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Calculation of Drug Dosages

A Work Text

TENTH EDITION



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CALCULATION OF DRUG DOSAGES

A Work Text

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A Work Text

TENTH EDITION

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CALCULATION OF DRUG DOSAGES:
A WORK TEXT, TENTH EDITION

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*To David, my husband and best friend, for your patience, support, and love;
and to our wonderful family, John, Shannon, Kate, Claire,
Amy, Ryan, Connor, Justin, Maya, and Celeste.
Love, Sheila, Mom, and Nana.*

S.J.O.

*To my parents, Richard and Arlene Duke,
for their love and support when I said I wanted to be a nurse.
Love, Linda.*

L.K.F.

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ACKNOWLEDGMENTS

We are grateful to the students and instructors who have chosen to use this book; we continue to learn so much from each of you. You have helped us understand the problems that students have with basic mathematics and with the calculation of drug dosages. We appreciate the physicians, nurses, pharmacists, and representatives of various health care agencies who took the time to discuss topics with us. We hope this book will provide readers with a feeling of confidence when working with a variety of mathematical problems.

We want to give special thanks to the reviewers of this text. Your sincere evaluation and critique played an integral part in the revision of this edition, and your attention to detail was most helpful.

We would also like to acknowledge Danielle Frazier and Yvonne Alexopoulos for their help and support during the writing of this tenth edition. Danielle supplied answers to many questions, pushed to meet deadlines, and offered her services as needed. She also remained calm and offered guidance during the entire revision process. Yvonne has been diligent in providing clarity on the needs of students, faculty, and hospitals as the scope and use of the book continue to grow.

Thank you all so much!

Sheila J. Ogden

Linda K. Fluharty

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This work text is designed for students in professional and vocational schools of nursing and for nurses returning to practice after being away from the clinical setting. It can be used in the classroom or for individual study. The work text contains an extensive review of basic mathematics to assist students who have not mastered the subject in previous educational experiences. It can also be used by those who have not attended school for a number of years and feel a lack of confidence in the area of mathematics computations.

ORGANIZATION OF MATERIAL

A pretest precedes each chapter in Parts One and Two and may be used for evaluating present skills. For those students who are comfortable with basic mathematics, a quick assessment of each area will confirm their competency in the subject matter.

Part Two begins with the use of the metric system, which is predominant in the medical field. The apothecary system continues to decline in use to the point of being almost extinct. However, in remembering that differences in practice exist throughout the United States and the world, it was felt that some of that content should remain in the book. Therefore it has been placed in the Appendix for reference. A new Chapter 7 has been added with the emphasis on calculations used in patient assessments.

Part Three helps students prepare for the actual calculation of drug dosages. The new Chapter 8 has combined material from all previous chapters and discusses various points concerning patient safety as it relates to medication administration. This chapter also includes safety issues for the nurse in the dispensing of medication. The case scenarios really emphasize the importance of delivering the correct medication to the patient as ordered. Chapter 9 provides an emphasis on the interpretation of the physician's orders, and Chapter 10 explains how to read medication labels.

Part Four has been renamed the Calculation of Drug Dosages. As students begin their clinical experiences, they start with basic medical surgical patients. Therefore the content moves from oral to parenteral, units, reconstitution and, finally, intravenous flow rates. Beginning in Part Four, we have added substantial content on dimensional analysis as a method for solving problems of drug calculations. This method has become the preferred method of use by numerous schools of nursing.

However, many schools are remaining with the ratio/proportion or formula methods. Examples of each type of calculation are now shown first with dimensional analysis followed by the proportion and formula methods. The division of the three methods will allow instructors to target the area of study they prefer for their students and/or schools.

The actual drug labels have been updated and increased in number in all chapters that discuss the calculation of drug dosages. Also in Part Four, we have separated and expanded the content for dosages measured in units (Chapter 13) and the reconstitution of medications (Chapter 14). These are two separate concepts and are sometimes difficult for students to understand. This separation allows for extended practice and attention to each chapter's content.

