Joyce LeFever Kee | Sally M. Marshall
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# Clinical Calculations

## With Applications to General and Specialty Areas

TENTH EDITION

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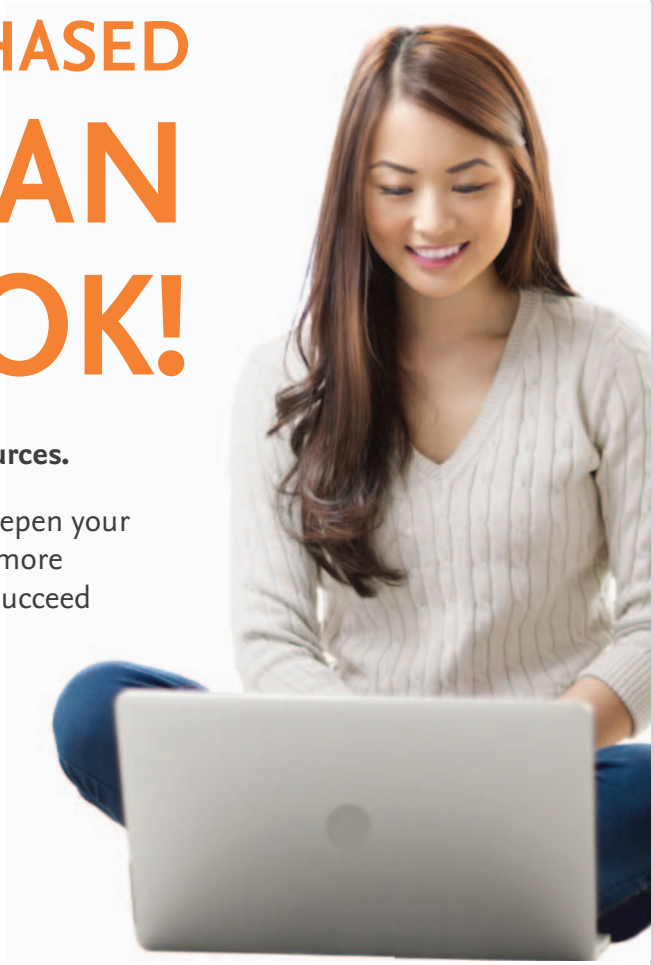

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The Joint Commission (TJC) list of abbreviations that should be spelled out.

| *Abbreviation* | *Use Instead* |
|---|---|
| q.d., Q.D. | Write "daily" or "every day." |
| q.o.d., Q.O.D. | Write "every other day." |
| U | Write "unit." |
| IU | Write "international unit." |
| MS, $MSO_4$ | Write "morphine sulfate." |
| $MgSO_4$ | Write "magnesium sulfate." |
| .5 mg | Write "0.5 mg," use zero before a decimal point when the dose is less than a whole. |
| 1.0 mg | Do not use a decimal point or zero after a whole number. |

The following abbreviations could possibly be included in future Joint Commission "Do Not Use" lists. These abbreviations are as follows:

| *Abbreviation* | *Use Instead* |
|---|---|
| c.c. | Use "mL" (milliliter). |
| $\mu g$ | Use "mcg" (microgram). |
| > | Write "greater than." |
| < | Write "less than." |
| Drug name abbreviations | Write out the full name of the drug. |
| Apothecary units | Use metric units. |
| @ | Write "at." |

Other abbreviations can be found in Chapter 3, page 54.

*Metric and Standard Measurement Conversions*

| | *Metric* | *Standard* | | |
|---|---|---|---|---|
| Weight | 1 kilogram | 2.2 lbs | | |
| | 0.45 kg | 1 lb | | |
| | 30 g | 1 oz | | |
| | 15 g | 1/2 oz | | |
| Volume | 1 liter | 32 oz | 1 quart | |
| | 500 mL | 16 oz | 1 pint | |
| | 250 mL | 8 oz | 1 cup | |
| | 30 mL | 1 oz | 2 tablespoons | |
| | 15 mL | 1/2 oz | 1 tablespoon | 3 teaspoons |
| | 5 mL | | | 1 teaspoon |
| | 2.5 mL | | | 1/2 teaspoon |
| Length | 1 meter | 3.28 ft | 39.37 in | |
| | 1 cm | 0.39 in | | |

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## With Applications to General and Specialty Areas

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St. Louis, Missouri 63043

CLINICAL CALCULATIONS WITH APPLICATIONS TO GENERAL AND SPECIALTY AREAS, TENTH EDITION
ISBN: 978-0-323-80983-2


**International Standard Book Number: 978-0-323-80983-2**

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Printed in China
Last digit is the print number: 9 8 7 6 5 4 3 2 1

*To my granddaughter, Kimberly Cibroski, BSN, RN*
*Emergency Room, ChristianaCare, Newark, Delaware*
**Joyce Kee**

*To Bob*
**Sally Marshall**

*To my parents, Bill and Rebecca, and my husband, Mark*
**Katie Forrester**

*To my family, friends, and Roxie*
**Katy Woods**

# Preface to the Instructor

*Clinical Calculations with Applications to General and Specialty Areas* arose from the need to bridge the learning gap between education and practice. We believe that this bridge is needed for the student to understand the wide range of clinical calculations used in nursing practice. This book provides a comprehensive application of calculations in nursing practice and has been expanded in this tenth edition to include Next-Generation NCLEX® examination-style questions.

*Clinical Calculations* is unique in that it has problems not only for the general patient areas but also for the specialty units—pediatrics, critical care, pediatric critical care, labor and delivery, and community. This text is useful for nurses at all levels of nursing education who are learning for the first time how to calculate dosage problems and for beginning practitioners in specialty areas. It also can be used in nursing refresher courses, in-service programs, hospital units, home health care, and other settings of nursing practice.

The use of the latest methods, techniques, and equipment is included: unit dose dispensing system, electronic medication administration record (eMAR), computerized prescriber order system (CPOS), various methods of calculating drug doses with the use of body mass index (BMI), ideal body weight (IBW ) with adjusted body weight (ABW ), insulin pump, patient-controlled analgesia pumps, multi-channel infusion pumps, IV filters, and many more. This text also provides the six (6) methods for calculating drug dosages—basic formula, ratio and proportion, fractional equation, dimensional analysis, body weight, and body surface area.

This book is divided into five parts. Part I is the basic math review, written concisely for nursing students to review Roman numerals, fractions, decimals, percentages, and ratio and proportion. A post-math review test follows. The post-math test can be taken first and, if the student has a score of 90% or higher, the basic review section can be omitted. Part II covers metric and household measurement systems used in drug calculations; conversion of units; reading drug labels, drug orders, eMAR, computerized prescriber order systems, and abbreviations; and methods of calculations. We suggest that you assign Parts I and II, which cover delivery of medication, before the class. Part III covers calculation of drug and fluid dosages for oral, injectable, insulin administration, and intravenous administration. Clinical drug calculations for specialty areas are found in Part IV, which includes pediatrics, critical care for adults and children, labor and delivery, and community. Part V contains the post-test for students to test their competency in mastering oral, injectable, intravenous, and pediatric drug calculations. A passing grade is 88%. Appendix A includes guidelines for administration of medications (oral, injectable, and intravenous).

Each chapter has a content list, objectives, introduction, and numerous practice problems. The practice problems are related to clinical drug problems that are currently used in clinical settings. Illustrations of tablets, capsules, medicine cup, syringes, ampules, vials, intravenous bag and bottle, IV tubing, electronic IV devices, intramuscular injection sites, central venous sites, and many other related images are provided throughout the text.

Also included are Next-Generation NCLEX® examination-style or NGN® Prep questions, based on a Clinical Judgment Model developed by the National Council of State Boards of Nursing (NCSBN). The style of question is designed to assess critical thinking, judgment, and decision-making based on actual clinical situations.

Calculators may be used in solving dosage problems. Many institutions have calculators available. The student should work the problem without a calculator and then check the answer with a calculator.

## FEATURES FOR THE TENTH EDITION

- Next-Generation NCLEX® examination-style and NGN® Prep questions have been added to relevant chapters.
- Problems using the newest drug labels are provided in most chapters.
- Six methods for calculating drug dosages have been divided into two chapters. Chapter 6 gives four methods: basic formula, ratio and proportion, fractional equations, and dimensional analysis. Chapter 7 contains two individual methods for calculating drug doses: body weight and body surface area.
- Emphasis is placed on the metric system along with the household system of measurement.
- Illustrations of intraosseous and intraspinal access are included in the Alternative Methods for Drug Administration chapter.
- Several chapters have nomograms for adults and children.
- Explanation on the unit dose dispensing system, computer-based drug administration, computerized prescriber order system, bar code medication administration, MAR, electronic medication administration record (eMAR), and automation of medication dispensing administration are provided.
- Incorporation of guidelines for safe practice and the medication administration set by the Joint Commission (TJC) and the Institute for Safe Medicine Practices (ISMP) are included.
- Explanation of the four groups of inhaled medications include: MDI inhalers with and without spacers, dry powder inhalers, and nebulizers.
- Calculations by BMI, IBW, and ABW for obese and debilitated persons are presented.
- Body Surface Area (BSA or $m^2$) using the square root method is included.
- Use of fingertip units for cream applications is illustrated.
- Explanations are provided for the use of the insulin pump, insulin pen injectors, and the patient-controlled analgesic pump.
- Illustrations of types of syringes, safety needle shield, various insulin and tuberculin syringes, and needleless syringes are provided.
- Illustrations of pumps are provided, including insulin, enteral infusion, and various intravenous infusion pumps (single and multi-channel, patient-controlled analgesia, and syringe).
- Coverage of direct intravenous injection (IV push or IV bolus) is provided with practice problems in Chapter 11.
- Methods and information for critical care, pediatrics, and labor and delivery calculations are presented.

## ANCILLARIES

Evolve resources for instructors and students can be found online at http://evolve.elsevier.com/KeeMarshall/clinical/

The Instructor Resources are designed to help you present the material in this text and include the following:

- Test Bank—with over 500 questions.
- TEACH consists of customizable Lesson Plans and Lecture Outlines, and PowerPoint slides. It is an online resource designed to help you to reduce your lesson preparation time, give you new and creative ideas to promote student learning, and help you to make full use of the rich array of resources in the Clinical Calculations teaching package.
- Drug Label Glossary—includes all of the drug labels from the text. Instructors can search for labels by trade or generic name.
- **NEW!** NGN® Case Studies are available for instructors to assign as supplemental testing or extra NGN® preparation.

