CALCULATE WITH CONFIDENCE

DEBORAH C. MORRIS

EIGHTH EDITION

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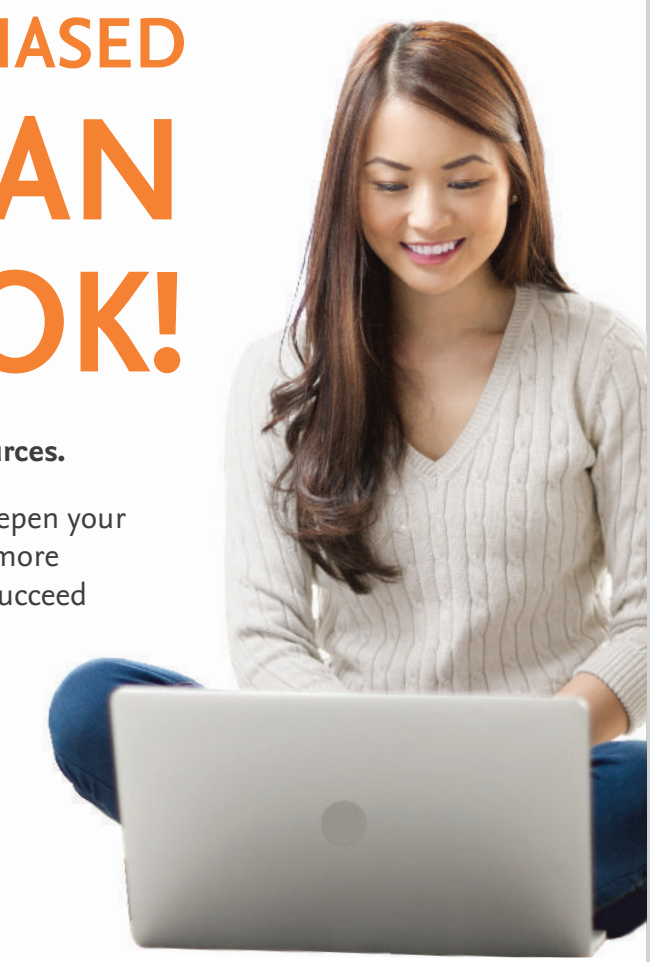

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CALCULATE with CONFIDENCE

Eighth Edition

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To my children, Cameron, Kimberly, Kanin, and Cory, thanks for your love and support. You light up my life. To my mother, your love, support, guidance, and nurturing helped me to become the person I am today. To my husband, Reggie, thank you for all the hard work you did in helping me with the current and previous editions of this text. Your support and encouragement kept me on track and focused.

To the two special additions and loves of my life, my two grandsons, Ryan and Eison, you touch my life more than you know.

Thank you to friends, nursing colleagues, and students past and present. To future and current practitioners of nursing, I hope this book will be valuable in teaching the principles of dosage calculation and reinforcing the importance of safety in administration of medications to all clients regardless of the setting.

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Preface to the Instructor

Safety is a priority in the delivery of health care. To advance client safety and its importance in health care delivery worldwide, several organizations are involved in reinforcing the promotion of client safety in health care, which includes emphasis on improving safety in medication administration. These organizations include the Institute of Medicine (IOM), the Institute for Safe Medication Practices (ISMP), and The Joint Commission (TJC).

The Quality and Safety Education for Nurses (QSEN) looks at six competencies, two of which are relevant to medication administration: safety and informatics. *Safety* refers to reducing the risk of harm to clients, and *informatics* refers to technology used to mitigate errors. Safety and informatics will be referred to in this text where applicable. The text uses the term *client* to denote one who is the recipient of health care and can also be referred to as *patient, resident,* and *health care consumer.*

The eighth edition of ***Calculate with Confidence*** not only teaches the aspects of dosage calculation, it also emphasizes the importance of safety in medication administration. ***Calculate with Confidence*** is written to meet the needs of nursing students as well as nurses returning to the workforce after being away from the clinical setting. It is also suitable for courses within nursing curricula whose content reflects the calculation of dosages and solutions. The text can generally be used as a reference by any health care professional whose responsibilities include safe administration of medications and solutions to clients in diverse clinical settings.

Calculate with Confidence, eighth edition, has incorporated feedback from users of previous editions, including students, instructors, and reviewers. This edition has maintained a style similar to previous editions. The text presents three methods of dosage calculation—dimensional analysis, formula method, and ratio and proportion. Each method is illustrated, empowering students to choose the method that suits their learning style and works for them. It also enables the instructor to teach a preferred method or multiple methods to students.

The new edition responds to changes in the health care field and includes the introduction of new medications, discussion of new methods for medication administration, and an emphasis on clinical reasoning in prevention of medication errors. Principles of QSEN have been incorporated where applicable. An ample number of practice problems that include the shading of syringes where indicated continues to be featured to allow for visualization of dosages, reinforcement of clinical thinking skills, and prevention of medication errors. Safety alerts are also incorporated throughout the chapters to further reinforce the importance of error prevention in medication administration. Despite technological advances in equipment, health care professionals must continue to use clinical reasoning skills and have a consistent focus on safety to minimize the risk of harm to clients. Answers to practice problems include rationales to enhance understanding of principles and answers related to dosages. Answers have been placed at the end of chapters to allow for immediate feedback.

In response to the increased need for competency in basic math as an essential prerequisite for dosage calculation, practice problems in the basic math section are provided to allow the student to identify his or her strengths and weaknesses in basic math areas that provide the foundation for math skills applied in dosage calculation.

The once controversial use of calculators is now a more accepted practice, and they are used on many nursing examinations, including the NCLEX; however, their use is individualized. Many health care agencies have policies that require the use of calculators to verify calculations (e.g., critical care calculations) to avoid medication errors. A basic handheld calculator that has functions of addition, subtraction, multiplication, division, and a square

root key is usually sufficient for medical dosage calculation, and students should know how to use such a calculator.

ORGANIZATION OF CONTENT

The eighth edition continues to be organized in a progression from simple topics to more complex ones, making content relevant to the needs of the student and using realistic practice problems to enhance learning and make material clinically applicable.

The 24 chapters are arranged into 5 units.

Unit One includes Chapters 1 through 4. This unit provides a review of basic arithmetic skills, including fractions, decimals, ratio and proportion, and percentages. A Pre-Test and Post-Test are included. This unit allows the student to determine his or her weaknesses and strengths in arithmetic and provides a review of basic math, which includes fractions, decimals, percents, and ratio and proportion. Ample practice problems as well as word problems are included in the basic math sections.

Unit Two includes Chapters 5 through 8. Chapters 5 through 7 introduce the student to the three systems of measurement: metric, household, and apothecary. The metric system is emphasized, and some aspects of household measures are discussed because of their implications for care at home. The apothecary system is discussed in terms of its non-use, and the error-prone abbreviations from this system to avoid in this system have been placed in Appendix A. Chapter 8 provides conversions relating to temperature, length, weight, and military time. Calculation of intake and output (I&O) is included (both basic and complex). A brief discussion of completion times for IV therapy is also presented.

Unit Three includes Chapters 9 through 15. This unit provides essential information that is needed as a foundation for dosage calculation and safe medication administration. Chapter 9 includes an expanded discussion of medication errors; routes of medication administration; equipment used in medication administration; the six basic rights of medication administration, as well as additional rights to be considered when administering medications; and the nursing role in preventing medication errors. Chapter 10 presents the abbreviations used in medication administration and interpretation of medication orders. Chapter 11 introduces students to medication administration records and has been updated to include the various medication distribution systems. Chapter 12 provides the student with the skills necessary to read medication labels to calculate dosages. Medication labels include medications in current use as well as some of the newer medication labels on the market. The important skill of reading labels is developed by providing practice with identification of information on labels. Resources that include TJC's official "Do Not Use" list and ISMP's list of Error-Prone Abbreviations, Symbols, and Dose Designations are emphasized and have been included in the appendices, along with other resources. Emphasis is placed on the nurse's responsibility to stay abreast of standards regarding medication orders to ensure client safety and prevent errors in medication administration. Chapters 13 through 15 introduce the various methods used for dosage calculation (ratio and proportion, formula method, and dimensional analysis). Practice problems are provided for each method, giving the student the opportunity to practice the various methods and choose the one preferred.

Unit Four includes Chapters 16 through 19. In Chapter 16, the student learns the principles and calculations related to oral medications (solid and liquids). In Chapter 17, the student learns about the various types of syringes and the skills needed for calculating injectable medications. Chapter 18 introduces concepts of solutions. Calculations associated with reconstituted solutions for injectable and oral medications are discussed. Calculations associated with preparation of noninjectable solutions, including nutritional feedings, determining the strength of solutions, and calculation of solutions, are also included. Chapter 19 introduces the student to insulin types, including U-500 insulin and the U-500 insulin syringe. The chapter has been expanded to include discussion of insulin pens, the use of the sliding scale, and glucose monitoring systems. The methods of dosage calculation are illustrated in the chapters (ratio and proportion, formula method, and dimensional analysis), and practice problems are provided in each chapter.

Unit Five includes Chapters 20 through 24. Chapters 20 and 21 provide a discussion of equipment used in the administration of intravenous (IV) fluids and IV solutions, as well as associated calculations related to IV therapy. Content includes a focus on safety with IV administration, recalculating IV flow rate with an alternative method of determining the percentage of variation, and determining infusion and completion time for IV therapy. IV labels have been

added throughout the chapter, with a discussion of additives to IV solutions. Chapter 22 presents a discussion of heparin and new heparin labels. Heparin weight-based protocol has been expanded to include adjusting IV heparin based on activated partial thromboplastin time (aPTT). Chapter 23 provides the student with the skills necessary to calculate critical care IV medications. Titration of IV flow rates for titrated medications is explained, as well as how to develop a titration table. Additional practice problems have also been added to the chapter. Chapter 24 provides the student with the skills and principles for calculation of pediatric and adult dosages and verification of safe dosages based on weight. Determining the body surface area (BSA) using a nomogram and formula is discussed, and calculation and verification of safe dosages based on BSA is also included. Calculation of daily fluid maintenance, also referred to as daily fluid requirement (DFR), for children has also been included, as have practice problems.

Safety Alerts, Tips for Clinical Practice, Practice Problems, Clinical Reasoning scenarios, and Points to Remember are included throughout the text. A Comprehensive Post-Test is included at the end of the text and includes practice problems covering content from all 24 chapters. A Drug Label Index is also included.

NEW FEATURES TO THE EIGHTH EDITION

- A change in format in some chapters for ease of reading.
- Updates in the chapter on Medication Administration that include the "culture of safety" and the Risk Evaluation and Mitigation Strategy (REMS).
- Discussion of Clinical Decision-Making Support Systems (CDSS) and Computerized Provider Order Entry (CPOE).
- Updated labels that include current medications on the market are provided throughout the text, along with discussion of the Black Box Warning.
- An update of the Insulin chapter with current insulin labels provided by Eli Lilly and Company and an updated discussion of insulin syringes, which includes the U-500 insulin syringe.
- Current heparin labels in the Heparin Calculations chapter and throughout the text.
- Labels presented in easily readable format.
- Addition of case studies in select chapters to help prepare students for the Next-Generation NCLEX (NGN).
- Updates to Medication Distribution Systems.
- Calculation and verification of safe dosages using BSA.
- Updates in the chapters on IV therapy that include calculations and equipment used to administer IV fluids.

ANCILLARIES

Evolve Resources for ***Calculate with Confidence,*** eighth edition, are available to enhance student instruction. These online resources can be found at http://evolve.elsevier.com/GrayMorris/.

These resources correspond with the chapters of the main book and includes the following:

- Updated Student Review Questions and Test Bank Questions to coincide with the chapters, as well as sample NCLEX Review Questions.
- Elsevier's Interactive Drug Calculation Application, version 1: This interactive drug calculation application provides hands-on, interactive practice for the user to master drug calculations. Users can select the mode (Study, Exam, or Comprehensive Exam) and then the category for study and exam modes. There are eight categories that cover the main drug calculation topics. Users are also able to select the number of problems they want to complete and their preferred drug calculation method. A calculator is available for easy access within any mode, and the application also provides history of the work done by the user. There are 750 practice problems in this application.

It is my hope that this book will be a valuable asset to current and future practitioners. May it help you calculate dosages accurately and with confidence, using calculation and critical thinking skills to ensure that medications are administered safely to all clients regardless of the setting. This is both a priority and a primary responsibility of the nurse.