More medications are being delivered to patients via the intravenous route, not only in intensive care units, but in progressive care and medical surgical areas as well. Therefore, in addition to Chapter 15, Intravenous Flow Rates, a new Chapter 16, Intravenous Flow Rates for Dosages Measured in Units, has been added. Chapter 17 remains focused on Critical Care Intravenous Flow Rates. Chapter 18, Pediatric Dosages, continues to include oral, parenteral, and intravenous flow rate problems. Chapter 19, Obstetric Dosages, remains to address the calculation in regards to obstetric patients.

The majority of the calculation problems relating to drug dosages continue to represent actual physicians' orders in various health care settings.

FEATURES IN THE TENTH EDITION

- **Learning objectives** are listed at the beginning of each chapter so students will know the goals that must be achieved.
- Chapter **work sheets** provide the opportunity to practice solving realistic problems.
- Almost every chapter contains two **posttests** designed to evaluate the student's learning.
- A **comprehensive posttest** at the end of the book will help students assess their total understanding of the process of calculation of drug dosages.
- A **glossary** is included to define important terms.
- Numerous **full-color drug labels** continue to provide a more realistic representation of medication administration.
- **NEW! Chapter 13, Dosages Measured in Units, and Chapter 14, Reconstitution of Medications**, have been divided into two separate chapters.

ANCILLARIES

Evolve resources for instructors and students can be found online at <http://evolve.elsevier.com/Ogden/calculation/>

The instructor resources are designed to help instructors present the material in this text and include the following:

- Drug Label glossary
- TEACH Lesson Plan
- TEACH Lecture Outlines
- TEACH PowerPoint Slides
- Test Bank

NEW VERSION! *Drug Calculations Comprehensive Test Bank, version 4.* This generic test-bank contains over 700 questions on general mathematics, converting within the same system of measurements, converting between different systems of measurement, oral dosages, parenteral dosages, flow rates, pediatric dosages, IV calculations, and more.

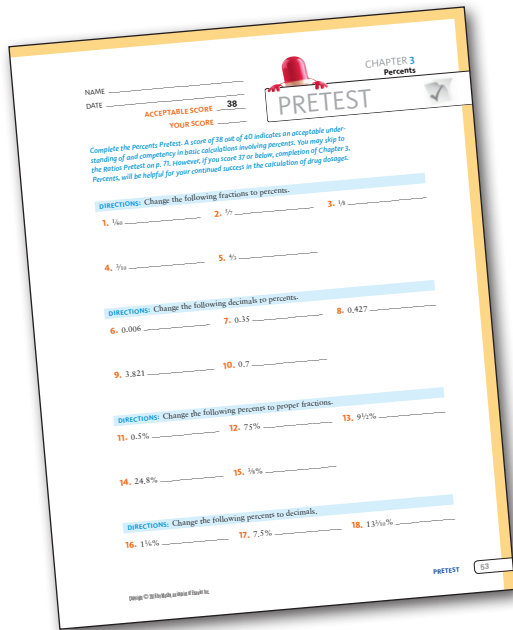
Student Resources provide students with additional tools for learning and include the following:

- Student Practice Problems and Learning Activities
- Flash Cards

NEW VERSION! *Drug Calculations Companion, version 5.* This is a completely updated, interactive student tutorial that includes an extensive menu of various topic areas within drug calculations, such as oral, parenteral, pediatric, and intravenous calculations. It contains over 600 practice problems covering ratio and proportion, formula, and dimensional analysis methods.