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

**Elsevier's Interactive Drug Calculation Application, Version 1**

- This interactive drug calculations 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.

# Preface to the Student

*Clinical Calculations with Applications to General and Specialty Areas,* tenth edition, can be used as a self-instructional mathematics and dosage calculation review tool.

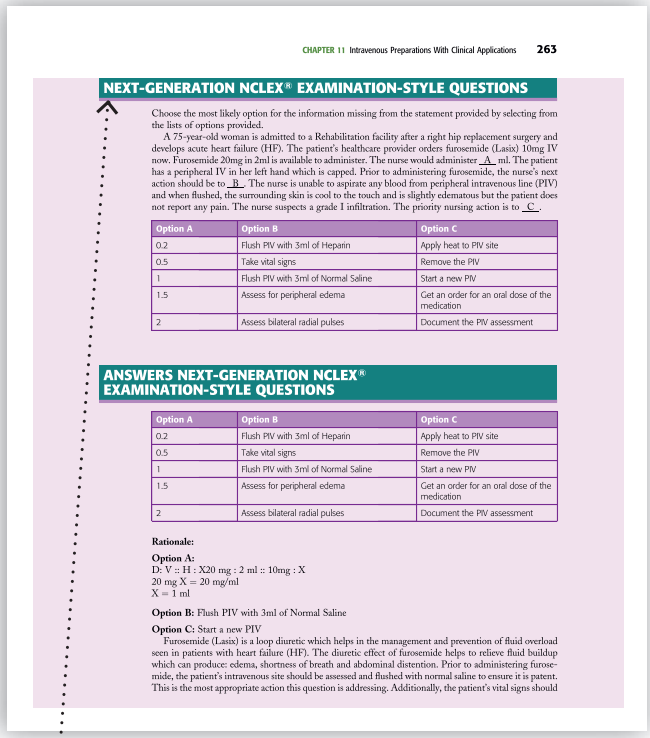
Part I, *Basic Math Review,* is a review of math concepts usually taught in middle school. Some students may need to review Part I as a refresher of basic math and then take the comprehensive math test at the end of the chapter. Others may choose to take the math test first. If your score on this test is 90% or higher, you should proceed to Part II; if your score is less than 90%, you should review Part I.

Part II, *Systems, Conversion, and Methods of Drug Calculation,* should be studied before the class on oral, injectable, insulin administration, and intravenous calculations, which are covered in Part III. In Part II you will learn the various systems of drug administration, conversion within the various systems, charting (MAR and eMAR), drug orders, abbreviations, methods of drug calculation, how to prevent medication errors, and alternative methods for drug administration. You can study Part II on your own. Chapter 6, "Methods of Calculation," gives the four methods commonly used to calculate drug dosages. You or the instructor should select one of the four methods to calculate drug dosages. Use that method in all practice problems starting in Chapter 6. This approach will improve your proficiency in the calculation of drug dosages.

Part III, *Calculations for Oral, Injectable, and Intravenous Drugs,* is usually discussed in class and during a clinical practicum. Before class, you should review the four chapters in Part III. Questions may be addressed and answered during class time. During the class or clinical practicum, you may practice drug calculations and the drawing up of drug doses in a syringe.

Part IV, *Calculations for Specialty Areas,* is usually presented when the topics are discussed in class. You should review the content in these chapters— "Pediatrics," "Critical Care," "Pediatric Critical Care," "Labor and Delivery," and "Community"— before the scheduled class. According to the requirements of your specific nursing program, this content may or may not be covered.

Part V, *Post-Test,* has 65 post-test questions you should solve to determine your competency in mastering oral, injectable, intravenous, and pediatric drug calculations. Take a look at the following features so that you may familiarize yourself with this text and maximize its value:



CHAPTER 11 Intravenous Preparations With Clinical Applications 263

## NEXT-GENERATION NCLEX® EXAMINATION-STYLE QUESTIONS

Choose the most likely option for the information missing from the statement provided by selecting from the lists of options provided.

A 75-year-old woman is admitted to a Rehabilitation facility after a right hip replacement surgery and develops acute heart failure (HF). The patient's healthcare provider orders furosemide (Lasix) 10mg IV now. Furosemide 20mg in 2ml is available to administer. The nurse would administer _A_ ml. The patient has a peripheral IV in her left hand which is capped. Prior to administering furosemide, the nurse's next action should be to _B_. The nurse is unable to aspirate any blood from peripheral intravenous line (PIV) and when flushed, the surrounding skin is cool to the touch and is slightly edematous but the patient does not report any pain. The nurse suspects a grade I infiltration. The priority nursing action is to _C_.

| Option A | Option B | Option C |
|---|---|---|
| 0.2 | Flush PIV with 3ml of Heparin | Apply heat to PIV site |
| 0.5 | Take vital signs | Remove the PIV |
| 1 | Flush PIV with 3ml of Normal Saline | Start a new PIV |
| 1.5 | Assess for peripheral edema | Get an order for an oral dose of the medication |
| 2 | Assess bilateral radial pulses | Document the PIV assessment |

## ANSWERS NEXT-GENERATION NCLEX® EXAMINATION-STYLE QUESTIONS

| Option A | Option B | Option C |
|---|---|---|
| 0.2 | Flush PIV with 3ml of Heparin | Apply heat to PIV site |
| 0.5 | Take vital signs | Remove the PIV |
| 1 | Flush PIV with 3ml of Normal Saline | Start a new PIV |
| 1.5 | Assess for peripheral edema | Get an order for an oral dose of the medication |
| 2 | Assess bilateral radial pulses | Document the PIV assessment |

**Rationale:**

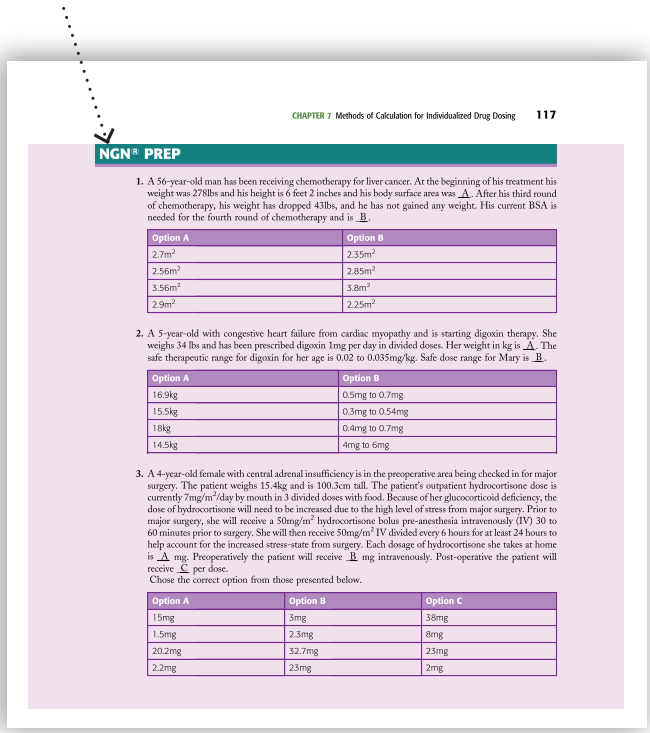
**Option A:**
D: V :: H : X20 mg : 2 ml :: 10mg : X
20 mg X = 20 mg/ml
X = 1 ml

**Option B:** Flush PIV with 3ml of Normal Saline

**Option C:** Start a new PIV

Furosemide (Lasix) is a loop diuretic which helps in the management and prevention of fluid overload seen in patients with heart failure (HF). The diuretic effect of furosemide helps to relieve fluid buildup which can produce: edema, shortness of breath and abdominal distention. Prior to administering furosemide, the patient's intravenous site should be assessed and flushed with normal saline to ensure it is patent. This is the most appropriate action this question is addressing. Additionally, the patient's vital signs should

Next-Generation NCLEX® examination-style or NGN® Prep questions are designed to introduce students to new elements from the updated NCLEX® exam, assessing critical thinking, judgment, and decision-making based on actual clinical situations.



CHAPTER 7 Methods of Calculation for Individualized Drug Dosing 117

## NGN® PREP

1. A 56-year-old man has been receiving chemotherapy for liver cancer. At the beginning of his treatment his weight was 278lbs and his height is 6 feet 2 inches and his body surface area was _A_. After his third round of chemotherapy, his weight has dropped 43lbs, and he has not gained any weight. His current BSA is needed for the fourth round of chemotherapy and is _B_.

| Option A | Option B |
|---|---|
| $2.7m^2$ | $2.35m^2$ |
| $2.56m^2$ | $2.85m^2$ |
| $3.56m^2$ | $3.8m^2$ |
| $2.9m^2$ | $2.25m^2$ |

2. A 5-year-old with congestive heart failure from cardiac myopathy and is starting digoxin therapy. She weighs 34 lbs and has been prescribed digoxin 1mg per day in divided doses. Her weight in kg is _A_. The safe therapeutic range for digoxin for her age is 0.02 to 0.035mg/kg. Safe dose range for Mary is _B_.

| Option A | Option B |
|---|---|
| 16.9kg | 0.5mg to 0.7mg |
| 15.5kg | 0.3mg to 0.54mg |
| 18kg | 0.4mg to 0.7mg |
| 14.5kg | 4mg to 6mg |

3. A 4-year-old female with central adrenal insufficiency is in the preoperative area being checked in for major surgery. The patient weighs 15.4kg and is 100.3cm tall. The patient's outpatient hydrocortisone dose is currently $7mg/m^2$/day by mouth in 3 divided doses with food. Because of her glucocorticoid deficiency, the dose of hydrocortisone will need to be increased due to the high level of stress from major surgery. Prior to major surgery, she will receive a $50mg/m^2$ hydrocortisone bolus pre-anesthesia intravenously (IV) 30 to 60 minutes prior to surgery. She will then receive $50mg/m^2$ IV divided every 6 hours for at least 24 hours to help account for the increased stress-state from surgery. Each dosage of hydrocortisone she takes at home is _A_ mg. Preoperatively the patient will receive _B_ mg intravenously. Post-operative the patient will receive _C_ per dose.
Chose the correct option from those presented below.

| Option A | Option B | Option C |
|---|---|---|
| 15mg | 3mg | 38mg |
| 1.5mg | 2.3mg | 8mg |
| 20.2mg | 32.7mg | 23mg |
| 2.2mg | 23mg | 2mg |

## LIQUIDS

Liquid medications come as tinctures, extracts, elixirs, suspensions, and syrups. Some liquid medications are irritating to the gastric mucosa and must be well diluted before being given (e.g., potassium chloride [KCl]). Medications in tincture form are always diluted or should be diluted. Liquid medication can be poured into a calibrated measuring cup or drawn up into a syringe (Figure 8.4) when greater accuracy is required (i.e., liquid narcotics).