Deborah C. Morris

Acknowledgments

I would like to extend sincere gratitude and appreciation to those individuals from both the past and present who have inspired and encouraged me throughout the writing of the editions of this text. Who knew that this text would now be in its eighth edition? First and foremost, thank you to my family for all of your support during the writing of every edition. A special thanks to my daughter-in-law, who we call Marcy (Marcella Willis-Gray, MD), for taking the time out of your busy schedule to answer questions relating to medication orders and guiding me to the source to obtain an electronic medication administration record (eMAR) for use in this edition.

I am particularly thankful for the encouragement and support of present and former colleagues at Bronx Community College of the City University of New York (CUNY). Thanks to Professor Lois Augustus, former chairperson of the Department of Nursing and Allied Health Sciences, for your friendship and encouragement. Thank you to Mr. Clarence Hodge (Lecturer) who currently teaches Pharmacology Computations; your feedback has been invaluable. Thank you to Professor Helen Papas-Kavalis, a friend and colleague, for sharing your pediatric expertise when needed. A special note of thanks and sincere appreciation to Professor Ellen Hoist, a colleague and a friend, who provided me with support, mentoring, and encouragement from the beginning with the first edition of this text, when I expressed doubt of editions beyond the first. You could see the potential even when I expressed doubt.

Thanks to former Chairpersons of the Department of Mathematics and Computer Sciences at Bronx Community College, Professor Germana Glier, and the late Dr. Gerald S. Lieblich, whose mathematical expertise was invaluable. A special thanks to the late Dr. Andrew McInerney, a colleague and friend (who also was a former Chairperson) for all of your suggestions and validation of answers in the mathematical portion of this text. Your help was invaluable, and you will always be missed.

Thanks to past and present students at Bronx Community College in the Department of Nursing and Allied Health Sciences who provided the inspiration for me to write this text. You helped me to have an appreciation for the problems students encounter with basic math and the calculation of medication dosages.

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To all of my friends, and especially to Anna Nunnally, my friend who always says I am her sis, thanks for your encouragement and admiration and for always saying "you can do it." To my friend the late Frank A. Rucker, your encouragement, inspiring words, and admiration for me as an author will always remain with me.

I wish to acknowledge and thank Eli Lilly and Company for providing current images of medication labels for reproduction in this text. I also want to thank the companies that provided images of medication equipment and documents for use in this edition. Thanks to Omnicell for the image of their Automated Dispensing Cabinet (ADC) and Becton Dickinson and Company (BD) for the image of the Flow Controller. Thank you to Epic for providing the image of an eMAR and to ISMP and TJC for granting permission for documents used in the text.

Thank you all!

Deborah C. Morris

Contents

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UNIT ONE

Math Review

An essential role of the nurse is providing safe medication administration to all clients. To accurately perform dosage calculations, the nurse must have knowledge of basic math, regardless of the problem-solving method used in calculation. Knowledge of basic math is a necessary component of dosage calculation that nurses need to know to prevent medication errors and ensure the safe administration of medications to all clients, regardless of the setting. Serious harm to clients can result from a mathematical error during calculation and administration of a medication dosage. The nurse must practice and be proficient in the basic math used in dosage calculations. Knowledge of basic math is a prerequisite for the prevention of medication errors and ensures the safe administration of medications.

Although calculators are accessible for basic math operations, the nurse needs to be able to perform the processes involved in basic math. Even when a calculator is used, checking the accuracy of an answer often requires nurses to employ the skill of estimating an answer quickly in their heads. Calculators may indeed be recommended for complex calculations to ensure accuracy and save time; the types of calculations requiring their use are presented later in this text. However, because the basic math required for less complex calculations is often simple and can be done without the use of a calculator, it is a realistic expectation that each practitioner should be competent in the performance of basic math operations without its use. Performing basic math operations enables the nurse to think logically and critically about the dosage ordered and the dosage calculated.

PRE-TEST

This test is designed to evaluate your ability in the basic math areas reviewed in Unit One. The test consists of 72 questions. If you are able to complete the pre-test with 100% accuracy, you may want to bypass Unit One. Any problems answered incorrectly should be used as a basis for what you might need to review. The purposes of this test and the review that follows are to build your confidence in basic math skills and to help you avoid careless mistakes when you begin to perform dosage calculations.

Identify the fraction(s) equal to 1.

1. $\frac{26}{25}, \frac{3}{4}, \frac{8}{8}$ _____

Identify the fraction as a proper fraction, an improper fraction, or a mixed number.

2. $\frac{13}{7}$ _____
3. $\frac{7}{12}$ _____
4. $8\frac{2}{7}$ _____
5. $3\frac{5}{8}$ _____
6. $\frac{14}{14}$ _____
7. $\frac{5}{21}$ _____

Change the following fractions to whole or mixed numbers and reduce if necessary.

8. $\frac{28}{14}$ _____
9. $\frac{20}{8}$ _____
10. $\frac{48}{10}$ _____

Reduce the following fractions to lowest terms.

11. $\frac{14}{21}$ _____
12. $\frac{25}{100}$ _____
13. $\frac{2}{150}$ _____
14. $\frac{24}{30}$ _____
15. $\frac{24}{36}$ _____

Perform the indicated operations; reduce to lowest terms where necessary.

16. $\frac{2}{3} \div \frac{3}{9} =$ _____
17. $4 \div \frac{3}{4} =$ _____
18. $\frac{2}{5} + \frac{1}{9} =$ _____
19. $7\frac{1}{7} - 2\frac{5}{6} =$ _____
20. $4\frac{2}{3} \times 4 =$ _____
21. $3\frac{5}{6} + 5\frac{2}{3} =$ _____
22. $5\frac{6}{7} + 3\frac{5}{7} =$ _____
23. $2\frac{1}{6} - 1\frac{1}{4} =$ _____
24. $9 - \frac{3}{5} =$ _____
25. $4\frac{1}{4} - 1\frac{3}{4} =$ _____
26. $7\frac{1}{5} - 1\frac{3}{4} =$ _____
27. $7 - \frac{9}{16} =$ _____
28. $3\frac{3}{10} - 1\frac{7}{10} =$ _____

Change the following fractions to decimals; express your answer to the nearest tenth.

29. $\frac{6}{7}$ _____ 31. $\frac{2}{3}$ _____

30. $\frac{6}{20}$ _____ 32. $\frac{7}{8}$ _____

Indicate the largest fraction in each group.

33. $\frac{3}{4}, \frac{4}{5}, \frac{7}{8}$ _____ 34. $\frac{7}{12}, \frac{11}{12}, \frac{4}{12}$ _____

Perform the indicated operations with decimals. Provide the exact answer; do not round off.

35. 20.1 + 67.35 = _____ 37. 4.6 × 8.72 = _____

36. 0.008 + 5 = _____ 38. 56.47 — 8.7 = _____

Divide the following decimals; express your answer to the nearest tenth.

39. 7.5 ÷ 0.004 = _____ 41. 84.7 ÷ 2.3 = _____

40. 45 ÷ 1.9 = _____

Indicate the largest decimal in each group.

42. 0.674, 0.659 _____ 44. 0.25, 0.6, 0.175 _____

43. 0.375, 0.37, 0.38 _____

Solve for *x,* the unknown value.

45. 8 : 2 = 48 : x _____ 47. $\frac{1}{10} : x = \frac{1}{2} : 15$ _____

46. x : 300 = 1 : 150 _____ 48. 0.1 : 1 = 0.2 : x _____

Round off to the nearest tenth.

49. 0.43 _____ 51. 1.47 _____

50. 0.66 _____

Round off to the nearest hundredth.

52. 0.735 _____ 54. 1.227 _____

53. 0.834 _____

Complete the table below, expressing the measures in their equivalents where indicated. Reduce to lowest terms where necessary.

	Percent	Decimal	Ratio	Fraction
55.	6%	_____	_____	_____
56.	_____	_____	7 : 20	_____
57.	_____	_____	_____	$5\frac{1}{4}$
58.	_____	0.015	_____	_____

Find the following percentages. Express your answer to the hundredths place as indicated.

59. 5% of 95 _____

60. $\frac{1}{4}$% of 2,000 _____

61. 2 is what % of 600 _____

62. 20 is what % of 100 _____

63. 30 is what % of 164 _____

64. A client is instructed to take $1\frac{1}{2}$ teaspoons of a cough syrup three (3) times a day. How many teaspoons of cough syrup will the client take each day?
_____

65. A tablet contains 0.75 milligrams (mg) of a medication. A client receives three (3) tablets a day for five (5) days. How many mg of the medication will the client receive in five (5) days? _____

66. A client took 0.44 micrograms (mcg) of a medication every morning and 1.4 mcg each evening for five (5) days. What is the total amount of medication taken?
_____

67. Write a ratio that represents that every tablet in a bottle contains 0.5 milligrams (mg) of a medication. _____

68. Write a ratio that represents 60 milligrams (mg) of a medication in 1 milliliter (mL) of a liquid. _____

69. A client takes 10 milliliters (mL) of a medication three (3) times a day. How long will 120 mL of medication last? _____

70. A client weighed 275 pounds (lb) before dieting. After dieting, the client weighed 250 lb. What is the percentage of change in the client's weight? _____

71. A client was prescribed 10 milligrams (mg) of a medication for a week. After a week, the health care provider reduced the medication to seven (7) mg. What was the percentage of decrease in medication? _____

72. A client received 22.5 milligrams (mg) of a medication in tablet form. Each tablet contained 4.5 mg of medication. How many tablets were given to the client? _____

Answers on p. 5

ANSWERS

1. 8/8
2. improper fraction
3. proper fraction
4. mixed number
5. mixed number
6. improper fraction
7. proper fraction
8. 2
9. $\frac{20}{8} = 2\frac{4}{8} = 2\frac{1}{2}$
10. $\frac{48}{10} = 4\frac{8}{10} = 4\frac{4}{5}$
11. $\frac{2}{3}$
12. $\frac{1}{4}$
13. $\frac{1}{75}$
14. $\frac{4}{5}$
15. $\frac{2}{3}$
16. 2
17. $5\frac{1}{3}$
18. $\frac{23}{45}$
19. $4\frac{13}{42}$
20. $18\frac{2}{3}$
21. $9\frac{3}{6} = 9\frac{1}{2}$
22. $8\frac{11}{7} = 9\frac{4}{7}$
23. $\frac{11}{12}$
24. $8\frac{2}{5}$
25. $2\frac{2}{4} = 2\frac{1}{2}$
26. $5\frac{9}{20}$
27. $6\frac{7}{16}$
28. $1\frac{6}{10} = 1\frac{3}{5}$
29. 0.9
30. 0.3
31. 0.7
32. 0.9
33. $\frac{7}{8}$
34. $\frac{11}{12}$
35. 87.45
36. 5.008
37. 40.112
38. 47.77
39. 1,875
40. 23.7
41. 36.8
42. 0.674
43. 0.38
44. 0.6
45. $x = 12$
46. $x = 2$
47. $x = 3$
48. $x = 2$
49. 0.4
50. 0.7
51. 1.5
52. 0.74
53. 0.83
54. 1.23

	Percent	Decimal	Ratio	Fraction
55.	6%	0.06	3 : 50	$\frac{3}{50}$
56.	35%	0.35	7 : 20	$\frac{7}{20}$
57.	525%	5.25	21 : 4	$5\frac{1}{4}$
58.	1.5%	0.015	3 : 200	$\frac{3}{200}$

59. 4.75
60. 5
61. 0.33%
62. 20%
63. 18.29%
64. $4\frac{1}{2}$ teaspoons
65. 11.25 milligrams (mg)
66. 9.2 micrograms (mcg)
67. 0.5 mg : 1 tablet *or* 0.5 mg/1 tablet
68. 60 mg : 1 mL *or* 60 mg/1 mL
69. 4 days
70. 9%
71. 30%
72. 5 tablets

CHAPTER 1
Fractions

Objectives

After reviewing this chapter, you should be able to:

1. Compare the size of fractions
2. Add fractions
3. Subtract fractions
4. Divide fractions
5. Multiply fractions
6. Reduce fractions to lowest terms

Health care professionals need to have an understanding of fractions. Fractions may be seen in medical orders, client records, prescriptions, documentation relating to care given to clients, and literature related to health care. Nurses often encounter fractions when converting metric to household measures in dosage calculation.