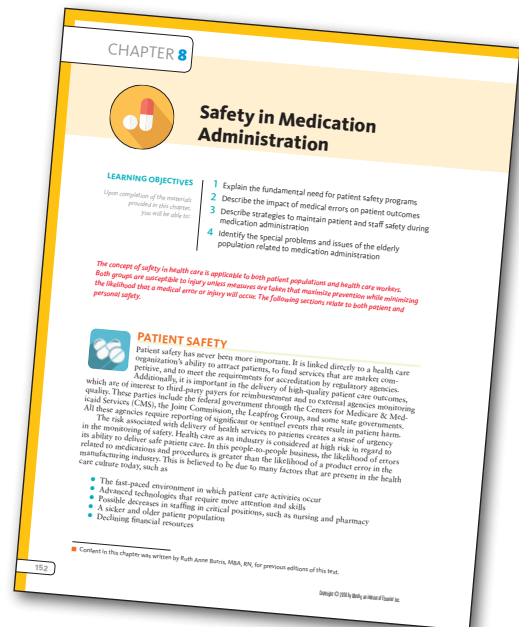
DESCRIPTION AND FEATURES

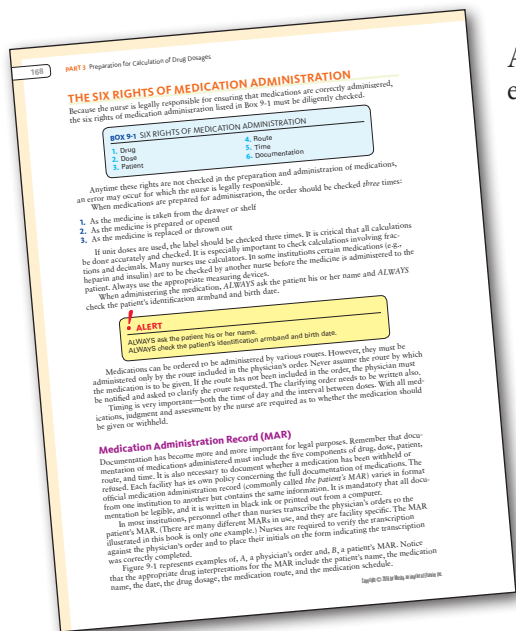
Calculation of Drug Dosages is an innovative drug calculation work text designed to provide you with a systematic review of mathematics and a simplified method of calculating drug dosages. It affords you the opportunity to move at a comfortable pace to ensure success. It includes information on the dimensional analysis, ratio and proportion, and formula methods of drug calculation, as well as numerous practice problems. Take a look at the following features so that you may familiarize yourself with this text and maximize its value.



Pretests evaluate your present skills in utilizing mathematics, units, and measurements.

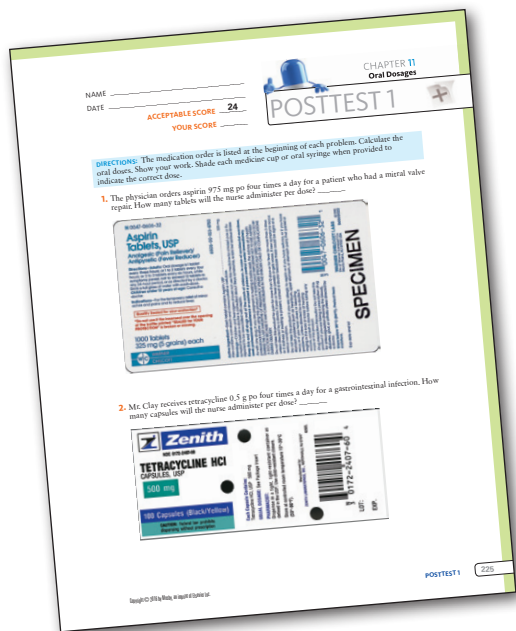
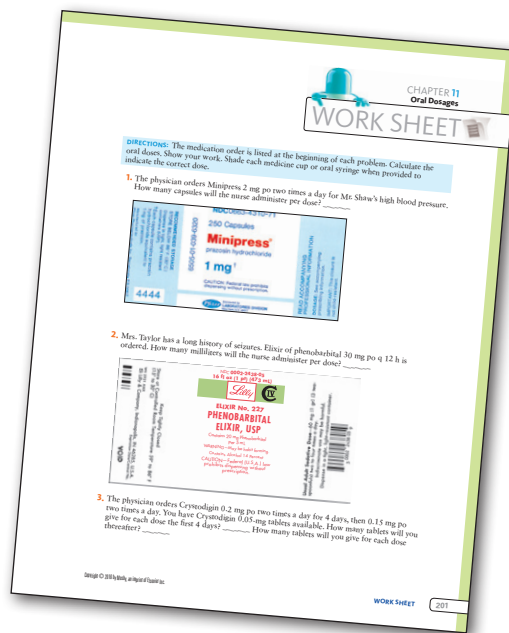
Learning Objectives highlight key content and goals that must be achieved.





Alerts highlight potential and common drug calculation errors.

Work Sheets provide you with the opportunity to practice solving realistic problems.



Posttests are designed to assess your learning and identify your strengths and weaknesses.