Liquids are designed to be taken orally or through an enteral tube and are made palatable by the addition of sweeteners such as suctrose, aspartame, saccharin, fructose, and sorbitol. Unpalatable liquid drugs can be mixed with 30 to 60 mL of fruit juice. Grapefruit juice interacts with many medications. Check with the pharmacist before choosing which juice to mix with the drug.

**CAUTION**

- Concentrated liquid medication that can irritate the gastric mucosa should be diluted in *at least* 6 ounces of fluid, preferably 8 ounces of fluid.
- Liquid medication that can discolor the teeth *should be well diluted* and taken through a drinking straw.

**Figure 8.4** Liquid medication drawn up into a syringe.

*Caution* boxes alert you to potential problems related to various medications and their administration.

*You Must Remember* boxes identify pertinent concepts that students should commit to memory.



Nurse educators have resources through the Quality and Safety Education for Nurses (QSEN) Institute to assist students to learn the complexities of safe practice in drug administration.

**YOU MUST REMEMBER**

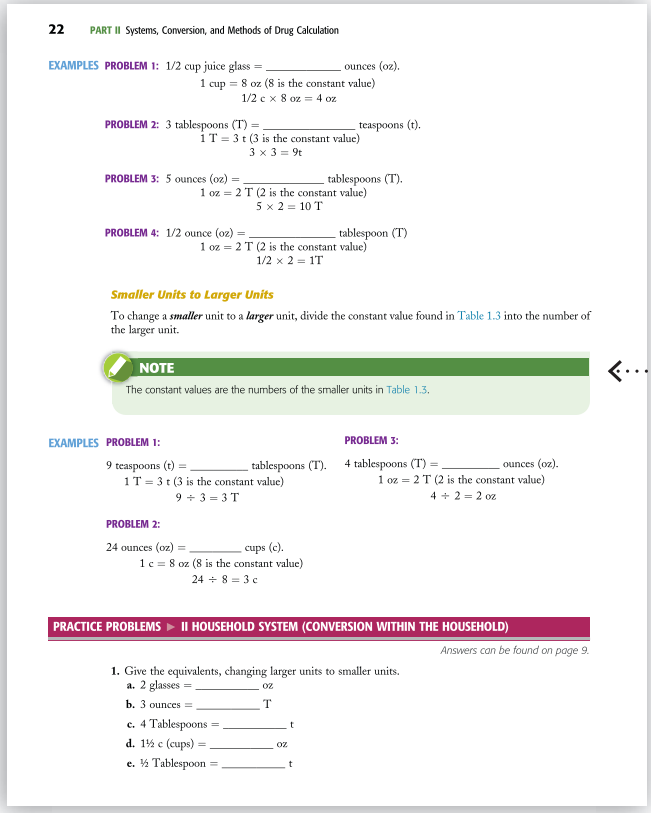
The person who administers the medication, usually the nurse, is responsible if an ME occurs.

Here are some examples of the types of medication errors (MEs):

1. The physician or health care provider makes a prescribing error and/or the written drug order is **NOT** legible.
2. Transcription errors occur because the medications have similar names; the decimals and zeros are not correctly written; or numbers are transposed.
3. Telephone and verbal orders are misinterpreted.
4. Interruptions occur when preparing medications.
5. Drug labels look similar (names and color), and packing obscures print on the label.
6. Trade names and generic names for drugs are used interchangeably, which causes confusion.
7. Oral dosages and intravenous dosages are different for the same drug.
8. Subcutaneous insulin is given in a tuberculin syringe and **NOT** in an insulin syringe.
9. The pharmacy delivers the wrong drug.
10. Intravenous medication is given too fast or too concentrated.
11. The amount of the drug is incorrectly calculated.
12. The drug is given intramuscularly or subcutaneously and should be given intravenously OR the drug is given intravenously and should be given intramuscularly.
13. Two incompatible drugs are given intravenously, which can cause crystallization of the drugs.
14. Two or three patients with the same names are on the same unit and their identification wristbands are hard to read. One patient receives another's medication.
15. Medication is given and not monitored, and an overdose occurs.
16. An infusion pump malfunctions or is incorrectly programmed.

**Ways to prevent medication errors (MEs):**

1. Ask the physician or health care provider to rewrite or clarify medication order.
2. Use only approved abbreviations from The Joint Commission (TJC) list for medication dosages. Do not use "u" for unit; it should be spelled out. Avoid use of a slash mark (/), which could be interpreted as a one (1).
3. Do not use abbreviations for medication names (e.g., $MSO_4$ for morphine sulfate).
4. Use leading zeros for doses less than a unit (e.g., **0.1** mg; **NOT .1** mg). Do not use a zero following a whole number (e.g., 5 mg; **NOT** 5.0 mg). The decimal point after 5 may not be noticed and would look like 50 mg.
5. Check medication orders with written order and MAR/eMAR.
6. Check the drug dose sent from the pharmacy with the MAR/eMAR.
7. Prepare medications in a clean, distraction-free environment.
8. Never administer a medication that has been prepared by another nurse.
9. Have another nurse check the dosage preparation, especially if in doubt. Recalculate drug dosage as needed.
10. Check if the patient is allergic to any specific drugs. If an allergy exists, report the type of reaction the patient experiences.
11. Check the patient's identification band with the eMAR and bar code.
12. Do not leave medication at the bedside. Stay with the patient until the medications are swallowed.



22 PART II Systems, Conversion, and Methods of Drug Calculation

EXAMPLES **PROBLEM 1:** 1/2 cup juice glass = _____ ounces (oz).
1 cup = 8 oz (8 is the constant value)
1/2 c × 8 oz = 4 oz

**PROBLEM 2:** 3 tablespoons (T) = _____ teaspoons (t).
1 T = 3 t (3 is the constant value)
3 × 3 = 9t

**PROBLEM 3:** 5 ounces (oz) = _____ tablespoons (T).
1 oz = 2 T (2 is the constant value)
5 × 2 = 10 T

**PROBLEM 4:** 1/2 ounce (oz) = _____ tablespoon (T)
1 oz = 2 T (2 is the constant value)
1/2 × 2 = 1T

***Smaller Units to Larger Units***

To change a ***smaller*** unit to a ***larger*** unit, divide the constant value found in Table 1.3 into the number of the larger unit.

**NOTE**

The constant values are the numbers of the smaller units in Table 1.3.

EXAMPLES **PROBLEM 1:**

9 teaspoons (t) = _____ tablespoons (T).
1 T = 3 t (3 is the constant value)
9 ÷ 3 = 3 T

**PROBLEM 2:**

24 ounces (oz) = _____ cups (c).
1 c = 8 oz (8 is the constant value)
24 ÷ 8 = 3 c

**PROBLEM 3:**

4 tablespoons (T) = _____ ounces (oz).
1 oz = 2 T (2 is the constant value)
4 ÷ 2 = 2 oz

**PRACTICE PROBLEMS ▶ II HOUSEHOLD SYSTEM (CONVERSION WITHIN THE HOUSEHOLD)**

*Answers can be found on page 9.*

1. Give the equivalents, changing larger units to smaller units.
   a. 2 glasses = _____ oz
   b. 3 ounces = _____ T
   c. 4 Tablespoons = _____ t
   d. 1½ c (cups) = _____ oz
   e. ½ Tablespoon = _____ t

*Notes* emphasize important points for students as they learn material in each chapter.

**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.

At the end of various chapters, there are references to **Elsevier's Interactive Drug Calculation Application, Version 1** for additional practice problems and content information.

## ACKNOWLEDGMENTS

Thank you to Joyce LeFever Kee for the years of collaboration and support on this text. Your encouragement of new ideas and concept in our broad field of nursing were much appreciated.

**Sally M. Marshall, Author**

It has been an honor and my great pleasure to work with Joyce LeFever Kee on several editions of *Clinical Calculations*. Joyce was a devoted educator and author and I thank her for her tremendous contributions in helping to educate nursing students over the years with her drug calculations and pharmacology texts. Joyce and I shared a wonderful author-editor relationship, but more importantly, we became friends over the editions and shared many stories about our travels. Joyce could tell me anything about any place in the world because she had already traveled there! I loved listening to her stories! Joyce, wishing you all the best of health and happiness in this next phase of your life, we will miss you!

**Yvonne Alexopoulos, Content Strategist**

The Publisher would also like to thank the following reviewers for their time and effort reviewing all the math components of this title:

**Lou Ann Boose, RN, MSN**
**Paula Silver, BS, PHD**

# Contents



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# PART I

# BASIC MATH REVIEW

**Objectives**

- Express a fraction as simple, proper, or improper.
- Use the process of simplification and reduction with fractions to find the lowest common denominator.
- Add, subtract, multiply, and divide fractions.
- Express a fraction as a decimal.
- Name the value places for whole numbers and decimals.
- Use the process of rounding with decimals.
- Multiply and divide decimals.
- Change percentages to decimals, fractions, ratio and proportions.

**Outline**

The knowledge of basic mathematics is vital for nurses in the safe administration of medication and fluids. Medication errors are among the most common of all medical errors. Therefore, a working knowledge of mathematics is needed to calculate and accurately measure medication that will be administered to the patient.

A math test, found on pages 11 to 14, follows the basic math review. The test may be taken first, and, if a score of 90% or greater is achieved, the math review, or Part I, can be omitted. If the test score is less than 90%, the student should do the basic math review section. Some students may choose to start with Part I and then take the test.

Answers to the Practice Problems are at the end of Part I, before the Post-Math Test.

The basic math review will start with fractions and the decimal system. Ratio and proportions and percentages will be addressed. Working knowledge of arithmetic is necessary to perform the operations of addition, subtraction, multiplication, and division, which will allow the nurse to master basic math skills to solve drug dosage problems for the administration of medication.

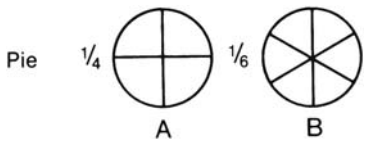
## FRACTIONS

Fractions are expressed as part(s) of a whole or part(s) of a unit. A fraction is composed of two basic numbers: a numerator (top number) represents how many parts. The denominator (bottom number) indicates the total number of parts. They are separated by a division line.