Fractions may be used occasionally in the writing of a medication order or used by the pharmaceutical manufacturer on a medication label (which usually includes the metric equivalent). In 2010 the Institute for Safe Medication Practices (ISMP) president Michael R. Cohen edited the abridged edition of the book *Medication Errors,* which contained this statement: "Occasionally using fractions instead of metric designation could help prevent errors." In 2020, 10 years later, this statement still is very true. For example, the dosage embossed on 2.5-mg Coumadin tablets is "2½ mg" and on 7.5 mg is "7½ mg" (see Figures 1.1 and 1.2). The use of "2½ mg" and "7½ mg" prevents confusion with "25" mg and "75" mg, respectively, eliminating the possibility of a patient receiving a massive overdose of this anticoagulation medication.

As you will see later in the text, some methods of solving dosage calculations rely on expressing relationships in a fraction format. Therefore proficiency with fractions can be beneficial in a variety of situations.

A fraction represents a part of a whole (Figure 1.3). It is written as two quantities: an upper number referred, to as the **numerator** (parts of the whole), and a **denominator,** the bottom part of the fraction that represents the whole. The numerator and denominator are separated by a horizontal line. The horizontal line above the denominator is a division sign; therefore a fraction may also be read as the numerator divided by the denominator.

$$\frac{\text{Numerator}}{\text{Denominator}} \leftarrow \text{horizontal bar (division sign)}$$

Examples: Suppose you have to administer a medication that is scored (marked) for division into four parts to a client, and you must administer one part of the tablet. The denominator represents the whole tablet, and the numerator represents the amount you administer. The fraction, or part, of the tablet you administer is written as:

$$\frac{\text{Numerator}}{\text{Denominator}} = \frac{1 \text{ part}}{4 \text{ parts}} = \frac{1}{4}$$

This number is read as one-fourth. The denominator is 4 because 4 parts make up the whole. If you administer one part, you administer $\frac{1}{4}$ of the tablet.

Figure 1.1 Coumadin 2.5 mg (expressed as 2½ mg).

Figure 1.2 Coumadin 7.5 mg (expressed as 7½ mg).

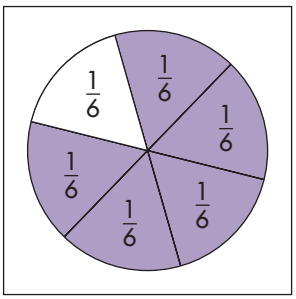

Figure 1.3 The shaded part of the circle, which is 5 parts, reflects the numerator, and the total number of parts (6) is the denominator. Therefore $\frac{5}{6}$ means 5 of 6 equal parts.

Occasionally fractions may be used to show the relationship between part of a group and the whole group. For example, you are working on a surgical unit, and in a group of 18 clients who had surgery, 7 developed infections. The number of clients in the full group, 18, is the whole, or the denominator. You write the fraction of clients who developed infections as:

$$\frac{\text{Part (numerator)}}{\text{Whole (denominator)}} = \frac{\text{Clients who developed infections}}{\text{Whole group}} = \frac{7}{18}$$

Types of Fractions

There are various types of fractions:

Proper Fraction: Numerator is less than the denominator, and the fraction has a value of less than 1.

Examples: $\frac{1}{8}, \frac{5}{6}, \frac{7}{8}, \frac{1}{150}$

Improper Fraction: Numerator is larger than, or equal to, the denominator, and the fraction has a value of 1 or greater than 1.

Examples: $\frac{3}{2}, \frac{7}{5}, \frac{300}{150}, \frac{4}{4}$

Mixed Number: Whole number and a proper fraction in which the total value of the mixed number is greater than 1.

Examples: $3\frac{1}{3}, 5\frac{1}{8}, 9\frac{1}{6}, 25\frac{7}{8}$

Complex Fraction: Numerator, denominator, or both are fractions. The value may be less than, greater than, or equal to 1.

Examples: $\frac{3\frac{1}{2}}{2}, \frac{\frac{1}{3}}{\frac{1}{2}}, \frac{2}{1\frac{1}{4}}, \frac{2}{\frac{1}{150}}$

Whole Numbers: Have an unexpressed denominator of one (1).

Examples: $1 = \frac{1}{1}, 3 = \frac{3}{1}, 6 = \frac{6}{1}, 100 = \frac{100}{1}$

Converting Fractions

An improper fraction can be changed to a mixed number or whole number by dividing the numerator by the denominator. If there is a remainder, that number is placed over the denominator, and the answer is reduced to lowest terms.

Examples: $\frac{6}{5} = 6 \div 5 = 1\frac{1}{5}, \frac{100}{25} = 100 \div 25 = 4, \frac{10}{8} = 10 \div 8 = 1\frac{2}{8} = 1\frac{1}{4}$

A mixed number can be changed to an improper fraction by multiplying the whole number by the denominator, adding it to the numerator, and placing the sum over the denominator.

Example: $5\frac{1}{8} = \frac{(5 \times 8) + 1}{8} = \frac{41}{8}$

Comparing Fractions

Comparing the size of fractions is important in the administration of medications. It helps the new practitioner learn the value of medication dosages early on. Fractions can be compared if the numerators are the same by comparing the denominators or if the denominators are the same by comparing the numerators. These rules are presented in Box 1.1.

BOX 1.1 Rules for Comparing Size of Fractions

Here are some basic rules to keep in mind when comparing fractions.

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

Example 1: $\frac{1}{2}$ is larger than $\frac{1}{3}$

Example 2: $\frac{1}{150}$ is larger than $\frac{1}{300}$

2. If the denominators are the same, the fraction with the larger numerator has the greater value.

Example 1: $\frac{3}{4}$ is larger than $\frac{1}{4}$

Example 2: $\frac{3}{100}$ is larger than $\frac{1}{100}$

Two or more fractions with different denominators can be compared by changing both fractions to fractions with the same denominator (see Box 1.1). This is done by finding the lowest common denominator (LCD), or the lowest number evenly divisible by the denominators of the fractions being compared.

Example: Which is larger, $\frac{3}{4}$ or $\frac{4}{5}$?

Solution: The lowest common denominator is 20, because it is the smallest number that can be divided by both denominators evenly. Change each fraction to the same terms by dividing the lowest common denominator by the denominator and multiplying that answer by the numerator. The answer obtained from this is the new numerator. The numerators are then placed over the lowest common denominator.

For the fraction $\frac{3}{4}$: $20 \div 4 = 5$; $5 \times 3 = 15$; therefore $\frac{3}{4}$ becomes $\frac{15}{20}$.

For the fraction $\frac{4}{5}$: $20 \div 5 = 4$; $4 \times 4 = 16$; therefore $\frac{4}{5}$ becomes $\frac{16}{20}$.

Therefore $\frac{4}{5}\left(\frac{16}{20}\right)$ is larger than $\frac{3}{4}\left(\frac{15}{20}\right)$.

Box 1.2 presents fundamental rules of fractions.

BOX 1.2 Fundamental Rules of Fractions

In working with fractions, there are some fundamental rules that we need to remember.

1. When the numerator and denominator of a fraction are both multiplied or divided by the same number, the value of the fraction remains unchanged.

Examples:

$$\frac{1}{2} = \frac{1 \times (2)}{2 \times (2)} = \frac{2}{4} = \frac{2 \times (25)}{4 \times (25)} = \frac{50}{100}, \text{ etc.}$$

$$\frac{50}{100} = \frac{50 \div (10)}{100 \div (10)} = \frac{5}{10} = \frac{5 \div (5)}{10 \div (5)} = \frac{1}{2}, \text{ etc.}$$

As shown in the examples, common fractions can be written in various forms, provided that the numerator, divided by the denominator, always yields the same number (quotient). The particular form of a fraction that has the smallest possible whole number for its numerator and denominator is called the *fraction in its lowest terms.* In the example, therefore $^{50}/_{100}$, $^{5}/_{10}$, or $^{2}/_{4}$ is $^{1}/_{2}$ in its lowest terms.

2. To change a fraction to its lowest terms, divide its numerator and its denominator by the largest whole number that will divide both evenly.

Example: Reduce $\frac{128}{288}$ to lowest terms.

$$\frac{128}{288} = \frac{128 \div 32}{288 \div 32} = \frac{4}{9}$$

Note: When you do not see the largest number that can be divided evenly at once, the fraction may have to be reduced by using repeated steps.

Example:

$$\frac{128}{288} = \frac{128 \div 4}{288 \div 4} = \frac{32}{72} = \frac{32 \div 8}{72 \div 8} = \frac{4}{9}$$

Note: If both the numerator and denominator cannot be divided evenly by a whole number, the fraction is already in lowest terms. Fractions should always be expressed in their lowest terms.

3. LCD (lowest common denominator) is the smallest whole number that can be divided evenly by all of the denominators within the problem.

Examples: $\frac{1}{3}$ and $\frac{5}{12}$: 12 is evenly divisible by 3; therefore 12 is the LCD.

$\frac{3}{7}$, $\frac{2}{14}$, and $\frac{2}{28}$: 28 is evenly divisible by 7 and 14; therefore 28 is the LCD.

PRACTICE PROBLEMS

Circle the fraction with the least value in each of the following sets.

1. $\frac{6}{30}$ $\frac{4}{5}$
2. $\frac{5}{4}$ $\frac{6}{8}$
3. $\frac{1}{75}$ $\frac{1}{100}$ $\frac{1}{150}$
4. $\frac{6}{18}$ $\frac{7}{18}$ $\frac{8}{18}$
5. $\frac{4}{5}$ $\frac{17}{85}$ $\frac{3}{5}$
6. $\frac{4}{8}$ $\frac{1}{8}$ $\frac{3}{8}$
7. $\frac{1}{40}$ $\frac{1}{10}$ $\frac{1}{5}$
8. $\frac{1}{300}$ $\frac{1}{200}$ $\frac{1}{175}$
9. $\frac{4}{24}$ $\frac{5}{24}$ $\frac{10}{24}$
10. $\frac{4}{3}$ $\frac{1}{2}$ $\frac{1}{6}$

Circle the fraction with the greater value in each of the following sets.

11. $\frac{6}{8}$ $\frac{5}{9}$
12. $\frac{7}{6}$ $\frac{2}{3}$
13. $\frac{1}{72}$ $\frac{6}{12}$ $\frac{1}{24}$
14. $\frac{1}{10}$ $\frac{1}{6}$ $\frac{1}{8}$
15. $\frac{1}{75}$ $\frac{1}{125}$ $\frac{1}{225}$
16. $\frac{2}{5}$ $\frac{6}{5}$ $\frac{3}{5}$
17. $\frac{1}{8}$ $\frac{4}{6}$ $\frac{1}{4}$
18. $\frac{7}{9}$ $\frac{5}{9}$ $\frac{8}{9}$
19. $\frac{1}{10}$ $\frac{1}{50}$ $\frac{1}{150}$
20. $\frac{2}{15}$ $\frac{1}{15}$ $\frac{6}{15}$

Answers on p. 21

Reducing Fractions

Fractions should always be reduced to their lowest terms.

RULE

To reduce a fraction to its lowest terms, the numerator and denominator are each divided by the largest number by which they are both evenly divisible.

Example 1: Reduce the fraction $\frac{6}{20}$.

Solution: Both numerator and denominator are evenly divisible by 2.

$$\frac{6}{20} \div \frac{2}{2} = \frac{3}{10}$$

$$\frac{6}{20} = \frac{3}{10}$$

Example 2: Reduce the fraction $\frac{75}{100}$.

Solution: Both numerator and denominator are evenly divisible by 25.

$$\frac{75}{100} \div \frac{25}{25} = \frac{3}{4}$$

$$\frac{75}{100} = \frac{3}{4}$$

PRACTICE **PROBLEMS**

Reduce the following fractions to their lowest terms.

21. $\frac{10}{15} =$ _____
22. $\frac{7}{49} =$ _____
23. $\frac{64}{128} =$ _____
24. $\frac{100}{150} =$ _____
25. $\frac{20}{28} =$ _____
26. $\frac{14}{98} =$ _____
27. $\frac{10}{18} =$ _____
28. $\frac{24}{36} =$ _____
29. $\frac{10}{50} =$ _____
30. $\frac{9}{27} =$ _____
31. $\frac{9}{9} =$ _____
32. $\frac{15}{45} =$ _____
33. $\frac{124}{155} =$ _____
34. $\frac{12}{18} =$ _____
35. $\frac{36}{64} =$ _____

Answers on p. 21

Adding Fractions

RULE

To add fractions with the same denominator, add the numerators, place the sum over the denominator, and reduce to lowest terms.

