volume
   - **Answer:** liter

10. weight
    - **Answer:** gram

Interpret the following notations.

12. gtt
    - **Answer:** drop

22. mL
    - **Answer:** milliliter

13. 3
    - **Answer:** fluid ounce

23. pt
    - **Answer:** pint

14. oz
    - **Answer:** ounce

24. T
    - **Answer:** ton

15. gr
    - **Answer:** grain

25. mm
    - **Answer:** millimeter

16. mg
    - **Answer:** milligram

26. g
    - **Answer:** gram

17. mcg
    - **Answer:** microgram

27. cm
    - **Answer:** centimeter

18. 5
    - **Answer:** liter

28. L
    - **Answer:** liter

19. mEq
    - **Answer:** milliequivalent

29. m
    - **Answer:** meter

20. t
    - **Answer:** ton

30. kg
    - **Answer:** kilogram

21. qt
    - **Answer:** quart

31. mj
    - **Answer:** microjoule

Express the following amounts in proper notation.

32. three hundred and twenty-five micrograms
    - **Answer:** 325 mcg

33. one-half grain
    - **Answer:** 0.5 gr

34. two teaspoons
    - **Answer:** 2 tsp

35. one-third ounce
    - **Answer:** 0.333 oz

36. five million units
    - **Answer:** 5,000,000 units

37. one-half liter
    - **Answer:** 0.5 L

38. one-fourth grain
    - **Answer:** 0.25 gr

39. one two hundredths of a grain
    - **Answer:** 0.005 gr

40. five hundredths of a milligram
    - **Answer:** 0.05 mg

Express the following numeric amounts in words.

41. $8 \frac{1}{4}$ oz
    - **Answer:** eight and one-fourth ounces

42. 375 g
    - **Answer:** three hundred and seventy-five grams
43. \(\frac{1}{4}\) gr

44. 2.6 mL

45. 20 mEq

46. 0.4 L

47. \(\frac{1}{400}\) gr

48. 0.17 mg

49. Describe the strategy that would prevent the medication error.

Possible Scenario
Suppose a physician ordered oral Coumadin (an anticoagulant) for a patient with a history of deep vein thrombosis. The physician wrote an order for 10 mg but while writing the order placed a decimal point after the 10 and added a 0:

Incorrectly Written

\[\text{Coumadin 10.0 mg orally once per day}\]

Coumadin 10.0 mg was transcribed on the medication record as Coumadin 100 mg. The patient received ten times the correct dosage.

Potential Outcome
The patient would likely begin hemorrhaging. An antidote, such as vitamin K, would be necessary to reverse the effects of the overdose. However, it is important to remember that not all drugs have antidotes.

Prevention

50. Describe the strategy that would prevent a medication error or the need to notify the prescribing practitioner.

Possible Scenario
Suppose a physician ordered oral codeine (a mild narcotic analgesic) for an adult patient recovering from nasal surgery. The physician wrote the following order for 1 grain (equivalent to about 60 mg) but while writing the order placed the 1 before the abbreviation gr. The gr smeared and the abbreviation gr is unclear. Is it grains or grams?

Incorrectly Written

\[\text{Codeine 1 gr orally every 4 hours as needed for pain}\]

Codeine 1 gram was transcribed on the medication record. Because 1 gram is equivalent to 1,000 mg or about 15 grains, this erroneous dosage is about 15 times more than the intended amount.

Potential Outcome
Even though the nurse was in a rush to help ease the patient’s pain, she realized that the available codeine pills would not be dispensable in this amount. She would have to give the patient 15 tablets to equal the 1 gram amount. The nurse saw the questionable order and called the physician for clarification. The nurse correctly concluded it was unlikely that the physician would have ordered such an excessive number of pills or dosage.

Prevention

After completing these problems, see page 494 to check your answers.
REFERENCE