**EXAMPLE** Fraction: $\frac{3}{4}$ numerator (3 of 4 parts)
denominator (4 of 4 parts, or 4 total parts)

The value of a fraction depends mainly on the denominator. When the denominator increases, for example, from $^1/_{10}$ to $^1/_{20}$, the value of the fraction decreases, because it takes more parts to make a whole.

**EXAMPLE** Which fraction has the greater value: $^1/_4$ or $^1/_6$? The denominators are 4 and 6.




The larger value is $^1/_4$, because four parts make the whole, whereas for $^1/_6$, it takes six parts to make a whole. Therefore $^1/_6$ has the smaller value.

To make working with fractions as easy as possible, it is useful to find the lowest common denominator (LCD). The two functions used to find the LCD are simplification and reduction. Simplification means rewriting the numerator and the denominator without changing the value of the fraction to achieve the simplest and most usable fraction.

**EXAMPLE** To find the lowest common denominator:

Fraction: $\frac{30}{60} = \frac{3 \times 10}{3 \times 2 \times 10} =$ 1. Replace numbers with prime numbers as factors: 2, 3, 5, 7.

$\frac{30}{60} = \frac{{}^{1}\cancel{3} \quad {}^{1}\cancel{10}}{{}^{1}\cancel{3} \quad 2 \quad {}^{1}\cancel{10}} = \frac{1}{2}$ 2. Cancel common factors above and below the division line.

3. Then re-multiply the numerator and denominator.

**EXAMPLE** To find the lowest common denominator when adding and subtracting, multiply the denominators to find a common value.

Fraction: $\frac{1}{2}+\frac{2}{5}=$

$2\overline{)10}$ 5 quotient, common value $5 \times 1 = 5$ $\frac{1}{2}=\frac{5}{10}$

$5\overline{)10}$ 2 quotient, common value $2 \times 2 = 4$ $\frac{2}{5}=\frac{4}{10}$

$\frac{5}{10}+\frac{4}{10}=\frac{9}{10}$ or $\frac{1}{2}-\frac{2}{5}=\frac{5}{10}-\frac{4}{10}=\frac{1}{10}$

1. Multiply denominators together to find a common value or if the denominators are too large, try using prime numbers (2, 3, 5, 7...). For this example, 10 is the common value $2 \times 5 = 10$.
2. Divide each denominator into the common value then multiply the numerator by that quotient. Take the quotient/result and multiply by the numerator to find the value of the fraction.
3. Then add or subtract.

Reduction is another means to change the numerator and denominator by the same number until they are as small as possible. If a fraction is even, divide by 2, if it is odd try 3, or if it ends in 0 try 10.

**EXAMPLE** Fraction: $\frac{10}{16}\div\frac{2}{2}=\frac{5}{8}$ and $\frac{21}{36}\div\frac{3}{3}=\frac{7}{12}$ or $\frac{30}{60}\div\frac{10}{10}=\frac{3}{6}\div\frac{3}{3}=\frac{1}{2}$

## Proper, Improper, and Mixed Fractions

Proper or simple fractions have numerators with numbers less than denominators, e.g., ½, ⅔, ¾, ⅘.

Improper fractions have a large numerator and a small denominator and should be simplified or reduced, e.g., $\frac{4}{2}=\frac{2x\cancel{2}}{1x\cancel{2}}=2$ or $\frac{8}{5}=5\overline{)\begin{array}{r}1\\8\\-5\\\hline 3\end{array}}=1\frac{3}{5}$

A mixed number is a whole number and a fraction, e.g., $1\frac{3}{5}, 3\frac{1}{2}$. Mixed numbers can be changed to improper fractions by multiplying the denominator by the whole number and then adding the numerator, e.g., $1\frac{3}{5}=\frac{8}{5}(5\times1=5+3=8)$ and $3\frac{1}{2}=\frac{7}{2}(2\times3=6+1=7)$.

## Adding Fractions

Adding fractions must be done with fractions that share the same common denominator, then, all that is necessary is the adding of the numerators.

$$\frac{1}{5}+\frac{2}{5}=\frac{3}{5}$$

## Subtracting Fractions

Subtracting fractions must be done with fractions that share the same common denominator, again, all that is necessary is the subtracting of the numerators.

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

## Multiplying Fractions

To multiply fractions, multiply the numerators and then the denominators. Reduce the fraction, if possible, to lowest terms.

**EXAMPLES** **PROBLEM 1:** $\frac{1}{3} \times \frac{3}{5} = \frac{\overset{1}{\cancel{3}}}{\underset{5}{\cancel{15}}} = \frac{1}{5}$

The answer is $^3/_{15}$, which can be reduced to $^1/_5$. The number that divides into both 3 and 15 is 3. Therefore 3 divides into 3 one time, and 3 divides into 15 five times.

**PROBLEM 2:** $\frac{1}{3} \times 6 = \frac{\overset{2}{\cancel{6}}}{\underset{1}{\cancel{3}}} = 2$

A whole number can also be written as that number over one ($^6/_1$). Six is divided by 3 (6 ÷ 3); 3 divides into 6 two times.

**PROBLEM 3:** $\frac{4}{5} \times 12 = \frac{48}{5} = 9\frac{3}{5}$

## Dividing Fractions

To divide fractions, invert the *second fraction,* called the divisor, and then multiply.

**EXAMPLES** **PROBLEM 1:** $\frac{3}{4} \div \frac{3}{8}$ (divisor) $= \frac{\overset{1}{\cancel{3}}}{\underset{1}{\cancel{4}}} \times \frac{\overset{2}{\cancel{8}}}{\underset{1}{\cancel{3}}} = \frac{2}{1} = 2$

When dividing, invert the divisor $^3/_8$ to $^8/_3$ and multiply. To reduce the fraction to lowest terms, 3 divides into both 3s one time, and 4 divides into 4 and 8 one time and two times, respectively.

**PROBLEM 2:** $\frac{1}{6} \div \frac{4}{18} = \frac{1}{\underset{1}{\cancel{6}}} \times \frac{\overset{3}{\cancel{18}}}{4} = \frac{3}{4}$

Six and 18 are reduced, by dividing by 6, to 1 and 3.

**PROBLEM 3:** $3\frac{2}{3} \div \frac{5}{6} = \frac{11}{\underset{1}{\cancel{3}}} \times \frac{\overset{2}{\cancel{6}}}{5} = \frac{22}{5} = 4\frac{2}{5}$

Change $3^2/_3$ to an improper fraction and invert $^5/_6$ to $^6/_5$ and then multiply.
Reduce 3 and 6 by dividing by 3, to 1 and 2.

## Decimal Fractions

Change fraction to decimal. Divide the numerator by the denominator.

**EXAMPLES** **PROBLEM 1:** $\frac{3}{4} = 4\overline{)3.00}^{0.75}$ or 0.75

Therefore $\frac{3}{4}$ is the same as 0.75.

**PROBLEM 2** $\frac{12}{8} = 8\overline{)12.0}$ or 1.5

$$\begin{array}{r} 1.5 \\ 8\overline{)12.0} \\ \underline{8} \\ 40 \\ \underline{40} \end{array}$$

## PRACTICE PROBLEMS ▶ I FRACTIONS

*Answers can be found on page 9.*

Round off to the nearest tenth unless otherwise indicated.

**1. a.** Which has the greatest value: $^1/_{50}$, $^1/_{100}$, or $^1/_{150}$? _____

**b.** Which has the lowest value: $^1/_{50}$, $^1/_{100}$, or $^1/_{150}$? _____

**2.** Reduce improper fractions to whole or mixed numbers.

**a.** $^{12}/_4 =$ _____

**b.** $^{20}/_5 =$ _____

**c.** $^{22}/_3 =$ _____

**d.** $^{32}/_6 =$ _____

**3.** Multiply fractions to whole number(s) or lowest fraction or decimal.

**a.** $^2/_3 \times {}^1/_8 =$ _____

**b.** $2^2/_5 \times 3\,{}^3/_4 =$ _____

**c.** $^{500}/_{350} \times 5 =$ _____

**d.** $^{400{,}000}/_{200{,}000} \times 3 =$ _____

**4.** Divide fractions to whole number(s) or lowest fraction or decimal.

**a.** $^2/_3 \div 6 =$ _____

**b.** $^1/_4 \div {}^1/_5 =$ _____

**c.** $^1/_6 \div {}^1/_8 =$ _____

**d.** $^1/_{150}/^1/_{100} = (^1/_{150} \div {}^1/_{100}) =$ _____

**e.** $^1/_{200} \div {}^1/_{300} =$ _____

**f.** $9^3/_5 \div 4 = {}^{48}/_5 \div {}^4/_1 =$ _____

**5.** Change each fraction to a decimal.

**a.** $^1/_4 =$ _____

**b.** $^1/_{10} =$ _____

**c.** $^2/_5 =$ _____

**d.** $^{35}/_4 =$ _____

**e.** $^{78}/_5 =$ _____

## DECIMALS

The decimal system or metric system is a base 10 number system, 1-9, where each number or combination of numbers have a place or position that gives it value. The decimal system consists of whole numbers to the left of the decimal or zero, that start with a place value of units, tens, hundreds, thousands. Fractional numbers are to the right of the decimal point. Decimal fractions are written in tenths, hundredths, thousandths, ten-thousandths. Tenths means 0.1 or 1/10, hundredths means 0.01 or 1/100, thousandths means 0.001 or 1/1000 and ten-thousandths means 0.0001 or 1/10,000. For example, use the number 2468.8642 and assign place value.

| Whole Numbers | | | | | Decimal Fractions | | | |
|---|---|---|---|---|---|---|---|---|
| 2 | 4 | 6 | 8 | • | 8 | 6 | 4 | 2 |
| Thousands | Hundreds | Tens | Units | | Tenths | Hundredths | Thousandths | Ten Thousandths |

With the decimal system, the answer to decimal problems can be long because decimal fractions are exact. When decimal fractions are long, they may need to be shortened to be more useful, and they are shortened by rounding.

**Rounding rule:** First identify the place value where the rounding will end, either the tenths, hundredths, or thousandths place. Then look at the number to the right, if that number is 5 or greater, round up by adding one to the place value. If the number to the right is less than 5, nothing is added to the place value.

**EXAMPLES** **PROBLEM 1:** Round 2468.8642 to the nearest hundredths.The number 4 occupies the thousandths place and is less than 5, therefore nothing is added to the hundredths place and the number is 2468.86.

**PROBLEM 2:** Round 2468.86 to the nearest tenth. The number 6 is greater than 5 so the number would be rounded to 2468.9.