Example 1: $\frac{1}{6} + \frac{4}{6} = \frac{5}{6}$

Example 2: $\frac{1}{6} + \frac{3}{6} + \frac{4}{6} = \frac{8}{6}$

$$\frac{8}{6} = \frac{4}{3} = 1\frac{1}{3}$$

NOTE

In addition to reducing to lowest terms in Example 2, the improper fraction was changed to a mixed number.

RULE

To add fractions with different denominators, change fractions to their equivalent fraction with the lowest common denominator, add the numerators, write the sum over the common denominator, and reduce if necessary.

Example 1: $\frac{1}{4} + \frac{1}{3}$

Solution: The lowest common denominator is 12. Change to equivalent fractions.

$$\begin{array}{r} \frac{1}{4} = \frac{3}{12} \\ +\frac{1}{3} = \frac{4}{12} \\ \hline \frac{7}{12} \end{array}$$

Example 2: $\frac{1}{2} + 1\frac{1}{3} + \frac{2}{4}$

Solution: Change the mixed number $1\frac{1}{3}$ to $\frac{4}{3}$. Find the lowest common denominator, change fractions to equivalent fractions, add, and reduce if necessary. The lowest common denominator is 12.

$$\begin{array}{r} \frac{1}{2} = \frac{6}{12} \\ \frac{4}{3} = \frac{16}{12} \\ +\frac{2}{4} = \frac{6}{12} \\ \hline \frac{28}{12} = 2\frac{4}{12} = 2\frac{1}{3} \end{array}$$

Subtracting Fractions

RULE

To subtract fractions with the same denominator, subtract the numerators, and place this amount over the denominator. Reduce to lowest terms if necessary.

Example 1: $\frac{5}{4} - \frac{3}{4} = \frac{2}{4} = \frac{1}{2}$

Example 2: $2\frac{1}{6} - \frac{5}{6}$

Solution: Change the mixed number $2\frac{1}{6}$ to $\frac{13}{6}$

$$\frac{13}{6} - \frac{5}{6} = \frac{8}{6} = \frac{4}{3} = 1\frac{1}{3}$$

RULE

To subtract fractions with different denominators, find the lowest common denominator, change to equivalent fractions, subtract the numerators, and place the sum over the common denominator. Reduce to lowest terms if necessary.

Example 3: $\frac{15}{6} - \frac{3}{5}$

Solution: The lowest common denominator is 30. Change to equivalent fractions, and subtract.

$$\begin{array}{r} \frac{15}{6} = \frac{75}{30} \\ -\frac{3}{5} = \frac{18}{30} \\ \hline \frac{57}{30} = 1\frac{27}{30} = 1\frac{9}{10} \end{array}$$

Example 4: $2\frac{1}{5} - \frac{4}{3}$

Solution: Change the mixed number $2\frac{1}{5}$ to $\frac{11}{5}$. Find the lowest common denominator, change to equivalent fractions, subtract, and reduce if necessary.
The lowest common denominator is 15.

$$\begin{array}{r} \frac{11}{5} = \frac{33}{15} \\ -\frac{4}{3} = \frac{20}{15} \\ \hline \frac{13}{15} \end{array}$$

Subtracting a Fraction From a Whole Number

RULE

To subtract a fraction from a whole number, follow these steps:

1. Borrow 1 from the whole number and change it to a fraction, creating a mixed number.
2. Change the fraction so that it has the same denominator as the fraction to be subtracted.
3. Subtract the fraction from the mixed number.
4. Reduce if necessary.

Example 1: Subtract $\frac{7}{12}$ from 6.

$$\begin{array}{r} 6 = 5 + \frac{\mathbf{1}}{1} = 5\frac{\mathbf{12}}{12} \\ -\frac{\mathbf{7}}{12} = \frac{7}{12} \\ \hline 5\frac{\mathbf{5}}{\mathbf{12}} \end{array}$$

Subtracting Fractions Using Borrowing

RULE

To subtract fractions using borrowing, use the following steps:

1. Change both fractions to the same denominator if necessary.
2. Borrow 1 from the whole number and change it to the same denominator as the fraction in the mixed number. Add the two fractions together.
3. Subtract the fractions and the whole numbers.
4. Reduce if necessary.

Example 2: $5\frac{1}{4} - 3\frac{3}{4}$

In the above example, because $\frac{3}{4}$ is larger than $\frac{1}{4}$, subtraction of the fractions is not possible. Both fractions have the same denominator; no changes need to be made. Therefore borrow 1 from the whole number part (5), and add the 1 to the fractional part $\left(\frac{1}{4}\right)$.

This results in

$$5\frac{1}{4} = 4 + \frac{1}{1} + \frac{1}{4} = 4 + \frac{4}{4} + \frac{1}{4} = 4\frac{5}{4}$$

$$5\frac{1}{4} = 4\frac{5}{4}$$

$$\underline{-3\frac{3}{4} = 3\frac{3}{4}}$$

$$1\frac{5-3}{4} = 1\frac{2}{4} = 1\frac{1}{2}$$

Example 3: Subtract $4\frac{3}{4}$ from $9\frac{2}{3}$.

Both fractions need to be changed to the same denominator of 12:

$$9\frac{2}{3} = 9\frac{8}{12} \text{ and } 4\frac{3}{4} = 4\frac{9}{12}$$

Subtraction of the fractions is not possible because $\frac{9}{12}$ is larger than $\frac{8}{12}$.

Therefore borrow 1 from 9.

$$9\frac{8}{12} = 8 + \frac{1}{1} + \frac{8}{12} = 8 + \frac{12}{12} + \frac{8}{12} = 8\frac{20}{12}$$

Now subtract:

$$9\frac{2}{3} = 9\frac{8}{12} = 8\frac{20}{12}$$

$$\underline{-4\frac{3}{4} = 4\frac{9}{12} = 4\frac{9}{12}}$$

$$4\frac{11}{12}$$

Multiplying Fractions

RULE

1. Cancel terms if possible.
2. Multiply the numerators, multiply the denominators.
3. Reduce the result (product) to the lowest terms, if necessary.

Notice in this example that the numerator and denominator of any of the fractions involved in multiplication may be cancelled when they can be divided by the same number (cross-cancellation).

Example 1: $\frac{3}{\cancel{4}_{2}} \times \frac{\overset{1}{\cancel{2}}}{5} = \frac{3}{10}$

Example 2: $\frac{2}{4} \times \frac{3}{4}$

Solution: Reduce $\frac{2}{4}$ to $\frac{1}{2}$ and then multiply.

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

Example 3: $6 \times \frac{5}{6}$

$$\frac{\overset{1}{\cancel{6}}}{1} \times \frac{5}{\cancel{6}_{1}} = 5$$

or

$$\frac{6 \times 5}{6} = \frac{30}{6} = 5$$

Example 4: $3\frac{1}{3} \times 2\frac{1}{2}$

Solution: Change mixed numbers to improper fractions. Proceed with multiplication.

$$3\frac{1}{3} = \frac{10}{3}; 2\frac{1}{2} = \frac{5}{2}$$

$$\frac{10}{3} \times \frac{5}{2} = \frac{50}{6} = 8\frac{2}{6} = 8\frac{1}{3}$$

or

$$\frac{\overset{5}{\cancel{10}}}{3} \times \frac{5}{\cancel{2}_{1}} = \frac{25}{3} = 8\frac{1}{3}$$

Dividing Fractions

RULE

1. To divide fractions, invert (turn upside down) the second fraction (divisor); change ÷ to ×.
2. Cancel terms, if possible.
3. Multiply fractions.
4. Reduce where necessary.

Example 1: $\frac{3}{4} \div \frac{2}{3}$

Solution: $\frac{3}{4} \times \frac{3}{2} = \frac{9}{8} = 1\frac{1}{8}$

Example 2: $1\frac{3}{5} \div 2\frac{1}{10}$

Solution: Change mixed numbers to improper fractions. Proceed with steps of division.

$$1\frac{3}{5} = \frac{8}{5}; 2\frac{1}{10} = \frac{21}{10}$$

$$\frac{\overset{1}{\cancel{8}}}{\cancel{5}_{1}} \times \frac{\overset{2}{\cancel{10}}}{21} = \frac{16}{21}$$

Example 3: $5 \div \frac{1}{2}$

Solution: $5 \times \frac{2}{1} = \frac{10}{1} = 10$

or

$$\frac{5}{1} \times \frac{2}{1} = \frac{10}{1} = 10$$

With dosage calculations that involve division, the fractions may be written as follows: $\frac{1/4}{1/2}$. In this case, $\frac{1}{4}$ is the numerator and $\frac{1}{2}$ is the denominator. Therefore the problem is set up as: $\frac{1}{4} \div \frac{1}{2}$, which becomes $\frac{1}{\cancel{4}_{2}} \times \frac{\overset{1}{\cancel{2}}}{1} = \frac{1}{2}$.

PRACTICE **PROBLEMS**

Change the following improper fractions to mixed numbers, and reduce to lowest terms.

36. $\frac{18}{5} =$ _____

37. $\frac{60}{14} =$ _____

38. $\frac{13}{8} =$ _____

39. $\frac{35}{12} =$ _____

40. $\frac{112}{100} =$ _____

Change the following mixed numbers to improper fractions.

41. $1\frac{4}{25} =$ _____

42. $4\frac{2}{8} =$ _____

43. $4\frac{1}{2} =$ _____

44. $3\frac{3}{8} =$ _____

45. $15\frac{4}{5} =$ _____

Add the following fractions and mixed numbers, and reduce fractions to lowest terms.

46. $\frac{2}{3} + \frac{5}{6} =$ _____

47. $2\frac{1}{8} + \frac{2}{3} =$ _____

48. $2\frac{3}{10} + 4\frac{1}{5} + \frac{2}{3} =$ _____

49. $7\frac{2}{5} + \frac{2}{3} =$ _____

50. $12\frac{1}{2} + 10\frac{1}{3} =$ _____

Subtract and reduce fractions to lowest terms.

51. $\frac{4}{3} - \frac{3}{7} =$ _____

52. $3\frac{3}{8} - 1\frac{3}{5} =$ _____

53. $\frac{15}{16} - \frac{1}{4} =$ _____

54. $2\frac{5}{6} - 2\frac{3}{4} =$ _____

55. $\frac{1}{8} - \frac{1}{12} =$ _____

56. $14 - \frac{5}{9} =$ _____

57. $3\frac{3}{10} - 1\frac{7}{10} =$ _____

Multiply the following fractions and mixed numbers, and reduce to lowest terms.

58. $\frac{2}{3} \times \frac{4}{5} =$ _____

59. $\frac{6}{25} \times \frac{3}{5} =$ _____

60. $\frac{1}{50} \times 3 =$ _____

61. $2\frac{5}{8} \times 2\frac{3}{4} =$ _____

62. $\frac{5}{12} \times \frac{4}{9} =$ _____

Divide the following fractions and mixed numbers, and reduce to lowest terms.

63. $2\frac{6}{8} \div 1\frac{2}{3} =$ _____

64. $\frac{1}{60} \div \frac{1}{2} =$ _____

65. $6 \div \frac{2}{5} =$ _____

66. $\frac{7}{8} \div \frac{7}{8} =$ _____

67. $3\frac{1}{3} \div 1\frac{7}{12} =$ _____

Answers on p. 21

CHAPTER REVIEW

Change the following improper fractions to mixed numbers, and reduce to lowest terms.

1. $\frac{10}{8} =$ _____

2. $\frac{30}{4} =$ _____

3. $\frac{67}{10} =$ _____

4. $\frac{11}{4} =$ _____

5. $\frac{64}{15} =$ _____

6. $\frac{100}{13} =$ _____

Change the following mixed numbers to improper fractions.

7. $7\frac{3}{8} =$ _____

8. $8\frac{4}{10} =$ _____

9. $3\frac{1}{5} =$ _____

10. $12\frac{3}{4} =$ _____

11. $6\frac{5}{7} =$ _____

Add the following fractions and mixed numbers. Reduce to lowest terms.