NEW VERSION! Drug Calculations Companion, version 5. This is a completely updated, interactive student tutorial that includes an extensive menu of various topic areas within drug calculations, such as oral, parenteral, pediatric, and intravenous calculations. It contains over 600 practice problems covering ratio and proportion, formula, and dimensional analysis methods.

evolve Look for this icon at the end of the chapters. It will refer to *Drug Calculations Companion, version 5* for additional practice problems and content information.

A pretest precedes each chapter in Parts One and Two to assess previous learning. If your grade on the pretest is acceptable (an acceptable score is noted at the top of the test), you may continue to the next pretest. If your score on the pretest indicates a need for further study, read the introduction to the chapter, study the method of solving the problems, and complete the work sheet. If you have difficulty with a problem, refer to the examples in the introduction.

On completion of the work sheet, refer to the answer key at the end of each chapter to verify that your answers are correct. Rework all the incorrect problems to find your errors. It may be necessary to refer again to the examples in each chapter. Then proceed to the first posttest and grade the test. If your grade is acceptable, as indicated at the top of the test, continue to the next chapter. If your grade is less than acceptable, rework all incorrect problems to find your errors. Review as necessary before completing the second posttest. Again, verify that your answers are correct. At this point, if you have followed the system of study, your grade on the second posttest should be more than acceptable. Follow the same system of study in each of the chapters.

When all the chapters in the work text are completed with acceptable scores (between 95% and 100%), you should be proficient in solving problems relating to drug dosages; more important, you will have completed the first step toward becoming a safe practitioner of medication administration.

On completion of the material provided in this work text, you will have mastered the following mathematical concepts for use in the accurate performance of computations:

1. Solving problems using fractions, decimals, percents, ratios, proportions, and dimensional analysis
2. Solving problems involving the apothecary, metric, and household systems of measurements
3. Solving problems measured in units and milliequivalents
4. Solving problems related to oral and parenteral dosages
5. Solving problems involving intravenous flow rates and critical care intravenous flow rates
6. Solving problems confirming the correct dosage of pediatric medications
7. Solving problems confirming the correct dosages of OB medications
8. Solving problems by using the or dimensional analysis, ratio and proportion, and formula methods.

You are now ready to begin Chapter 1!

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PART ONE**Review of Mathematics**

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- CHAPTER 5 Proportions, 87

REVIEW OF MATHEMATICS POSTTEST, 101**PART TWO****Units and Measurements for the Calculation of Drug Dosages**

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- CHAPTER 15 Intravenous Flow Rates, 421

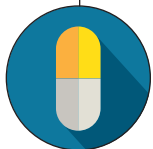
- CHAPTER **16** Intravenous Flow Rates for Dosages Measured in Units, 459
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REVIEW of MATHEMATICS



REVIEW OF MATHEMATICS PRETEST

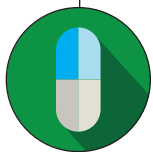
CHAPTER 1 Fractions

CHAPTER 2 Decimals

CHAPTER 3 Percents

CHAPTER 4 Ratios

CHAPTER 5 Proportions



REVIEW OF MATHEMATICS POSTTEST

A solid knowledge base of general mathematics is necessary before you will be able to use these concepts in the more complicated calculations of drug dosages. It is this knowledge that allows for the safe administration of medications to your patients and prevents medication errors.

For students who have been away from basic mathematics awhile, please take the time and effort to review the multiplication tables of one through twelve. These tables must be memorized to allow ease in the computation of all problems found in this textbook.

As you prepare to learn how to calculate drug dosages, an assessment of your current basic mathematics understanding and competency is essential. A general mathematics pretest is provided. Allow 1 to 2 hours in a quiet study area to complete the pretest without the use of a calculator. This is your opportunity to assess your true capability of performing basic math problems. Calculators are very useful tools. In most areas of health care, the use of a calculator is actually required to ensure accuracy in the delivery of medications. Follow the direction of your instructor as to the acceptable use of calculators while using this text on your path to safe administration of medications.

The pretest allows you to assess your need for a more extensive review. After completion of the test, check your answers with the key provided. A score of 95%, or 48 out of 50 problems correct, indicates a firm foundation in basic mathematics. You may then skip to Part II, Units and Measurements for the Calculation of Drug Dosages. However, a score of 47 or below indicates a need to

review fraction, decimal, percent, ratio, and/or proportion calculations. Chapters 1 through 5 allow you to work on these basic mathematical skills at your leisure.