### Multiplying Decimals

To multiply decimal numbers, multiply the multiplicand by the multiplier. Count how many numbers (spaces) are to the right of the decimals in the problem. Mark off the number of decimal spaces in the answer (right to left) according to the number of decimal spaces in the problem. Answers are rounded off to the nearest **tenths.**

**EXAMPLE**

multiplicand 1.34
multiplier ×2.3
402
268
product 3.082 or 3.1 (rounded off in tenths)

Answer 3.1. Because 8 is greater than 5, the "tenth" number is increased by 1.

## Dividing Decimals

To divide decimal numbers, move the decimal point in the divisor to the right to make a whole number. The decimal point in the dividend is also moved to the right according to the number of decimal spaces in the divisor. Answers are rounded off to the nearest **tenths.**

**EXAMPLE** Dividend ÷ Divisor = Quotient

$2.46 \div 1.2$ or $\frac{2.46}{1.2} =$

2.05 = 2.1 (quotient)

(divisor) 1.2 )2.4 60 (dividend)

24

60

60

0

## PRACTICE PROBLEMS ► II DECIMALS

*Answers can be found on page 10.*

Round off to the nearest tenths.

**1.** Multiply decimals.

**a.** $6.8 \times 0.123 =$ _____ **b.** $52.4 \times 9.345 =$ _____

**2.** Divide decimals.

**a.** $69 \div 3.2 =$ _____ **c.** $100 \div 4.5 =$ _____

**b.** $6.63 \div 0.23 =$ _____ **d.** $125 \div 0.75 =$ _____

**3.** Change decimals to fractions.

**a.** 0.46 = _____ **b.** 0.05 = _____ **c.** 0.012 = _____

**4.** Which has the greatest value: 0.46, 0.05, or 0.012? Which has the smallest value? _____

## RATIO AND PROPORTION

A *ratio* is the relation between two numbers and is separated by a colon, e.g., 1:2 (1 is to 2). It is another way of expressing a fraction, e.g., 1:2 =½.

*Proportion* is the relation between two ratios separated by a double colon (::) or equals sign (=).

To solve a ratio and proportion problem, the inside numbers *(means)* are multiplied and the outside numbers *(extremes)* are multiplied. To solve for the unknown, which is X, the X goes to the left side and is followed by an equals sign.

**EXAMPLES** **PROBLEM 1:** $1:2::2:X$ (1 is to 2, as 2 is to X)

means: 2 and X; extremes: 1 and 2

Multiply the extremes and the means, and solve for X.

$X = 4$ (1 X is the same as X)

Answer: 4 (1:2::2:4)

**PROBLEM 2:** $4:8::X:12$

$8X = 48$

$X = {}^{48}/_{8} = 6$

Answer: 6 (4:8::6:12)

**PROBLEM 3:** A ratio and proportion problem may be set up as a fraction.

| *Ratio and Proportion* | *Fraction* |
|---|---|
| $2:3::4:X$ | $\frac{2}{3} = \frac{4}{X}$ (cross-multiply) |
| $2X = 12$ | $2X = 12$ |
| $X = {}^{12}/_{2} = 6$ | $X = 6$ |

Answer: 6. Remember to cross-multiply when the problem is set up as a fraction.

## PRACTICE PROBLEMS ▶ III RATIO AND PROPORTION

*Answers can be found on page 10.*

Solve for X.

**1.** $2:10::5:X$ _____

**2.** $0.9:100 = X:1000$ _____

**3.** Change the ratio and proportion to a fraction and solve for X.
3:5::X:10 _____

**4.** It is 500 miles from Washington, DC to Boston, MA. Your car averages 22 miles per 1 gallon of gasoline. How many gallons of gasoline will be needed for the trip? _____

## PERCENTAGE

Percent (%) means 100. Two percent (2%) means 2 parts of 100, and 0.9% means 0.9 part (less than 1) of 100. A percent can be expressed as a fraction, a decimal, or a ratio.

### EXAMPLES

| *Percent* | | *Fraction* | *Decimal* | *Ratio* |
|---|---|---|---|---|
| 60% | = | $^{60}/_{100}$ | 0.6 | 60:100 |
| 0.45% | = | $^{0.45}/_{100}$ or $^{45}/_{10,000}$ | 0.0045 | 0.45:100 or 45:10,000 |

**Note:** *To change a Percent to a decimal, move the decimal point two places to the left.*

## PRACTICE PROBLEMS ► IV PERCENTAGE

*Answers can be found on page 10.*

Change percent to fraction, decimal, and ratio.

| *Percent* | *Fraction* | *Decimal* | *Ratio* |
|---|---|---|---|
| 1. 2% | | | |
| 2. 0.33% | | | |
| 3. 150% | | | |
| 4. ½% (0.5%) | | | |
| 5. 0.9% | | | |

# ANSWERS

## I Fractions (Round off to the nearest tenths unless otherwise indicated.)

**1. a.** $^{1}/_{50}$ has the greatest value.
**b.** $^{1}/_{150}$ has the lowest value.

**2. a.** 3
**b.** 4
**c.** $7\frac{1}{3}$
**d.** $5\frac{2}{6}$ or $5\frac{1}{3}$

**3. a.** $^{2}/_{24} = {}^{1}/_{12}$

**b.** $^{12}/_{5} \times {}^{15}/_{4} = \dfrac{180}{20} = 9$

**c.** $\dfrac{\overset{10}{\cancel{500}}}{\underset{7}{\cancel{350}}} \times 5 = \dfrac{50}{7} = 7.1$

**d.** $\dfrac{\overset{2}{\cancel{400{,}000}}}{\underset{1}{\cancel{200{,}000}}} \times 3 = 6$

**4. a.** $^{2}/_{3} \div 6 = {}^{2}/_{3} \times {}^{1}/_{6}$
$= {}^{2}/_{18} = {}^{1}/_{9} = 0.11$

**b.** $^{1}/_{4} \div {}^{1}/_{5} =$
$^{1}/_{4} \times {}^{5}/_{1} = {}^{5}/_{4} =$
$1\frac{1}{4}$, or 1.25 or 1.3

**c.** $\dfrac{1}{6} \div \dfrac{1}{8} = \dfrac{1}{\underset{3}{\cancel{6}}} \times \dfrac{\overset{4}{\cancel{8}}}{1} = \dfrac{4}{3} = 1.33$, or 1.3

**d.** $^{1}/_{150} \div {}^{1}/_{100} = \dfrac{1}{\underset{3}{\cancel{150}}} \times \dfrac{\overset{2}{\cancel{100}}}{1}$
$= {}^{2}/_{3}$, or 0.666, or 0.67 or 0.7

**e.** $^{1}/_{200} \div {}^{1}/_{300} = {}^{1}/_{200} \times {}^{300}/_{1} = {}^{300}/_{200} = 1\frac{1}{2}$, or 1.5

**f.** $\dfrac{48}{5} \div \dfrac{4}{1} = \dfrac{48}{5} \times \dfrac{1}{4} = \dfrac{48}{20} = 2.4$

**5. a.** $\dfrac{1}{4} = 4\overline{)1.00}$ $\dfrac{0.25}{}$ or 0.3 rounded off

**b.** $\dfrac{1}{10} = 10\overline{)1.00}$ $\dfrac{0.10}{}$ or 0.1

**c.** $\dfrac{2}{5} = 5\overline{)2.00}$ $\dfrac{0.40}{}$ or 0.4

**d.** $\dfrac{35}{4} = 4\overline{)35.00}$ $\dfrac{8.75}{}$ or 8.8 rounded off

**e.** $\dfrac{78}{5} = 5\overline{)78.00}$ $\dfrac{15.60}{}$ or 15.6

## II Decimals

**1. a.**
$$\begin{array}{r} 0.123 \\ \times\ 6.8 \\ \hline 984 \\ 738 \\ \hline 0.8364 \end{array}$$
, or 0.8 (round off to tenths: 3 hundredths is less than 5)

**b.** 489.6780, or 489.7 (7 hundredths is greater than 5)

**2. a.** 21.56, or 21.6 (6 hundredths is greater than 5, so the tenth is increased by one)

**b.** 28.826, or 28.8 (2 hundredths is less than 5, so the tenth is not changed)

**c.** $100 \div 4.5 = 4.5\overset{\curvearrowright}{)}\overset{\curvearrowright}{100.0}\dot{} = 22.2$, or 22 (rounded off to whole number)

**d.** $125 \div 0.75 = 0.75\overset{\curvearrowright}{)}\overset{\curvearrowright}{125.00}\dot{} = 166.6$ , or 167 (rounded off to whole number)

**3. a.** $^{46}/_{100} = {}^{23}/_{50}$

**b.** $^{5}/_{100} = {}^{1}/_{20}$

**c.** $^{12}/_{1000} = {}^{3}/_{250}$

**4.** 0.46 has the greatest value; 0.012 has the lowest value. Forty-six hundredths is greater than 12 thousandths.

## III Ratio and Proportion

**1.** $2\ X = 50$
$X = 25$

**2.** $100\ X = 900$
$X = 9$

**3.** $^{3}/_{5} = {}^{x}/_{10} = 5\ X = 30$
$X = 6$

**4.** 1 gal : 22 miles :: X gal : 500
$22\ X = 500$
$X = 22.7$ gal.
22.7 gallons of gasoline are needed.

## IV Percentage

| | *Percent* | *Fraction* | *Decimal* | *Ratio* |
|---|---|---|---|---|
| **1.** | 2 | $^{2}/_{100}$ | 0.02 | 2:100 |
| **2.** | 0.33 or 0.3 | $^{0.33}/_{100}$ or $^{33}/_{10,000}$ | 0.0033 | 0.33:100 or 33:10,000 |
| **3.** | 150 | $^{150}/_{100}$ | 1.50 | 150:100 |
| **4.** | 0.5 | $^{0.5}/_{100}$ or $^{5}/_{1000}$ | 0.005 | 0.5:100 or 5:1000 |
| **5.** | 0.9 | $^{0.9}/_{100}$ or $^{9}/_{1000}$ | 0.009 | 0.9:100 or 9:1000 |

## POST-MATH TEST

*Answers can be found on pages 13 and 14.*

The math test is composed of four sections: fractions, decimals, ratios and proportions, and percentages. There are 52 questions. A passing score is 47 or more correct answers (90%). A nonpass- ing score is 5 or more incorrect answers. Answers to the Post-Math Test can be found on pages 13 and 14.

### Fractions

Which fraction has the larger value?