12. $\frac{2}{5} + \frac{1}{3} + \frac{7}{10} =$ _____

13. $\frac{1}{4} + \frac{1}{6} + \frac{1}{8} =$ _____

14. $6\frac{1}{4} + \frac{2}{9} + \frac{1}{36} =$ _____

15. $10\frac{1}{6} + 12\frac{4}{6} =$ _____

16. $1\frac{4}{5} + 7\frac{9}{10} + 3\frac{1}{2} =$ _____

Subtract the following fractions and mixed numbers. Reduce to lowest terms.

17. $2\frac{1}{4} - 1\frac{1}{2} =$ _____

18. $\frac{4}{5} - \frac{1}{6} =$ _____

19. $\frac{4}{5} - \frac{1}{4} =$ _____

20. $4\frac{1}{6} - 1\frac{1}{3} =$ _____

21. $\frac{8}{5} - \frac{1}{3} =$ _____

22. $\frac{5}{6} - \frac{7}{12} =$ _____

23. $48\frac{6}{11} - 24 =$ _____

24. $39\frac{11}{18} - 8\frac{3}{6} =$ _____

Multiply the following fractions and mixed numbers. Reduce to lowest terms.

25. $\frac{1}{3} \times \frac{4}{12} =$ _____

26. $2\frac{7}{8} \times 3\frac{1}{4} =$ _____

27. $36 \times \frac{3}{4} =$ _____

28. $\frac{5}{4} \times \frac{2}{4} =$ _____

29. $\frac{10}{25} \times \frac{5}{3} =$ _____

30. $\frac{1}{2} \times \frac{3}{4} \times \frac{3}{5} =$ _____

31. $\frac{3}{5} \times 3\frac{1}{8} =$ _____

32. $2\frac{2}{5} \times 4\frac{1}{6} =$ _____

33. $2 \times 4\frac{3}{8} =$ _____

34. $\frac{2}{5} \times \frac{5}{4} =$ _____

Divide the following fractions and mixed numbers. Reduce to lowest terms.

35. $2\frac{1}{3} \div 4\frac{1}{6} =$ _____

36. $25 \div 12\frac{1}{2} =$ _____

37. $\frac{7}{8} \div 2\frac{1}{4} =$ _____

38. $\frac{4}{6} \div \frac{1}{2} =$ _____

39. $\frac{3}{10} \div \frac{5}{25} =$ _____

40. $3 \div \frac{2}{5} =$ _____

41. $\frac{15}{30} \div 10 =$ _____

42. $\frac{3}{4} \div \frac{3}{8} =$ _____

43. $12 \div \frac{2}{3} =$ _____

44. $\frac{7}{8} \div 14 =$ _____

45. $\frac{15}{8} \div 5 =$ _____

Arrange the following fractions in order from largest to the smallest.

46. $\frac{3}{16}, \frac{1}{16}, \frac{5}{16}, \frac{14}{16}, \frac{7}{16}$

47. $\frac{5}{12}, \frac{5}{32}, \frac{5}{8}, \frac{5}{6}, \frac{5}{64}$

Apply the principles of borrowing, and subtract the following:

48. $2 - \frac{10}{21} =$ _____

49. $9\frac{1}{4} - \frac{3}{4} =$ _____

50. $5\frac{1}{2} - 3\frac{3}{4} =$ _____

51. A client is instructed to drink 20 ounces of water within 1 hour. The client has only been able to drink 12 ounces. What portion of the water remains? (Express your answer as a fraction reduced to lowest terms.) _____

52. A child's oral Motrin Suspension contains 100 milligrams per teaspoonful. 20 milligrams represents what part of a dosage? _____

53. A client is receiving 240 milliliters of Ensure by mouth as a supplement. The client consumes 200 milliliters. What portion of the Ensure remains? (Express your answer as a fraction reduced to lowest terms.) _____

54. A client takes $1\frac{1}{2}$ tablets of medication four times per day for 4 days. How many tablets will the client have taken at the end of the 4 days? _____

55. A juice glass holds 120 milliliters. If a client drinks $2\frac{1}{3}$ glasses, how many milliliters did the client consume? _____

56. On admission a client weighed $150\frac{3}{4}$ lb. On discharge the client weighed $148\frac{1}{2}$ lb. How much weight did the client lose? _____

57. How many hours are there in $3\frac{1}{2}$ days? _____

58. A client consumed the following: $2\frac{1}{4}$ ounces of tea, $\frac{1}{3}$ ounce of juice, $1\frac{1}{2}$ ounces of Jell-O. What is the total number of ounces consumed by the client?
_____

59. One tablet contains 200 milligrams of pain medication.

How many milligrams are in $3\frac{1}{2}$ tablets? _____

60. A bottle of medicine contains 30 doses. How many doses are in $2\frac{1}{2}$ bottles? _____

61. The nurse gave a client $\frac{3}{4}$ tablespoons (tbs) of medication with breakfast, $\frac{1}{2}$ tbs at lunch, $\frac{1}{2}$ tbs at dinner, and $1\frac{1}{4}$ tbs at bedtime. How much medication did the nurse administer? _____

62. A client weighed $160\frac{1}{2}$ pounds (lb) at the previous visit to the doctor. At this visit, the client weighs $2\frac{3}{4}$ lb more. How many lb does the client weigh? _____

63. At the beginning of a shift there are $5\frac{1}{4}$ bottles of hand sanitizer available. At the end of the shift, $3\frac{1}{2}$ bottles are left. How much was used? _____

64. A client was given a 16-ounce container of water to drink throughout the day. If the client drank $\frac{7}{8}$ of the container, how many ounces did the client drink? _____

65. How many $1\frac{1}{2}$-ounce doses of medication are there in a 24-ounce bottle?
_____

66. A bottle contains 36 tablets. If a client took $\frac{1}{3}$ of the tablets, how many tablets are left? _____

67. A client drank $4\frac{3}{4}$ ounces of juice, $5\frac{1}{2}$ ounces of coffee, and $4\frac{1}{4}$ ounces of water. How much fluid did the client drink? _____

68. One tablet contains 400 milligrams of medication. A client was given $1\frac{1}{2}$ tablets for 5 days. How many milligrams of medication did the client receive in 5 days? _____

69. An order is written for a client to receive $1\frac{1}{2}$ ounces of a powdered medication dissolved in water. The client drank $\frac{3}{4}$ ounces of the medication. How much more medication must be given to the client? _____

70. An infant grew $\frac{3}{4}$ inch in the first month, $\frac{1}{2}$ inch in the second month, $\frac{7}{8}$ inch in the third month, and $1\frac{1}{8}$ inches in the fourth month. How many inches has the infant grown? _____

71. For 4 days a client received $2\frac{1}{2}$ ounces of medication 4 times per day. How many ounces did the client receive over 4 days? _____

72. A bottle contains 24 ounces of a liquid pain medication. If a typical dose is $\frac{3}{4}$ ounce, how many doses are there in the bottle? _____

73. A nurse worked $9\frac{3}{4}$ hours on Monday, $11\frac{1}{2}$ hours on Tuesday, and $10\frac{3}{4}$ hours on Wednesday. How many hours did she work for the 3 days? _____

74. A nurse needs $\frac{1}{2}$ hour to complete an intake interview form on each new client. How many intake interview forms can the nurse complete in $2\frac{1}{2}$ hours?
_____

75. A client drinks $\frac{3}{4}$ of a glass of juice that contains 180 milliliters. How many milliliters of juice did the client drink? _____

76. A client is instructed to drink the equivalent of 8 glasses of water daily. How many times will the client need to drink $\frac{1}{2}$ glass of water? _____

77. One tablet contains 150 milligrams of medication. How many milligrams are in $3\frac{1}{2}$ tablets? _____

78. A client at home was instructed to take $\frac{3}{4}$ ounce of medication with meals. The nurse learns that the client took $\frac{2}{3}$ ounce. Did the client take too little, too much, or just the right amount? _____

79. A client has taken $\frac{3}{4}$ of a bottle of tablets that contained 100 tablets. How many tablets has the client taken? _____

80. A client drank $3\frac{1}{2}$ cups of water from a cup that held 210 milliliters. How many milliliters did the client drink? _____

Answers on p. 22

ANSWERS

Chapter 1

Answers to Practice Problems

1. LCD = 30; therefore $\frac{6}{30}$ has the lesser value.
2. LCD = 8; therefore $\frac{6}{8}$ has the lesser value.
3. $\frac{1}{150}$ has the lesser value; the denominator (150) is larger.
4. $\frac{6}{18}$ has the lesser value; the numerator (6) is smaller.
5. $\frac{17}{85}$ has the lesser value; reduced to $\frac{1}{5}$; the numerator (1) is smaller.
6. $\frac{1}{8}$ has the lesser value; the numerator (1) is smaller.
7. $\frac{1}{40}$ has the lesser value; the denominator (40) is larger.
8. $\frac{1}{300}$ has the lesser value; the denominator (300) is larger.
9. $\frac{4}{24}$ has the lesser value; the numerator (4) is smaller.
10. LCD = 6; therefore $\frac{1}{6}$ has the lesser value.
11. LCD = 72; therefore $\frac{6}{8}$ has the higher value.
12. LCD = 6; therefore $\frac{7}{6}$ has the higher value.
13. LCD = 72; therefore $\frac{6}{12}$ has the higher value.
14. $\frac{1}{6}$ has the higher value; the denominator (6) is smaller.
15. $\frac{1}{75}$ has the higher value; the denominator (75) is smaller.
16. $\frac{6}{5}$ has the higher value; the numerator (6) is larger.
17. LCD = 24; therefore $\frac{4}{6}$ has the higher value.
18. $\frac{8}{9}$ has the higher value; the numerator (8) is larger.
19. $\frac{1}{10}$ has the higher value; the denominator (10) is smaller.
20. $\frac{6}{15}$ has the higher value; the numerator (6) is larger.
21. $\frac{10 \div 5}{15 \div 5} = \frac{2}{3}$
22. $\frac{7 \div 7}{49 \div 7} = \frac{1}{7}$
23. $\frac{64 \div 32}{128 \div 32} = \frac{2}{4} = \frac{1}{2}$
24. $\frac{100 \div 50}{150 \div 50} = \frac{2}{3}$
25. $\frac{20 \div 4}{28 \div 4} = \frac{5}{7}$
26. $\frac{14 \div 14}{98 \div 14} = \frac{1}{7}$
27. $\frac{10 \div 2}{18 \div 2} = \frac{5}{9}$
28. $\frac{24 \div 12}{36 \div 12} = \frac{2}{3}$
29. $\frac{10 \div 10}{50 \div 10} = \frac{1}{5}$
30. $\frac{9 \div 9}{27 \div 9} = \frac{1}{3}$
31. $\frac{9 \div 9}{9 \div 9} = \frac{1}{1} = 1$
32. $\frac{15 \div 15}{45 \div 15} = \frac{1}{3}$
33. $\frac{124 \div 31}{155 \div 31} = \frac{4}{5}$
34. $\frac{12 \div 6}{18 \div 6} = \frac{2}{3}$
35. $\frac{36 \div 4}{64 \div 4} = \frac{9}{16}$
36. $3\frac{3}{5}$
37. $4\frac{2}{7}$
38. $1\frac{5}{8}$
39. $2\frac{11}{12}$
40. $1\frac{3}{25}$
41. $\frac{29}{25}$
42. $\frac{34}{8}$
43. $\frac{9}{2}$
44. $\frac{27}{8}$
45. $\frac{79}{5}$
46. $1\frac{1}{2}$
47. $2\frac{19}{24}$
48. $7\frac{1}{6}$
49. $8\frac{1}{15}$
50. $22\frac{5}{6}$
51. $\frac{19}{21}$
52. $1\frac{31}{40}$
53. $\frac{11}{16}$
54. $\frac{1}{12}$
55. $\frac{1}{24}$
56. $13\frac{4}{9}$
57. $1\frac{3}{5}$
58. $\frac{8}{15}$
59. $\frac{18}{125}$
60. $\frac{3}{50}$
61. $7\frac{7}{32}$
62. $\frac{5}{27}$
63. $1\frac{13}{20}$
64. $\frac{1}{30}$
65. 15
66. 1
67. $2\frac{2}{19}$