The pretest and review chapters are provided to ensure your success in the calculation and administration of your future patients' medications. Begin now, and good luck!

NAME _____

DATE _____

ACCEPTABLE SCORE **48**

YOUR SCORE _____



Review of Mathematics

PRETEST



DIRECTIONS: Perform the indicated computations. Reduce fractions to lowest terms.

1. $\frac{3}{8} + \frac{1}{3} =$ _____ 2. $2\frac{3}{7} + 1\frac{2}{3} =$ _____ 3. $1\frac{3}{5} + \frac{7}{8} \div \frac{1}{3} =$ _____

4. $1.03 + 2.2 + 1.134 =$ _____ 5. $1.479 + 28.68 + 4.5 =$ _____ 6. $1\frac{4}{15} - \frac{1}{6} =$ _____

7. $2\frac{1}{3} - \frac{1}{2} =$ _____ 8. $2.04 - 0.987 =$ _____ 9. $8.53 - 7.945 =$ _____

10. $3 \times \frac{4}{7} =$ _____ 11. $2\frac{1}{2} \times 3\frac{3}{5} =$ _____ 12. $0.315 \times 5.8 =$ _____

13. $4.884 \times 6.51 =$ _____ 14. $\frac{3}{5} \div \frac{5}{6} =$ _____ 15. $\frac{1}{150} \div \frac{1}{20} =$ _____

16. $2\frac{3}{4} \div 6\frac{2}{3} =$ _____ 17. $241.73 \div 3.6 =$ _____ 18. $22.68 \div 4.2 =$ _____

DIRECTIONS: Circle the decimal fraction that has the *least* value.

19. 0.3, 0.03, 0.003 20. 0.9, 0.45, 0.66 21. 0.72, 0.721, 0.0072

DIRECTIONS: Circle the decimal fraction that has the *greatest* value.

22. 0.1, 0.15, 0.155 23. 0.249, 0.1587, 0.00633 24. 2.913, 2.99, 2.9

DIRECTIONS: Change the following fractions to decimals.

25. $\frac{5}{8} =$ _____ 26. $1\frac{7}{25} =$ _____

DIRECTIONS: Change the following decimals to fractions reduced to lowest terms.

27. $0.375 =$ _____ 28. $0.05 =$ _____

DIRECTIONS: Perform the indicated computations.

29. Express 0.432 as a percent. 30. Express 65% as a proper fraction and reduce to the lowest terms.

31. Express 0.3% as a ratio. 32. What percent of 2.5 is 0.5?

33. What is $\frac{1}{4}\%$ of 60? 34. What is 65% of 450?

DIRECTIONS: Change the following fractions and decimals to ratios reduced to lowest terms.

35. $\frac{9}{42} =$ _____ 36. $1\frac{1}{2}/2\frac{2}{3} =$ _____ 37. $0.34 =$ _____

DIRECTIONS: Find the value of x .

38. $7 : \frac{7}{100} :: x : 4$ 39. $x : 40 :: 7 : 56$ 40. $2.5 : 6 :: 10 : x$

41. $x : \frac{1}{4}\% :: 9.6 : \frac{1}{300}$ 42. $\frac{1}{150} : \frac{1}{100} :: x : 30$ 43. $0.10 : 0.20 :: x : 200$

44. $\frac{1}{200} : \frac{1}{40} :: 100 : x$

45. $x : 85 :: 6 : 10$

46. $\frac{1}{20} / \frac{1}{5} : 5 :: x : 50$

47. $100 : 5 :: x : 3.4$

48. $75 : x :: 36 : 6$

49. $\frac{1}{3} : \frac{2}{5} :: x : 30$

50. $x : 9 :: 98 : 7$

ANSWERS ON P. 6.