**1.** $^{1}/100$ or $^{1}/_{150}$ _____

**2.** $^{1}/_{3}$ or $^{1}/_{2}$? _____

Reduce improper fractions to whole or mixed numbers.

**3.** $^{45}/_{9}$ = _____

**4.** $^{74}/_{3}$ = _____

Change a mixed number to an improper fraction.

**5.** $5^{2}/_{3}$ = _____

Change fractions to decimals.

**6.** $^{2}/_{3}$ = (reduce to tenths) =_____

**7.** $^{1}/_{12}$ = (reduce to tenths) = _____

Multiply fractions (reduce to lowest terms or to tenths).

**8.** $^{7}/_{8} \times {}^{4}/_{6}$ = _____

**10.** $21^{3}/_{4} \times {}^{7}/_{8}$ = _____

**9.** $23/5 \times 5/_{8}$ = _____

**11.** $4^{4}/_{5} \times 3^{2}/_{3}$ = _____

Divide fractions.

**12.** $^{1}/_{2} \div {}^{1}/_{3}$ = _____

**14.** $^{1}/_{8} \div {}^{1}/_{12}$ = _____

**13.** $6^{3}/_{4} \div 3$ = _____

**15.** $20^{3}/_{4} \div {}^{1}/_{6}$ = _____

## Decimals

Round off decimal numbers to tenths.

**16.** 0.87 = _____

**17.** 2.56 = _____

**18.** 0.42 = _____

Change decimals to fractions.

**19.** 0.68 = _____

**20.** 0.9 = _____

**21.** 0.012 = _____

**22.** 0.33 = _____

Multiply decimals (round off to tenths or whole numbers).

**23.** 0.34 × 0.6 = _____

**24.** 2.123 × 0.45 = _____

Divide decimals.

**25.** 3.24 ÷ 0.3 = _____

**26.** 69.4 ÷ 0.23 = _____

## Ratio and Proportion

Change ratios to fractions.

**27.** 3 : 4 = _____

**28.** 65 : 90 = _____

**29.** 1 : 175 = _____

**30.** 0.9 : 100 = _____

Solve ratio and proportion problems.

**31.** 2 : 3 :: 8: X_____

**32.** 3 : 100 = X : 1000 _____

**33.** 0.5 : 20 :: X : 100 _____

**34.** 5 : 25 = 10 : X _____

Change ratios and proportions to fractions and solve.

**35.** 1 : 2 :: 4 : X _____

**36.** 5 : 50 :: X : 300 _____

**37.** 0.9 : 10 = X : 100 _____

## Percentage

Change percents to fractions.

**38.** 3% = _____ **39.** 27% = _____ **40.** 1.2% = _____ **41.** 5.75% = _____

Change percents to decimals (round off to tenths, hundredths, or thousandths).

**42.** 8% = _____ **44.** 0.9% = _____ **46.** 0.25% = _____
**43.** 15% = _____ **45.** 3.5% = _____ **47.** 0.45% = _____

Change percents to ratios.

**48.** 35% = _____ **50.** 4% = _____ **52.** 0.45% = _____
**49.** 12.5% = _____ **51.** 0.9% = _____

# ANSWERS POST-MATH TEST

## Fractions

**1.** $^{1}/_{100}$

**2.** ½

**3.** 5

**4.** $24^{2}/_{3}$

**5.** $^{17}/_{3}$

**6.** 0.66 or 0.7

**7.** 0.08 or 0.1

**8.** $\frac{28}{48}$ or $\frac{7}{12}$ or 0.58 or 0.6

**9.** $\frac{13}{\cancel{5}_{1}} \times \frac{\overset{1}{\cancel{5}}}{8} = {}^{13}/_{8} = 1\frac{5}{8}$

**10.** $\frac{87}{4} \times \frac{7}{8} = \frac{609}{32} =$ 19.03 or 19.0 or 19 (rounded off)

**11.** $\frac{24}{5} \times \frac{11}{3} = \frac{264}{15} = 17.6$

**12.** $\frac{1}{2} \times \frac{3}{1} = \frac{3}{2} = 1\frac{1}{2}$

**13.** $\frac{\overset{9}{\cancel{27}}}{4} \times \frac{1}{\underset{1}{\cancel{3}}} = \frac{9}{4} = 2\frac{1}{4}$

**14.** $\frac{1}{\underset{2}{\cancel{8}}} \times \frac{\overset{3}{\cancel{12}}}{1} = \frac{3}{2} = 1\frac{1}{2}$

**15.** $\frac{83}{\underset{2}{\cancel{4}}} \times \frac{\overset{3}{\cancel{6}}}{1} = {}^{249}/_{2} =$ 124.5 or 125 whole number

## Decimals

**16.** 0.9
**17.** 2.6
**18.** 0.4
**19.** $^{68}/_{100}$
**20.** $^{9}/_{10}$
**21.** $^{12}/_{1000}$
**22.** $^{33}/_{100}$
**23.** 0.204 or 0.2
**24.** 0.95535, or 0.96, or 1
**25.** 10.8
**26.** 301.739 or 301.7

## Ratio and Proportion

**27.** $^{3}/_{4}$
**28.** $^{65}/_{90}$
**29.** $^{1}/_{175}$
**30.** $^{9}/_{1000}$
**31.** 12
**32.** 30

**33.** 2.5
**34.** 50
**35.** $\frac{1}{2} \times \frac{4}{X} =$
(cross-multiply)
$X = 8$

**36.** $\frac{\overset{1}{\cancel{5}}}{\underset{10}{\cancel{50}}} = \frac{X}{300}$
$10X = 300$
$X = 30$

**37.** $^{0.9}/_{10} = {}^{x}/_{90}$
$10X = 90$
$X = 9$

## Percentage

**38.** $^{3}/_{100}$
**39.** $^{27}/_{100}$
**40.** $^{12}/_{1000}$
**41.** $^{575}/_{10,000}$
**42.** 0.08 or 0.1

**43.** 0.15
**44.** 0.009
**45.** 0.035
**46.** 0.0025
**47.** 0.0045

**48.** 35 : 100
**49.** 12.5 : 100 or 125 : 1000
**50.** 4 : 100
**51.** 0.9 : 100 or 9 : 1000
**52.** 0.45 : 100 or 45 : 10,000

# PART II

## SYSTEMS, CONVERSION, AND METHODS OF DRUG CALCULATION

# CHAPTER 1

# Systems Used for Drug Administration and Temperature Conversion

**Objectives**

- Identify the system of measurement accepted worldwide and the system of measurement used in home settings.
- List the basic units and subunits of weight, volume, and length of the metric system.
- Explain the rules for changing grams to milligrams and milliliters to liters.
- Give abbreviations for the frequently used metric units and subunits.
- List the basic units of measurement for volume in the household system.
- Convert units of measurement within the metric system and within the household system.
- Convert Fahrenheit to Celsius and Celsius to Fahrenheit.

**Outline**

**METRIC SYSTEM**
**HOUSEHOLD SYSTEM**
**TEMPERATURE CONVERSION**

There have been three systems used for measuring drugs and solutions: metric, apothecary, and household. The metric system, or decimal system, was developed in France and is based on units of 10. It is a very precise system of measure used in medicine and science, which has been adopted worldwide, and is now known as the International System of Units (SI).

The apothecary system of measure, which dates back to the middle ages, was used for measurements of mass and volume. The pound, ounce, and grain were measurements of mass, whereas, the gallon, pint, fluid ounce, dram, and minim were used for volume. Although the larger measures of pounds, ounces, gallons, and pints are still used, the smaller measures, of grains and minums, are no longer used for medication calculation or administration. All medications are manufactured, dosed, and measured by the International Standard of Units.

Standard household measurements, teaspoon, tablespoon, and cup, are primarily used in the home setting. Standard household measure can be converted to metric only if standard measuring devices are used, not tableware. Tableware cups and spoons vary in size and are not accurate for measuring. Standard measuring spoons and measuring cups are preferred. Medication for children should only use metric measuring devices, standard measuring devices should be discouraged because of the danger of inaccuracy.

Roman numerals were at one time used for prescribing and dosing of medication. Roman numerals are no longer used for medication prescribing but can be seen in labeling such as the I-IV designation on controlled substances. Roman numerals are not used for computation and cannot be broken down into fractions and like the apothecary system have been superceded by advances in mathematics.

## METRIC SYSTEM

The metric system is a decimal system based on multiples of 10 and decimal fractions of 10. There are three basic units of measurement. These basic units are as follows:

*Gram* (g): unit for weight
*Liter* (L): unit for volume or capacity
*Meter* (m): unit for linear measurement or length

Prefixes are used with the basic units to describe whether the units are larger or smaller than the basic unit. The prefixes indicate the size of the unit in multiples of 10. The prefixes for basic units are as follows:

| Prefix for Larger Unit | | Prefix for Smaller Unit | |
|---|---|---|---|
| Kilo | 1000 (one thousand) | Deci | 0.1 (one-tenth) |
| Hecto | 100 (one hundred) | Centi | 0.01 (one-hundredth) |
| Deka | 10 (ten) | Milli | 0.001 (one-thousandth) |
| | | Micro | 0.000001 (one-millionth) |
| | | Nano | 0.000000001 (one-billionth) |

Abbreviations of metric units that are frequently written in drug orders are listed in Table 1.1. Lowercase letters are usually used for abbreviations rather than capital letters.

The metric units of weight, volume, and length are given in Table 1.2. Meanings of the prefixes are stated next to the units of weight. Note that the larger units are 1000, 100, and 10 times the basic units (in bold type) and the smaller units differ by factors of 0.1, 0.01, 0.001, 0.000001, and 0.000000001. The size of a basic unit can be changed by multiplying or dividing by 10. Micrograms and nanograms are the exceptions: one (1) milligram = 1000 micrograms, and one (1) microgram = 1000 nanograms. Micrograms and nanograms are changed by 1000 instead of by 10.

### Conversion Within the Metric System

Drug administration often requires conversion within the metric system to prepare the correct dosage. Two basic methods are given for changing larger to smaller units and smaller to larger units.