Answers to Chapter Review

1. $1\frac{2}{8} = 1\frac{1}{4}$
2. $7\frac{2}{4} = 7\frac{1}{2}$
3. $6\frac{7}{10}$
4. $2\frac{3}{4}$
5. $4\frac{4}{15}$
6. $7\frac{9}{13}$
7. $\frac{59}{8}$
8. $\frac{84}{10}$
9. $\frac{16}{5}$
10. $\frac{51}{4}$
11. $\frac{47}{7}$
12. LCD = 30; $1\frac{13}{30}$
13. LCD = 24; $\frac{13}{24}$
14. LCD = 36; $\frac{234}{36} = 6\frac{18}{36} = 6\frac{1}{2}$
15. $22\frac{5}{6}$
16. LCD = 10; $13\frac{2}{10} = 13\frac{1}{5}$
17. LCD = 4; $\frac{3}{4}$
18. LCD = 30; $\frac{19}{30}$
19. LCD = 20; $\frac{11}{20}$
20. LCD = 6; $\frac{17}{6} = 2\frac{5}{6}$
21. LCD = 15; $\frac{19}{15} = 1\frac{4}{15}$
22. LCD = 12; $\frac{3}{12} = \frac{1}{4}$
23. $24\frac{6}{11}$
24. LCD = 18; $31\frac{1}{9}$
25. $\frac{4}{36} = \frac{1}{9}$
26. $9\frac{11}{32}$
27. 27
28. $\frac{10}{16} = \frac{5}{8}$
29. $\frac{50}{75} = \frac{2}{3}$
30. $\frac{9}{40}$
31. $1\frac{7}{8}$
32. 10
33. $8\frac{3}{4}$
34. $\frac{1}{2}$
35. $\frac{42}{75} = \frac{14}{25}$
36. 2
37. $\frac{7}{18}$
38. $1\frac{1}{3}$
39. $1\frac{25}{50} = 1\frac{1}{2}$
40. $7\frac{1}{2}$
41. $\frac{15}{300} = \frac{1}{20}$
42. 2
43. 18
44. $\frac{1}{16}$
45. $\frac{3}{8}$
46. $\frac{14}{16}, \frac{7}{16}, \frac{5}{16}, \frac{3}{16}, \frac{1}{16}$
47. $\frac{5}{6}, \frac{5}{8}, \frac{5}{12}, \frac{5}{32}, \frac{5}{64}$
48. $1\frac{11}{21}$
49. $8\frac{2}{4} = 8\frac{1}{2}$
50. $1\frac{3}{4}$
51. $\frac{2}{5}$ of water remains
52. $\frac{1}{5}$ the dosage
53. $\frac{1}{6}$ of Ensure remains
54. 24 tablets
55. 280 milliliters
56. $2\frac{1}{4}$ lb
57. 84 hours
58. $4\frac{1}{12}$ ounces
59. 700 milligrams
60. 75 doses
61. 3 tbs
62. $163\frac{1}{4}$ lb
63. $1\frac{3}{4}$ bottles
64. 14 ounces
65. 16 ($1\frac{1}{2}$ ounce doses in the bottle)
66. 24 tablets
67. $14\frac{1}{2}$ ounces
68. 3,000 milligrams
69. $\frac{3}{4}$ ounce
70. $3\frac{1}{4}$ inches
71. 40 ounces
72. 32 ($\frac{3}{4}$ ounce doses in the bottle)
73. 32 hours
74. 5 interview forms
75. 135 milliliters
76. 16 times
77. 525 milligrams
78. Too little
79. 75 tablets
80. 735 milliliters

CHAPTER 2
Decimals

Objectives

After reviewing this chapter, you should be able to:

1. Read decimals
2. Write decimals
3. Compare the size of decimals
4. Convert fractions to decimals
5. Convert decimals to fractions
6. Add decimals
7. Subtract decimals
8. Multiply decimals
9. Divide decimals
10. Round decimals to the nearest tenth
11. Round decimals to the nearest hundredth

Medication dosages and other measurements in the health care system use metric measures, which are based on the decimal system. An understanding of decimals is crucial to the calculation of dosages. In the administration of medications, nurses calculate dosages that contain decimals in addition to encountering labels that may have dosage strengths expressed as decimals. Some examples include Coreg, terbutaline, Flomax, and clonidine. See example labels in Figures 2.1 and 2.2 with dosage strengths expressed in decimal format.

Decimal points in dosages have been cited as a major source of medication errors. A misunderstanding of the value of a dosage expressed as a decimal or the omission of a decimal point can result in a serious medication error. Decimals should be written with great care to prevent misinterpretation of a value. A clear understanding of the importance of decimal points and their value will assist the nurse in the prevention of medication errors.

A decimal is a fraction that has a denominator that is a multiple of 10. A decimal fraction is written as a decimal by the use of a decimal point (.). The decimal point is used to indicate place value. Some examples are as follows:

Fraction	Decimal Number
$\frac{3}{10}$	0.3
$\frac{18}{100}$	0.18
$\frac{175}{1{,}000}$	0.175

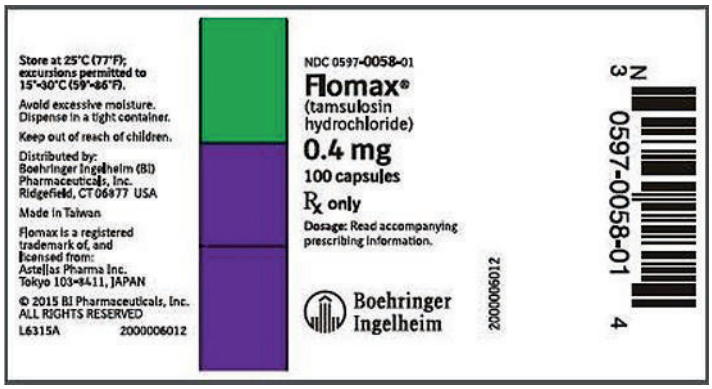

Figure 2.1 Flomax, each capsule is 0.4 mg.

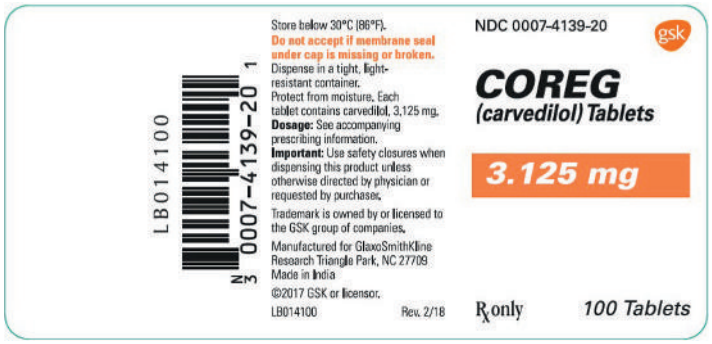

Figure 2.2 Coreg, each tablet is 3.125 mg.

The decimal point represents the center that separates whole and fractional amounts. The position of the numbers in relation to the decimal point indicates the place of value of numbers.

- The whole number is placed to the **left** of the decimal point. These numbers have a value of one (1) or greater.
- Decimal fractions are written to the **right** of the decimal point and represent a value that is less than one (1) or part of one. The words for all decimal fractions end in *-th(s)*.

The easiest way to understand decimals is to memorize the place values (Box 2.1).

BOX 2.1 Decimal Place Values

The decimal value is determined by its position to the right of the decimal point.

(100,000)	(10,000)	(1,000)	(100)	(10)	(1)	Decimal point	(0.1)	(0.01)	(0.001)	(0.0001)	(0.00001)
Hundred-thousands	Ten-thousands	Thousands	Hundreds	Tens	Ones (Units)	↓	Tenths	Hundredths	Thousandths	Ten-thousandths	Hundred-thousandths
6	5	4	3	2	1	.	1	2	3	4	5
Whole Numbers to the Left							Decimal Numbers to the Right				

Example 1: 0.3 = three tenths

Example 2: 0.03 = three hundredths

Example 3: 0.003 = three thousandths

SAFETY ALERT!

When there is no whole number before a decimal point, place a zero (0) to the left of the decimal point to emphasize that the number is a decimal fraction and has a value less than 1. This will emphasize its value and prevent errors in interpretation and avoid errors in dosage calculation. This zero does not change the value of the number. This has been emphasized by the Institute for Safe Medication Practices (ISMP) and is a requirement of the accrediting body for health care organizations, The Joint Commission (TJC), when writing decimal fractions in medical notation and is part of TJC's official "Do Not Use" list.

The source of many medication errors is misplacement of a decimal point or incorrect interpretation of a decimal value.

Reading and Writing Decimals

RULE

To read the decimal numbers, read:

1. The whole number
2. The decimal point as "and"
3. The decimal fraction by naming the value of the last decimal place

Notice that the words for all decimal fractions end in *-th(s)*.

Example 1: The decimal number 1.125 is read as "one and one hundred twenty-five thousandths."

Example 2: The number 12.5 is read as "twelve and five tenths."

Example 3: The number 10.03 is read as "ten and three hundredths."

RULE

When reading decimal numbers in which a zero is placed before the decimal, such as in a decimal fraction (whose value is less than 1), read the number alone, without stating the zero.

Example 1: The number 0.4 is read as "four tenths."

Example 2: The number 0.175 is read as "one hundred seventy-five thousandths."

TIPS FOR CLINICAL PRACTICE

An exception to this is in an emergency situation when a nurse must take a verbal order over the phone from a prescriber. When repeating back an order for a medication involving a decimal, the zero should be read aloud to prevent a medication error.

Example: "Zero point 4" would be the verbal interpretation of Example 1 and "zero point 175" of Example 2. In addition to repeating the order back, the receiver of the order should write down the complete order or enter it into a computer, then read it back, and receive confirmation of the order from the individual giving the order.

RULE

To write a decimal number, write the following:

1. The whole number (If there is no whole number, write zero [0] to the left of the decimal.)
2. The decimal point to indicate the place value of the rightmost number
3. The decimal portion of the number to the right of the decimal

Example 1: Written, seven and five tenths = 7.5

Example 2: Written, one hundred twenty-five thousandths = 0.125

Example 3: Written, five tenths = 0.5

RULE

When writing decimals, placing a zero after the last digit of a decimal fraction does not change its value and is not necessary.

Example: 0.37 = 0.370

SAFETY ALERT!

When writing decimals, trailing zeros should not be placed at the end of the number to avoid misinterpretation of a value. This is also a recommendation of the Institute for Safe Medication Practices (ISMP) and is a part of The Joint Commission's (TJC) official "Do Not Use" List. TJC forbids the use of trailing zeros for medication orders or other medication-related documentation. Omitting trailing zeros decreases the potential for giving a client 10 times the ordered dose or more. Exception: A trailing zero may be used only when required to demonstrate the level of precision of the value being reported, such as for laboratory results, imaging studies that report the size of lesions, or catheter/tube sizes.

Because the last zero does not change the value of the decimal, it is not necessary. For example, the required notation is 0.37, not 0.370, and 30, not 30.0, which could be interpreted as 370 and 300, respectively, if the decimal point is not clear or is missed.

RULE

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

Example 1: 0.375 ≠ (is not equal to) 0.0375

Example 2: 2.025 ≠ 20.025

However, .7 = 0.7 and 15 = 15.0, but you should write 0.7 (with a leading zero) and 15 (without a trailing zero).

PRACTICE **PROBLEMS**

Write each of the following numbers in word form.

1. 8.35 _____
2. 11.001 _____
3. 4.57 _____
4. 5.0007 _____
5. 10.5 _____
6. 0.163 _____

Write each of the following in decimal form.

7. four tenths _____

8. eighty-four and seven hundredths _____

9. seven hundredths _____

10. two and twenty-three hundredths _____

11. five hundredths _____

12. nine thousandths _____

Answers on p. 39

Comparing the Value of Decimals

It is essential to be able to compare decimal amounts and know which has the greater or lesser value in the calculation of dosages. This helps prevent errors in dosage and gives the nurse an understanding of the size of a dosage (i.e., 0.5 mg, 0.05 mg).

SAFETY ALERT!

Understanding the value of decimals helps ensure accuracy and prevents misinterpretation of values. There is an appreciable difference between 0.5 milligram (mg) and 0.05 milligram. In fact, 0.5 mg is 10 times larger than 0.05 mg. In dosage calculations, a misinterpretation of the value of decimals can result in serious consequences.

RULE

When decimal numbers contain whole numbers, the whole numbers are compared to determine which is greater.

Example 1: 4.8 is greater than 2.9

Example 2: 11.5 is greater than 7.5

Example 3: 7.37 is greater than 6.94

RULE

If the whole numbers being compared are the **same** (e.g., 5.6 and 5.2) or if there is **no whole number** (e.g., 0.45 and 0.37), then the number in the **tenths** place determines which decimal is greater.