ANSWERS

REVIEW OF MATHEMATICS PRETEST, pp. 3–5

- | | | | |
|--------------------|---------------------|---------------------|---------------------------|
| 1. $1\frac{7}{24}$ | 14. $1\frac{8}{25}$ | 27. $\frac{3}{8}$ | 40. 24 |
| 2. $4\frac{2}{21}$ | 15. $\frac{2}{15}$ | 28. $\frac{1}{20}$ | 41. $7\frac{1}{5}$ or 7.2 |
| 3. $4\frac{9}{40}$ | 16. $\frac{33}{80}$ | 29. 43.2% | 42. 20 |
| 4. 4.364 | 17. 67.14722 | 30. $1\frac{3}{20}$ | 43. 100 |
| 5. 34.659 | 18. 5.4 | 31. 3:1000 | 44. 500 |
| 6. $2\frac{3}{30}$ | 19. 0.003 | 32. 20% | 45. 51 |
| 7. $1\frac{5}{6}$ | 20. 0.45 | 33. 0.15 | 46. $2\frac{1}{2}$ or 2.5 |
| 8. 1.053 | 21. 0.0072 | 34. 292.5 | 47. 68 |
| 9. 0.585 | 22. 0.155 | 35. 3:14 | 48. 12.5 |
| 10. $1\frac{5}{7}$ | 23. 0.249 | 36. 9:16 | 49. 25 |
| 11. 9 | 24. 2.99 | 37. 17:50 | 50. 126 |
| 12. 1.827 | 25. 0.625 | 38. 400 | |
| 13. 31.79484 | 26. 0.68 | 39. 5 | |

NAME _____

DATE _____

ACCEPTABLE SCORE **29**

YOUR SCORE _____



PRETEST



Complete the Fractions Pretest. A score of 29 out of 30 indicates an acceptable understanding of and competency in basic calculations involving fractions. You may skip to the Decimals Pretest on p. 31. However, if you scored 28 or below, completion of Chapter 1, Fractions, will be helpful for your continued success in the calculation of drug dosages.

DIRECTIONS: Perform the indicated calculations and reduce fractions to lowest terms.

1. $\frac{5}{7} + \frac{4}{9} =$ _____

2. $2\frac{1}{2} + 8\frac{1}{6} =$ _____

3. $3\frac{13}{20} + 1\frac{3}{10} + 4\frac{4}{5} =$ _____

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

5. $5\frac{6}{11} + 3\frac{1}{2} =$ _____

6. $3\frac{2}{3} + 4\frac{2}{9} =$ _____

7. $1\frac{3}{4} + 2\frac{3}{8} + 1\frac{5}{6} =$ _____

8. $\frac{9}{10} - \frac{3}{5} =$ _____

9. $2\frac{1}{4} - 1\frac{3}{8} =$ _____

10. $6\frac{1}{8} - 3\frac{1}{2} =$ _____

11. $4\frac{5}{6} - 2\frac{1}{8} =$ _____

12. $3\frac{3}{4} - 1\frac{11}{12} =$ _____

13. $7\frac{1}{2} - 5\frac{7}{10} =$ _____

14. $6\frac{1}{2} - 4\frac{2}{3} =$ _____

15. $\frac{4}{5} \times \frac{1}{12} =$ _____

16. $1\frac{1}{3} \times 3\frac{3}{4} =$ _____

17. $3\frac{2}{7} \times 2\frac{2}{9} =$ _____

18. $\frac{5}{8} \times 1\frac{5}{7} =$ _____

19. $\frac{1}{1000} \times \frac{1}{10} =$ _____

20. $2\frac{4}{9} \times 1\frac{3}{4} =$ _____

21. $4\frac{1}{6} \times 2\frac{9}{10} =$ _____

22. $1\frac{1}{8} \times 2\frac{4}{7} =$ _____

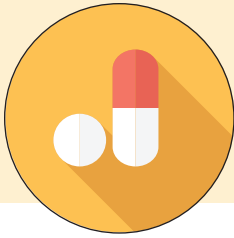
23. $\frac{1}{4} \div \frac{4}{5} =$ _____

24. $2\frac{1}{6} \div 1\frac{5}{8} =$ _____

25. $\frac{1}{3} \div \frac{1}{100} =$ _____ 26. $1\frac{3}{4} \div 2 =$ _____ 27. $\frac{4}{5} \div \frac{3}{5} =$ _____

28. $\frac{1}{3} \div \frac{3}{5} =$ _____ 29. $2\frac{5}{6} \div 1\frac{2}{3} =$ _____ 30. $4\frac{1}{2} \div 2\frac{1}{4} =$ _____

ANSWERS ON P. 29.