**TABLE 1.1** Metric Units and Abbreviations

| | Names | Abbreviations |
|---|---|---|
| Weight | Kilogram | kg |
| | Gram | g |
| | Milligram | mg |
| | Microgram | mcg |
| | Nanogram | ng |
| Volume | Kiloliter | kL |
| | Liter | L |
| | Deciliter | dL |
| | Milliliter | mL |
| | Microliter | mcL |
| Length | Kilometer | km |
| | Meter | m |
| | Centimeter | cm |
| | Millimeter | mm |

**TABLE 1.2 Units of Measurement in the Metric System With Their Prefixes**

| Weight per Gram | Meaning |
|---|---|
| *1 kilogram (kg) = 1000 grams | One thousand |
| 1 hectogram (hg) = 100 grams | One hundred |
| 1 dekagram (dag) = 10 grams | Ten |
| ***1 gram (g) = 1 gram** | **One** |
| 1 decigram (dg) = 0.1 gram ($^1/_{10}$) | One-tenth |
| 1 centigram (cg) = 0.01 gram ($^1/_{100}$) | One-hundredth |
| *1 milligram (mg) = 0.001 gram ($^1/_{1000}$) | One-thousandth |
| *1 microgram (mcg) = 0.000001 gram ($^1/_{1,000,000}$) | One-millionth |
| *1 nanogram (ng) = 0.000000001 gram ($^1/_{1,000,000,000}$) | One-billionth |
| **Volume per Liter** | **Length per Meter** |
| *1 kiloliter (kL) = 1000 liters | *1 kilometer (km) = 1000 meters |
| 1 hectoliter (hL) = 100 liters | 1 hectometer (hm) = 100 meters |
| 1 dekaliter (daL) = 10 liters | 1 dekameter (dam) = 10 meters |
| ***1 liter (L) = 1 liter** | **1 meter (m) = 1 meter** |
| 1 deciliter (dL) = 0.1 liter | 1 decimeter (dm) = 0.1 meter |
| 1 centiliter (cL) = 0.01 liter | *1 centimeter (cm) = 0.01 meter |
| *1 milliliter (mL) = 0.001 liter | *1 millimeter (mm) = 0.001 meter |
| 1 microliter (mcL) = 0.000001 liter | |

*Commonly used units of measurements.

### *Larger Units to Smaller Units*

To change from a ***larger*** unit to a ***smaller*** unit, multiply by 10 for each unit decreased, or move the decimal point one space to the right for each unit changed.

When changing three units from larger to smaller, such as from gram to milligram (a change of three units), multiply by 10 three times (or by 1000), or move the decimal point three spaces to the right.

Change 1 gram (g) to milligrams (mg):

**a.** $1 \times 10 \times 10 \times 10 = 1000$ mg

**b.** 1 g $\times$ 1000 = 1000 mg

**or**

**c.** 1 g = 1.000 mg (1000 mg)

When changing two units, such as kilogram to dekagram (a change of two units from larger to smaller), multiply by 10 twice (or by 100), or move the decimal point two spaces to the right.

Change 2 kilograms (kg) to dekagrams (dag):

**a.** $2 \times 10 \times 10 = 200$ dag

**b.** 2 kg $\times$ 100 = 200 dag

**or**

**c.** 2 kg = 2.00 dag (200 dag)

When changing one unit, such as liter to deciliter (a change of one unit from larger to smaller), multiply by 10, or move the decimal point one space to the right.

Change 3 liters (L) to deciliters (dL):

**a.** 3 $\times$ 10 = 30 dL

**b.** L $\times$ 10 = 30 dL

**or**

**c.** 3 L = 3.0 dL (30 dL)

A micro unit is one thousandth of a milli unit, and a nano unit is one thousandth of a micro unit. To change from a milli unit to a micro unit, multiply by 1000, or move the decimal place three spaces to the right. Changing micro units to nano units involves the same procedure, multiplying by 1000 or moving the decimal place three spaces to the right.

**EXAMPLES**

**PROBLEM 1:** Change 2 grams (g) to milligrams (mg).

$$2\text{ g} \times 1000 = 2000\text{ mg}$$

**or**

$$2\text{ g} = 2.000\text{ mg (2000 mg)}$$

**PROBLEM 2:** Change 10 milligrams (mg) to micrograms (mcg).

$$10\text{ mg} \times 1000 = 10,000\text{ mcg}$$

**or**

$$10\text{ mg} = 10.000\text{ mcg (10,000 mcg)}$$

**PROBLEM 3:** Change 4 liters (L) to milliliters (mL).

$$4\text{ L} \times 1000 = 4000\text{ mL}$$

**or**

$$4\text{ L} = 4.000\text{ mL (4000 mL)}$$

**PROBLEM 4:** Change 2 kilometers (km) to hectometers (hm).

$$2\text{ km} \times 10 = 20\text{ hm}$$

**or**

$$2\text{ km} = 2.0\text{ hm (20 hm)}$$

### *Smaller Units to Larger Units*

To change from a ***smaller*** unit to a ***larger*** unit, divide by 10 for each unit increased, or move the decimal point one space to the left for each unit changed.

When changing three units from smaller to larger, divide by 1000, or move the decimal point three spaces to the left.

Change 1500 milliliters (mL) to liters (L):

**a.** $1500\text{ mL} \div 1000 = 1.5\text{ L}$

**or**

**b.** $1500\text{ mL} = 1\,500.\text{ L (1.5 L)}$

When changing two units from smaller to larger, divide by 100, or move the decimal point two spaces to the left.

Change 400 centimeters (cm) to meters (m):

**a.** $400\text{ cm} \div 100 = 4\text{ m}$

**or**

**b.** $400\text{ cm} = 4\,00.\text{ m (4 m)}$

When changing one unit from smaller to larger, divide by 10, or move the decimal point one space to the left.

Change 150 decigrams (dg) to grams (g):

**a.** 150 dg ÷ 10 = 15 g

**or**

**b.** 150 dg = 15 0. g (15 g)

**EXAMPLES**

**PROBLEM 1:** Change 8 grams (g) to kilograms (kg).

8 g ÷ 1000 = 0.008 kg

**or**

8 g = 008. kg (0.008 kg)

**PROBLEM 2:** Change 1500 milligrams (mg) to decigrams (dg).

1500 mg ÷ 100 = 15 dg

**or**

1500 mg = 15 00. dg (15 dg)

**PROBLEM 3:** Change 750 micrograms (mcg) to milligrams (mg).

750 mcg ÷ 1000 = 0.75 mg

**or**

750 mcg = 750. mg (0.75 mg)

**PROBLEM 4:** Change 2400 milliliters (mL) to liters (L).

2400 mL ÷ 1000 = 2.4 L

**or**

2400 mL = 2 400. L (2.4 L)

## PRACTICE PROBLEMS ▶ I METRIC SYSTEM (CONVERSION WITHIN THE METRIC SYSTEM)

*Answers can be found on page 24.*

**1.** Conversion from larger units to smaller units: *Multiply* by 10 for each unit changed (multiply by 10, 100, 1000), or move the decimal point one space to the *right* for each unit changed (move one, two, or three spaces).

**a.** 7.5 grams to milligrams _____

**b.** 10 milligrams to micrograms _____

**c.** 35 kilograms to grams _____

**d.** 2.5 liters to milliliters _____

**e.** 1.25 liters to milliliters _____

**f.** 20 centiliters to milliliters _____

**g.** 18 decigrams to milligrams _____

**h.** 0.5 kilograms to grams _____

2. Conversion from smaller units to larger units: *Divide* by 10 for each unit changed (divide by 10, 100, 1000), or move the decimal point one space to the *left* for each unit changed (move one, two, or three spaces).
   - **a.** 500 milligrams to grams _____
   - **b.** 7500 micrograms to milligrams _____
   - **c.** 250 grams to kilograms _____
   - **d.** 4000 milliliters to liters _____
   - **e.** 325 milligrams to grams _____
   - **f.** 100 milliliters to deciliters _____
   - **g.** 2800 milliliters to liters _____
   - **h.** 75 millimeters to centimeters _____

## HOUSEHOLD SYSTEM

The use of household measurement is common in the home because that is what is readily available for cooking and baking. The household system of measurement is considered less accurate than the metric system because it lacks standardization. However, newer measuring cups and spoons have both household and metric measure. A teaspoon (t) is considered 5 mL and 15 mL is considered one tablespoon (T). One cup is 250 mL and 500 mL is a pint. Since oral intake at home is measured in household measure, it is useful to know the conversions.

The community health nurse may use and teach the household units of measurements to patients and caregivers.

Table 1.3 gives the commonly used units of measurement in the household system. You might want to memorize the equivalents in Table 1.3 or refer to the table as needed.

**TABLE 1.3 Units of Measurement in the Household System**

| | | | |
|---|---|---|---|
| 1 teaspoon (t) | = 5 mL | 1 measuring cup | = 8 ounces (oz) |
| 1 tablespoon (T) | = 3 teaspoons (t) | 2 cups | = 1 pint |
| 1 ounce (oz) | = 2 tablespoons (T) | 4 cups | = 1 quart |

### Conversion Within the Household System

For changing larger units to smaller units and smaller units to larger units within the household system, the same methods that applied to the apothecary system can be used. With household measurements, a fluid ounce is usually indicated as an ounce.

#### *Larger Units to Smaller Units*

To change a ***larger*** unit to a ***smaller*** unit, multiply the constant value found in Table 1.3 by the number of the larger unit.

**EXAMPLES** **PROBLEM 1:** 1/2 cup juice glass = _____ ounces (oz).

1 cup = 8 oz (8 is the constant value)

1/2 c × 8 oz = 4 oz

**PROBLEM 2:** 3 tablespoons (T) = _____ teaspoons (t).

1 T = 3 t (3 is the constant value)

3 × 3 = 9t

**PROBLEM 3:** 5 ounces (oz) = _____ tablespoons (T).

1 oz = 2 T (2 is the constant value)

5 × 2 = 10 T

**PROBLEM 4:** 1/2 ounce (oz) = _____ tablespoon (T)

1 oz = 2 T (2 is the constant value)

1/2 × 2 = 1T

### *Smaller Units to Larger Units*

To change a ***smaller*** unit to a ***larger*** unit, divide the constant value found in Table 1.3 into the number of the larger unit.

**NOTE**

The constant values are the numbers of the smaller units in Table 1.3.

**EXAMPLES** **PROBLEM 1:**

9 teaspoons (t) = _____ tablespoons (T).

1 T = 3 t (3 is the constant value)

9 ÷ 3 = 3 T

**PROBLEM 2:**

24 ounces (oz) = _____ cups (c).

1 c = 8 oz (8 is the constant value)

24 ÷ 8 = 3 c

**PROBLEM 3:**

4 tablespoons (T) = _____ ounces (oz).