Example 1: 0.45 is greater than 0.37

Example 2: 1.75 is greater than 1.25

RULE

If the whole numbers are the same or zero and the numbers in the **tenths place** are the **same**, then the decimal with the higher number in the **hundredths place** has the greater value, and so forth.

Example 1: 0.67 is greater than 0.66

Example 2: 0.17 is greater than 0.14

PRACTICE **PROBLEMS**

Circle the decimal with the largest value in the following:

13.	0.5	0.15	0.05	16.	0.175	0.1	0.05
14.	2.66	2.36	2.87	17.	7.02	7.15	7.35
15.	0.125	0.375	0.25	18.	0.067	0.087	0.077

Answers on p. 39

Adding and Subtracting Decimals

RULE

To add or subtract decimals, place the numbers in columns so that the decimal points are lined up directly under one another and add or subtract from right to left. Zeros may be added at the end of the decimal fraction, making all decimals of equal length, but unnecessary zeros should be eliminated in the final answer.

SAFETY ALERT!

Eliminate unnecessary zeros in the final answer to avoid confusion and prevent errors in misinterpretation of values.

Example 1: Add 16.4 + 21.8 + 13.2

$$\begin{array}{r} 16.4 \\ 21.8 \\ +\,13.2 \\ \hline 51.4 \end{array} = 51.4$$

Example 2: Add 2.25 + 1.75

$$\begin{array}{r} 2.25 \\ +\,1.75 \\ \hline 4.00 \end{array} = 4$$

Example 3: Subtract 2.6 from 18.6

$$\begin{array}{r} 18.6 \\ -\,2.6 \\ \hline 16.0 \end{array} = 16$$

Example 4: Add 11.2 + 16

$$\begin{array}{r} 11.2 \\ +\,16.0 \\ \hline 27.2 \end{array} = 27.2$$

Example 5: Subtract 3.78 from 12.84

$$\begin{array}{r} 12.84 \\ -\,3.78 \\ \hline 9.06 \end{array} = 9.06$$

Example 6: Subtract 0.007 from 0.05

$$\begin{array}{r} 0.050 \\ -\,0.007 \\ \hline 0.043 \end{array} = 0.043$$

Example 7: Add 6.54 + 2.26

$$\begin{array}{r} 6.54 \\ +\,2.26 \\ \hline 8.80 \end{array} = 8.8$$

Example 8: Add 0.7 + 0.75 + 0.23 + 2.324

$$\begin{array}{r} 0.700 \\ 0.750 \\ 0.230 \\ +\,2.324 \\ \hline 4.004 \end{array} = 4.004$$

Example 9: Subtract 0.2 from 0.375

$$\begin{array}{r} 0.375 \\ -\,0.200 \\ \hline 0.175 \end{array} = 0.175$$

PRACTICE **PROBLEMS**

Add the following decimals.

19. 4.7 + 5.3 + 8.4 = _____

20. 38.52 + 0.029 + 1.9 = _____

21. 0.7 + 3.25 = _____

22. 2.2 + 1.67 = _____

Subtract the following decimals.

23. 3.67 − 0.75 = _____

24. 64.3 − 21.2 = _____

25. 0.08 − 0.045 = _____

26. 6.75 − 0.87 = _____

Answers on p. 39

Multiplying Decimals

RULE

To multiply decimals, multiply as with whole numbers. In the answer (product), count off from right to left as many decimal places as there are in the numbers being multiplied. Zeros may also be added to the left if necessary.

Example 1: 1.2 × 3.2

$$\begin{array}{rl} 1.2 & \text{(1 decimal place)} \\ \times\,3.2 & \text{(1 decimal place)} \\ \hline 24 & \\ 36 & \\ \hline 384. & \end{array}$$

Answer: 3.84

In Example 1, 1.2 has one number after the decimal, and 3.2 also has one. Therefore you will need to place the decimal point two places to the left in the answer (product).

RULE

When there are insufficient numbers in the answer for correct placement of the decimal point, add as many zeros as needed to the left of the answer.

Example 2: 1.35×0.65

$$\begin{array}{rl} 1.35 & \text{(2 decimal places)} \\ \times 0.65 & \text{(2 decimal places)} \\ \hline 675 & \\ 810 & \\ \hline 8775. & \end{array}$$

Answer: 0.8775

In Example 2, 1.35 has two numbers after the decimal, and 0.65 also has two. Therefore you will need to place the decimal point four places to the left in the answer (product), and add a zero in front of the decimal point.

Example 3: 0.11×0.33

$$\begin{array}{rl} 0.11 & \text{(2 decimal places)} \\ \times 0.33 & \text{(2 decimal places)} \\ \hline 33 & \\ 33 & \\ \hline 0363. & \end{array}$$

Answer: 0.0363

In Example 3, four decimal places are needed (two numbers after each decimal in 0.11 and 0.33), but there are only three numbers in the product. A zero must be placed to the left of these numbers for correct placement of the decimal point. Place a zero before the decimal point.

Example 4: 1.6×0.05

$$\begin{array}{rl} 1.6 & \text{(1 decimal place)} \\ \times 0.05 & \text{(2 decimal places)} \\ \hline 080. & \end{array}$$

Answer: $0.080 = 0.08$

In Example 4, three decimal places are needed (1.6 has one number after the decimal and 0.05 has two), so a zero has to be placed between the decimal point and 8 to allow for enough places. The unnecessary zero is eliminated in the final answer, and a zero is placed before the decimal point.

Multiplication by Decimal Movement

RULE

This method may be preferred when doing metric conversions because it is based on the decimal system. Multiplying by 10, 100, 1,000, and so forth can be done by moving the decimal point to the right the same number of places as there are zeros in the number by which you are multiplying.

When multiplying by 10, move the decimal one place to the right; by 100, two places to the right; by 1,000, three places to the right; and so forth.

Example 1: $1.6 \times 10 = 16$ (The multiplier 10 has 1 zero; decimal point moved 1 place to the right.)

Example 2: $5.2 \times 100 = 520$ (The multiplier 100 has 2 zeros; decimal point moved 2 places to the right.)

Example 3: $0.463 \times 1{,}000 = 463$ (The multiplier 1,000 has 3 zeros; decimal point moved 3 places to the right.)

Example 4: $6.64 \times 10 = 66.4$ (The multiplier 10 has 1 zero; decimal point moved one place to the right.)

SAFETY ALERT!

When multiplying decimals, be sure the decimal is placed in the correct position in the answer (product). Misplacement of decimal points can lead to a critical medication error.

PRACTICE **PROBLEMS**

Multiply the following decimals.

27. $3.15 \times 0.015 =$ _____

28. $3.65 \times 0.25 =$ _____

29. $9.65 \times 1{,}000 =$ _____

30. $8.9 \times 0.2 =$ _____

31. $14.001 \times 7.2 =$ _____

Answers on p. 39

Dividing Decimals

Division of decimals is done in the same manner as division of whole numbers except for placement of the decimal point. Incorrect placement of the decimal point changes the numerical value and can cause errors in calculation. Errors made in the division of decimals are commonly caused by improper placement of the decimal point, incorrect placement of numbers in the quotient (answer), and omission of necessary zeros in the quotient.

The parts of a division problem are as follows:

$$\text{Divisor})\overline{\text{Quotient}}\text{Dividend}$$

The number being divided is called the **dividend,** the number being divided into the dividend is the **divisor,** and the answer is the **quotient.**

Symbols used to indicate division are as follows:

1. $)\overline{}$

   Example: $9)\overline{27}$ Read as 27 divided by 9.

2. $\div$

   Example: $27 \div 9$ Read as 27 divided by 9.

3. The horizontal bar with the dividend on the top and the divisor on the bottom

   Example: $\frac{27}{9}$ Read as 27 divided by 9.

4. The slanted bar with the dividend to the left and the divisor to the right

Example: $27/9$ Read as 27 divided by 9.

Dividing a Decimal by a Whole Number

RULE

To divide a decimal by a whole number, place the decimal point in the quotient directly above the decimal point in the dividend. Proceed to divide as with whole numbers.

Example: Divide 17.5 by 5

$$\begin{array}{r} 3.5 \\ 5\overline{)17.5} \\ -15 \\ \hline 25 \\ -25 \\ \hline 0 \end{array}$$

Answer: 3.5

Dividing a Decimal or a Whole Number by a Decimal

RULE

To divide by a decimal, the decimal point in the divisor is moved to the right until the number is a whole number. The decimal point in the dividend is moved the same number of places to the right, and zeros are added as necessary. Proceed to divide as with whole numbers.

Example: Divide 6.96 by 0.3

Step 1: $6.96 \div 0.3 = 0.3\overline{)6.96}$

$3\overline{)69.6}$ (after moving decimals in the divisor the same number of places as the dividend)

Step 2:

$$\begin{array}{r} 23.2 \\ 3\overline{)69.6} \\ -6 \\ \hline 9 \\ -9 \\ \hline 6 \\ -6 \\ \hline 0 \end{array}$$

Answer: 23.2

Division by Decimal Movement

RULE

To divide a decimal by 10, 100, or 1,000, move the decimal point to the **left** the same number of places as there are zeros in the divisor.

Example 1: $0.46 \div 10 = 0.046$ (The divisor 10 has 1 zero; the decimal point is moved 1 place to the left.)

Example 2: $0.07 \div 100 = 0.0007$ (The divisor 100 has 2 zeros; the decimal point is moved 2 places to the left.)

Example 3: 0.75 ÷ 1,000 = 0.00075 (The divisor 1,000 has 3 zeros; the decimal point is moved 3 places to the left.)

Rounding Off Decimals

NOTE

In some instances, such as critical care or pediatrics, it may be necessary to compute decimal calculations to thousandths (three decimal places) and round to hundredths (two decimal places). These areas may require this level of accuracy.

The determination of how many places to carry your division when calculating dosages is based on the equipment being used. Some syringes are marked in **tenths** and some in **hundredths.** As you become familiar with the equipment used in dosage calculation, you will learn how far to carry your division and when to round off. To ensure accuracy, most calculation problems require that you carry your division at least **two decimal places (hundredths place)** and **round off to the nearest tenth.**

RULE

To express an answer to the nearest tenth, carry the division to the hundredths place (two places after the decimal). If the number in the hundredths place **is 5 or greater,** add 1 to the tenths place. If the number **is less than 5,** drop the number to the right of the desired decimal place.

Example 1: Express 4.15 to the nearest tenth.

Answer: 4.2 (The number in the hundredths place is 5, so the number in the tenths place is **increased by one.** 4.1 becomes 4.2.)

Example 2: Express 1.24 to the nearest tenth.

Answer: 1.2 (The number in the hundredths place is less than 5, so the number in the **tenths place does not change.** The 4 is dropped.)

Example 3: Express 0.98 to the nearest tenth.

Answer: 1.0 = 1 (The number in the hundredths place is 8, so the number in the tenths place is **increased by one.** 0.9 becomes 1. The zero at the end of this decimal is dropped, because it is unnecessary and can cause potential confusion.)

RULE

To express an answer to the nearest hundredth, carry the division to the thousandths place (three places after the decimal). If the number in the thousandths place is **5 or greater,** add one to the hundredths place. If the number **is less than 5,** drop the number to the right of the desired decimal place.

Example 1: Express 0.176 to the nearest hundredth.

Answer: 0.18 (The number in the thousandths place is 6, so the number in the hundredths place is **increased by one.** 0.17 becomes 0.18.)

Example 2: Express 0.554 to the nearest hundredth.

Answer: 0.55 (The number in the thousandths place is less than 5, so the number in **the hundredths place does not change.**) The 4 is dropped.

Example 3: Express 0.40 to the nearest hundredth.

Answer: 0.4 (There is a 0 in the hundredths place. When this is rounded to the hundredths, the final zero should be dropped. It is not necessary to clarify the number and can cause potential confusion.)

PRACTICE **PROBLEMS**

Divide the following decimals. Carry division to the hundredths place where necessary. Do not round off.

32. $2 \div 0.5 =$ _____

33. $1.4 \div 1.2 =$ _____

34. $63.8 \div 0.9 =$ _____

35. $39.6 \div 1.3 =$ _____

36. $1.9 \div 3.2 =$ _____

Express the following decimals to the nearest tenth.