Fractions

LEARNING OBJECTIVES

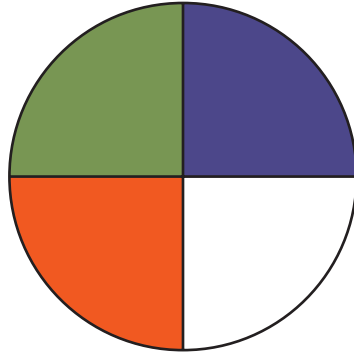
Upon completion of the materials provided in this chapter, you will be able to perform computations accurately by mastering the following mathematical concepts:

- 1 Changing an improper fraction to a mixed number
- 2 Changing a mixed number to an improper fraction
- 3 Changing a fraction to an equivalent fraction with the lowest common denominator
- 4 Changing a mixed number to an equivalent fraction with the lowest common denominator
- 5 Adding fractions having the same denominator, having unlike denominators, or involving whole numbers and unlike denominators
- 6 Subtracting fractions having the same denominator, having unlike denominators, or involving whole numbers and unlike denominators
- 7 Multiplying fractions and mixed numbers
- 8 Dividing fractions and mixed numbers
- 9 Reducing a complex fraction
- 10 Reducing a complex fraction involving mixed numbers



Study the introductory material for fractions. The processes for the calculation of fraction problems are listed in steps. Memorize the steps for each type of calculation before beginning the work sheet. Complete the work sheet at the end of this chapter, which provides extensive practice in the manipulation of fractions. Check your answers. If you have difficulties, go back and review the steps for that type of calculation. When you feel ready to evaluate your learning, take the first posttest. Check your answers. An acceptable score (number of answers correct) as indicated on the posttest signifies that you are ready for the next chapter. An unacceptable score signifies a need for further study before you take the second posttest.

A **fraction** indicates the number of equal parts of a whole. For example, $\frac{3}{4}$ means three of four equal parts.



The **denominator** indicates the number of parts into which a whole has been divided. The denominator is the number *below* the fraction line. The **numerator** designates the number of parts that you have of a divided whole. It is the number *above* the fraction line. The line also indicates division to be performed and can be read as “divided by.” The example $\frac{3}{4}$, or three fourths, can therefore be read as “three divided by four.” In other words the numerator is “divided by” the denominator. The numerator is the **dividend**, and the denominator is the **divisor**. When numbers are multiplied, the answer is the **product**. When numbers are divided, the answer is the **quotient**.

A fraction can often be expressed in smaller numbers without any change in its real value. This is what is meant by the direction “Reduce to lowest terms.” The reduction is accomplished by dividing both numerator and denominator by the same number.

EXAMPLE 1: $\frac{6}{8}$

a. $6 \div 2 = 3$

b. $8 \div 2 = 4$

c. $\frac{6}{8} = \frac{3}{4}$

EXAMPLE 2: $\frac{3}{9}$

a. $3 \div 3 = 1$

b. $9 \div 3 = 3$

c. $\frac{3}{9} = \frac{1}{3}$

EXAMPLE 3: $\frac{4}{10}$

a. $4 \div 2 = 2$

b. $10 \div 2 = 5$

c. $\frac{4}{10} = \frac{2}{5}$

There are several different types of fractions. A **proper fraction** is one in which the numerator is smaller than the denominator. A proper fraction is sometimes called a *common* or *simple fraction*.

EXAMPLES: $\frac{2}{3}$, $\frac{1}{8}$, $\frac{5}{12}$

An **improper fraction** is a fraction in which the numerator is larger than or equal to the denominator.

EXAMPLES: $\frac{8}{7}$, $\frac{6}{6}$, $\frac{4}{2}$

A **complex fraction** is one that contains a fraction in its numerator, its denominator, or both.

EXAMPLES: $\frac{2\frac{1}{3}}{3}$, $\frac{2}{\frac{1}{2}}$, $\frac{\frac{3}{4}}{\frac{3}{8}}$

Sometimes a fraction is seen in conjunction with a whole number. This combination is called a **mixed number**.

EXAMPLES: $2\frac{3}{8}$, $4\frac{1}{3}$, $6\frac{1}{2}$