37. 3.57 _____

38. 0.95 _____

39. 1.98 _____

Express the following decimals to the nearest hundredth.

40. 3.550 _____

41. 0.607 _____

42. 0.738 _____

Divide the following decimals.

43. $0.005 \div 10 =$ _____

44. $0.004 \div 100 =$ _____

Multiply the following decimals.

45. $58.4 \times 10 =$ _____

46. $0.5 \times 1{,}000 =$ _____

Answers on p. 39

Changing Fractions to Decimals

RULE

To change a fraction to a decimal, divide the numerator by the denominator and add zeros as needed. If the numerator doesn't divide evenly into the denominator, carry division three places.

Example 1: $\frac{2}{5} = 5\overline{)2} = 5\overline{)2.0}^{\,0.4}$

Example 2: $\frac{3}{8} = 8\overline{)3} = 8\overline{)3.000}^{\,0.375}$

Changing fractions to decimals can also be a method of comparing fraction size. The fractions being compared are changed to decimals, and the rules relating to comparing decimals are then applied. (See Comparing the Value of Decimals, p. 27.)

Example: Which fraction is larger, $\frac{1}{3}$ or $\frac{1}{6}$?

Solution: $\frac{1}{3} = 0.333\ldots$ as a decimal

$\frac{1}{6} = 0.166\ldots$ as a decimal

Answer: $\frac{1}{3}$ is therefore the larger fraction.

Changing Decimals to Fractions

RULE

To convert a decimal to a fraction, write the decimal number as a whole number in the numerator of the fraction, and express the denominator of the fraction as a power of 10. Place the number 1 in the denominator of the fraction, and add as many zeros as there are places to the right of the decimal point. Reduce to lowest terms if necessary. (See Reading and Writing Decimals, p. 25.)

Example 1: 0.4 is read "four tenths" and written $\frac{4}{10}$, which $= \frac{2}{5}$ when reduced.

Example 2: 0.65 is read "sixty-five hundredths" and written $\frac{65}{100}$, which $= \frac{13}{20}$ when reduced.

Example 3: 0.007 is read "seven thousandths" and written $\frac{7}{1{,}000}$.

Notice that the number of places to the right of the decimal point is the same as the number of zeros in the denominator of the fraction.

PRACTICE **PROBLEMS**

Change the following fractions to decimals, and carry the division three places as indicated. Do not round off.

47. $\frac{3}{4}$ _____

48. $\frac{5}{9}$ _____

49. $\frac{1}{2}$ _____

Change the following decimals to fractions, and reduce to lowest terms.

50. 0.75 _____

51. 0.0005 _____

52. 0.04 _____

Answers on p. 39

POINTS TO REMEMBER

- Read decimals carefully.
- When the decimal fraction is **not** preceded by a whole number (e.g., .12), **always place a "0"** to the left of the decimal (0.12) to avoid interpretation errors and to avoid overlooking the decimal point.
- Never follow a whole number with a decimal point and zero. This could result in a medication error because of misinterpretation (e.g., 3, not 3.0).
- Add zeros to the right as needed for making decimals of equal spacing for addition and subtraction. These zeros do not change the value. Eliminate unnecessary zeros at the end in the final answer.
- Adding zeros at the end of a decimal (except when called for to create decimals of equal length for addition or subtraction) can result in error (e.g., 1.5, not 1.50).
- Adding zeros after the decimal point can change the value (e.g., 1.5 is not equal to 1.05, nor is it the same number).
- To convert a fraction to a decimal, divide the numerator by the denominator.
- To convert a decimal to a fraction, write the decimal number as a whole number in the numerator and the denominator as a power of 10. Reduce to lowest terms (e.g., 0.05 = $^{5}/_{100}$ = $^{1}/_{20}$).
- Double-check work to avoid errors.

CHAPTER **REVIEW**

Identify the decimal with the largest value in the following sets.

1. 0.4, 0.44, 0.444 _____
2. 0.8, 0.7, 0.12 _____
3. 1.32, 1.12, 1.5 _____
4. 0.1, 0.05, 0.2 _____
5. 0.725, 0.357, 0.125 _____

Arrange the following decimals from smallest to largest.

6. 0.5, 0.05, 0.005 _____
7. 0.123, 0.1023, 1.23 _____
8. 0.64, 4.6, 0.46 _____
9. 5.15, 5.05, 5.55 _____
10. 0.73, 0.307, 0.703 _____

Perform the indicated operations. Give exact answers.

11. 3.005 + 4.308 + 2.47 = _____
12. 20.3 + 8.57 + 0.03 = _____
13. 5.886 − 3.143 = _____
14. 8.17 − 3.05 = _____
15. 3.8 − 1.3 = _____

Solve the following. Carry division to the hundredths place where necessary.

16. 5.7 ÷ 0.9 = _____
17. 3.75 ÷ 2.5 = _____
18. 1.125 ÷ 0.75 = _____
19. 0.15 × 100 = _____
20. 15 × 2.08 = _____
21. 472.4 × 0.002 = _____

Express the following decimals to the nearest tenth.

22. 1.75 _____
23. 0.13 _____

Express the following decimals to the nearest hundredth.

24. 1.427 _____ 25. 0.147 _____

Change the following fractions to decimals. Carry division three decimal places as necessary.

26. $\frac{8}{64}$ _____ 28. $6\frac{1}{2}$ _____

27. $\frac{3}{50}$ _____

Change the following decimals to fractions, and reduce to lowest terms.

29. 1.01 _____ 30. 0.065 _____

Add the following decimals.

31. You are to give a client one tablet labeled 0.15 milligram (mg) and one labeled 0.025 mg. What is the total dosage of these two tablets? _____

32. If you administer two tablets labeled 0.04 milligram (mg), what total dosage will you administer? _____

33. You have two tablets, one labeled 0.025 milligram (mg) and the other 0.1 mg. What is the total dosage of these two tablets? _____

34. You have just administered 3 tablets with dose strength of 1.5 milligrams (mg) each. What was the total dosage? _____

35. If you administer two tablets labeled 0.6 milligram (mg), what total dosage will you administer? _____

Multiply the following numbers by moving the decimal.

36. $0.08 \times 10 =$ _____ 37. $0.002 \times 100 =$ _____

Divide the following numbers, and round to the nearest hundredth.

38. $0.13 \div 0.25 =$ _____ 40. $6.45 \div 10 =$ _____

39. $4 \div 4.1 =$ _____

Round the following decimals to the nearest thousandth.

41. 4.2475 _____ 43. 7.8393 _____

42. 0.5673 _____ 44. 2.3249 _____

45. A client's water intake is 1.05 liters (L), 0.65 L, 2.05 L, and 0.8 L. What is the total intake in liters? _____

46. A client's creatinine level on admission was 2.5 milligrams per deciliter (mg/dL). By discharge the creatinine level dropped 0.9 mg. What is the client's current creatinine level? _____

47. A baby weighed 4.85 kilograms (kg) at birth and now weighs 7.9 kg. How many kilograms did the baby gain? _____

48. A client received a series of injections of medication in milliliters (mL): 1.5 mL, 2.3 mL, and 2.1 mL. What was the total amount of medication (in mL) the client received? _____

49. A client's sodium intake at one meal was the following: 0.002 gram (g), 0.35 g. How many grams of sodium did the client consume? _____

50. True or False? 2.4 grams (g) = 2.04 g _____

51. 0.7 milligram (mg) of a medication has been ordered. The recommended maximum dosage of the medication is 0.35 mg, and the minimum recommended dosage is 0.175 mg. Is the dosage ordered within the allowable limits? _____

52. A client weighed 85.4 kilograms (kg) in January. In February, the client gained 1.8 kg. In March, the client gained 2.3 kg. How much did the client weigh at the end of March? _____

53. If a dosage of medication is 2.5 milliliters (mL), how much medication is needed for 25 dosages? _____

54. A client received 17.5 milligrams (mg) of a medication in tablet form. Each tablet contained 3.5 mg of medication. How many tablets were given to the client? _____

55. A client received a total of 4.5 grams (g) of a medication. If the client received the total over a 3-day period and was given 3 doses per day, what was the strength of each dose? _____

56. A client is brought to the emergency room with a body temperature of 95.3°F. If the normal body temperature is 98.6°F, how far below normal was the client's temperature? _____

57. A vial holds a total of 7.5 milliliters (mL) of medication. If two injections are withdrawn from the vial (1.6 mL and 0.8 mL), how much medication is left in the vial? _____

58. One dose of flu vaccine is 0.5 milliliter (mL). How much vaccine is needed to vaccinate 30 walk-ins at a clinic? _____

59. A client's hemoglobin was 13.8 grams (g) before surgery. During surgery, the hemoglobin dropped 4.5 g. What was the hemoglobin value after it dropped? _____

60. For a certain medication, the safe dosage should be greater than or equal to 0.7 gram (g) but less than or equal to 2 g. Which of the following dosages fall within the range? (More than one answer is correct.)

    0.8 g, 0.25 g, 2.5 g, 1.25 g

61. In a 24-hour period, a premature infant drank 5.5 milliliters (mL), 15 mL, 5.25 mL, 15 mL, 6 mL, and 12.5 mL. How many mL did the infant drink in 24 hours? _____

62. A baby weighed 3.7 kilograms (kg) at birth. The baby now weighs 5.65 kg. How many kg did the baby gain? _____

63. A client receives a dosage of 5.5 milliliters (mL) of medication 4 times a day. How much medication would the client receive in 7 days? _____

64. A client received 17.5 milligrams (mg) of medication in tablet form. Each tablet contains 2.5 mg of medication. How many tablets were given to the client? _____

65. The doctor prescribed 1.5 tablets of a medication to be administered to a client 4 times a day for 7 days. How many tablets were prescribed? _____

Answers below

ANSWERS

Chapter 2

Answers to Practice Problems

1. eight and thirty-five hundredths
2. eleven and one thousandth
3. four and fifty-seven hundredths
4. five and seven ten thousandths
5. ten and five tenths
6. one hundred sixty-three thousandths

7. 0.4
8. 84.07
9. 0.07
10. 2.23
11. 0.05
12. 0.009
13. 0.5
14. 2.87
15. 0.375
16. 0.175
17. 7.35
18. 0.087
19. 18.4
20. 40.449
21. 3.95
22. 3.87
23. 2.92
24. 43.1
25. 0.035
26. 5.88
27. 0.04725
28. 0.9125
29. 9,650
30. 1.78
31. 100.8072
32. 4
33. 1.16
34. 70.88
35. 30.46
36. 0.59
37. 3.6
38. 1
39. 2
40. 3.55
41. 0.61
42. 0.74
43. 0.0005
44. 0.00004
45. 584
46. 500
47. 0.75
48. 0.555
49. 0.5
50. $\frac{3}{4}$
51. $\frac{1}{2{,}000}$
52. $\frac{1}{25}$

Answers to Chapter Review

1. 0.444
2. 0.8
3. 1.5
4. 0.2
5. 0.725
6. 0.005, 0.05, 0.5
7. 0.1023, 0.123, 1.23
8. 0.46, 0.64, 4.6
9. 5.05, 5.15, 5.55
10. 0.307, 0.703, 0.73
11. 9.783
12. 28.9
13. 2.743
14. 5.12
15. 2.5
16. 6.33
17. 1.5
18. 1.5
19. 15
20. 31.2
21. 0.94
22. 1.8
23. 0.1
24. 1.43
25. 0.15
26. 0.125
27. 0.06
28. 6.5
29. $1\frac{1}{100}$
30. $\frac{13}{200}$
31. 0.175 mg
32. 0.08 mg
33. 0.125 mg
34. 4.5 mg
35. 1.2 mg
36. 0.8
37. 0.2
38. 0.52
39. 0.98
40. 0.65
41. 4.248
42. 0.567
43. 7.839
44. 2.325
45. 4.55 L
46. 1.6 mg/dL
47. 3.05 kg
48. 5.9 mL
49. 0.352 g
50. False
51. No, 0.7 mg is outside the allowable limits of the safe dosage range of 0.175 mg to 0.35 mg. It is twice the allowable maximum dosage.
52. 89.5 kg
53. 62.5 mL
54. 5 tablets
55. 0.5 g per dose
56. 3.3°F
57. 5.1 mL
58. 15 mL
59. 9.3 g
60. 0.8 g, 1.25 g
61. 59.25 mL
62. 1.95 kg
63. 154 mL
64. 7 tablets
65. 42 tablets