1 oz = 2 T (2 is the constant value)

4 ÷ 2 = 2 oz

## PRACTICE PROBLEMS ▶ II HOUSEHOLD SYSTEM (CONVERSION WITHIN THE HOUSEHOLD)

*Answers can be found on page 24.*

**1.** Give the equivalents, changing larger units to smaller units.

**a.** 2 glasses = _____ oz

**b.** 3 ounces = _____ T

**c.** 4 Tablespoons = _____ t

**d.** 1½ c (cups) = _____ oz

**e.** ½ Tablespoon = _____ t

**2.** Give the equivalents, changing smaller units to larger units.

**a.** 9 teaspoons = _____ T

**b.** 6 tablespoons = _____ oz

**c.** 6 teaspoons = _____ oz

**d.** 12 ounces = _____ cups

**e.** 24 ounces = _____ cups

## TEMPERATURE CONVERSION

Temperature is commonly measured by two scales, Celsius and Fahrenheit (Figure 1.1). Celsius (C), or centigrade, describes temperature with 0° C as the freezing point of water and 100° C as the boiling point of water. The Celsius scale is widely used around the world. Medical devices and scientific equipment often use the Celsius scale because it is a base-10 system like the metric system. The Fahrenheit (F) scale describes temperature with the freezing point of water as 32° F and the boiling point of water as 212° F. The Fahrenheit scale is primarily used in the United States and its territories.

To convert from Fahrenheit to Celsius the formula is:

$$[C] = ([^\circ F] - 32) \times 5/9$$

To convert from Celsius to Fahrenheit the formula is:

$$[F] = ([^\circ C] \times 9/5) + 32$$

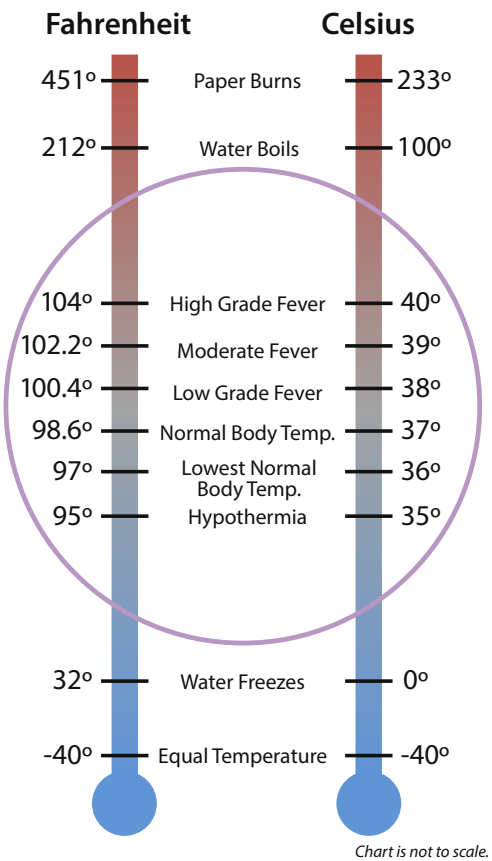



**Figure 1.1** Comparison of Fahrenheit and Celsius.

## PRACTICE PROBLEMS ▶ III TEMPERATURE CONVERSION

*Answers can be found below.*

**a.** Change 98.8° F to Celsius _____
**b.** Change 101° F to Celsius _____
**c.** Change 103° F to Celsius _____
**d.** Change 22° C to Fahrenheit _____
**e.** Change 30° C to Fahrenheit _____

# ANSWERS

## I Metric System

**1. a.** 7.5 g to mg
7.5 g × 1000 = 7500 mg
or
7.500 mg (7500 mg)

**b.** 35,000 g
**c.** 2500 mL
**d.** 1250 mL
**e.** 200 mL
**f.** 1 dL
**g.** 1800 mg
**h.** 500 g

**2. a.** 500 mg to g
500 ÷ 1000 = 0.5 g
or
500 mg = 500. g (0.5 g)

**b.** 7.5 mg
**c.** 0.25 kg
**d.** 4 L
**e.** 0.325 g
**f.** 1 dL
**g.** 2.8 L
**h.** 7.5 cm

## II Household System

**1. a.** 2 glasses = _____ oz
2 × 8 = 16 oz
**b.** 6 T
**c.** 12 t
**d.** 12 oz
**e.** 1½ t

**2. a.** 9 teaspoons = _____T
9 ÷ 3 = 3T
**b.** 3 oz
**c.** 1 oz
**d.** 1V2 cups
**e.** 3 cups

## III Temperature Conversion

**a.** ° C = ([98.8° F] − 32) × 5/9
° C = 66.8 × 5/9
= 334/9
° C = 37.1

**b.** ° C = ([101° F] − 32) × 5/9
° C = 69 × 5/9
= 345/9
° C = 38.3

**c.** ° C = ([103 °F] − 32) × 5/9
° C = 71 × 5/9
= 355/9
° C = 39.4

**d.** ° F = ([22° C] × 9/5) + 32
= 198/5 + 32
= 39.6 + 32
° F = 71.6

**e.** ° F = ([30° C] × 9/5) + 32
= 270/5 1 32
= 54 1 32
° F = 86

## SUMMARY PRACTICE PROBLEMS

*Answers can be found below.*

Make conversions within the two systems.

**1.** Metric system

**a.** 30 mg = _____ mcg

**b.** 3 g = _____ mg

**c.** 6 L = _____ mL

**d.** 1.5 kg = _____ g

**e.** 10,000 mcg = _____ mg

**f.** 500 mg = _____ g

**g.** 2500 mL = _____ L

**h.** 125 g = _____ kg

**i.** 120 mm = _____ cm

**j.** 5 m = _____ cm

**2.** Household system

**a.** 12 t = _____ T

**b.** 5 cups = _____ oz

**c.** 3 T = _____ t

**d.** 2 cups = _____ oz

**e.** 24 oz = _____ c (cups)

**f.** 4 oz = _____ T

## ANSWERS SUMMARY PRACTICE PROBLEMS

**1. a.** 30,000 mcg
**b.** 3000 mg
**c.** 6000 mL
**d.** 1500 g
**e.** 10 mg
**f.** 0.5 g
**g.** 2.5 L
**h.** 0.125 kg
**i.** 12 cm
**j.** 500 cm

**2. a.** 4 T
**b.** 40 oz
**c.** 9 t
**d.** 16 oz
**e.** 3 c (cups)
**f.** 8 T

# CHAPTER 2

# Conversion Within the Metric and Household Systems

**Objectives**

- Name the metric equivalents that are commonly used in health care.
- Name the metric equivalents for length, weight, and volume.
- Convert length, weight, and volume between metric and household measurements.
- Explain units, milliequivalents, and percents.

**Outline**



Health care primarily uses the metric system to measure for length, volume, and weight. Sometimes it is necessary to convert measurements from the common household system (cups, ounces, tablespoons, pounds, inches, etc.) to the metric system. Unlike the household system, the metric system has three fundamental units (grams, liters, and meters) which can be multiplied or divided by factors of 10. The metric system has prefixes based upon multiples of 10, which can make conversion with the system much easier.

Medications, such as drugs and intravenous fluids, are predominately ordered in metric units (grams, milligrams, liters, and milliliters). Standard household measurements are never used. Household measurements are commonly used in liquid measure, height, and weight. It is still necessary for the nurse to memorize the few common household and metric equivalents to easily convert between the two systems.

## UNITS, MILLIEQUIVALENTS, AND PERCENTS

Units, milliequivalents, and percents are measurements and are used to indicate the strength or potency of certain drugs. When a drug is developed, its strength is based on chemical assay or biological assay. Chemical assay denotes strength by weight, e.g., milligrams. Biological assays are used for drugs in which the chemical composition is difficult to determine. Biological assays assess potency by determining the effect that one unit of the drug can have on a laboratory animal. Units mainly measure the potency of hormones, vitamins, anticoagulants, and some antibiotics. Drugs that were once standardized by units and were later synthesized to their chemical composition may still retain units as an indication of potency, e.g., insulin.

Milliequivalents measure the strength of an ion concentration. Ions are given primarily for electrolyte replacement. They are measured in milliequivalents (mEq), one of which is $1/_{1000}$ of the equivalent weight of an ion. Potassium chloride (KCl) is a common electrolyte replacement and is ordered in milliequivalents.

Percents, the concentrations of weight dissolved in a volume, are always expressed as units of mass per units of volume. Common concentrations are g/mL, g/L, and mg/mL. These concentrations, expressed as percentages, are based on the definition of a 1% solution as 1 g of a drug in 100 mL of solution. Dextrose 50% in a 50-mL pre-filled syringe is a concentration of 50 g of dextrose in 100 mL of water. Calcium gluconate 10% in a 30-mL bottle is a concentration of 10 g of calcium gluconate in 100 mL of solution. Proportions can also express concentrations. A solution that is 1 : 100 has the same concentration as a 1% solution. Epinephrine 1 : 1000 means that 1 g of epinephrine was dissolved in a 1000-mL solution.

Units, milliequivalents, and percents cannot be directly converted into the metric system of measure.

## METRIC AND HOUSEHOLD EQUIVALENTS

Knowing how to convert drug doses between the systems of measurement is essential in the clinical setting. In discharge teaching for individuals receiving liquid medication converting metric to household measurement may be important. Table 2.1 gives the metric and household equivalents by weight, volume, and length.

**TABLE 2.1 Approximate Metric and Household Equivalents**

| | Metric System | Household System |
|---|---|---|
| **Weight** | 1 kg = 1000 g | 2.2 lbs |
| | 30 g | 1 oz |
| | 15 g | 0.5 oz |
| **Volume** | 1 L = 1000 mL | 1 qt = 32 fl oz |
| | 0.5 L = 500 mL | 1 pt = 16 fl oz |
| | 0.25 L = 250 mL | 1 c or 8 oz |
| | 0.18 L = 180 mL | 6 oz |
| | 30 mL | 2 T or 6 t or 1 oz |
| | 15 mL | 1 T or 0.5 oz |
| | 4-5 mL | 1 t |
| | 1 mL | 15-16 gtt (drops) |
| **Length** | 1 meter | 3.2808 feet |
| | 0.3048 m | 1 foot |
| | 0.0254 m | 1 inch |
| | 2.54 cm | 1 inch |

## CONVERSION IN METRIC AND HOUSEHOLD SYSTEMS BY WEIGHT

### MEMORIZE

**Metric and Household Equivalents**

1 Kilogram (kg) = 2.2 pounds (lbs)

30 grams (g) = 1 ounce (oz)

To convert kg to lbs, multiply the number of kg by 2.2 lbs/kg, the constant value.

**EXAMPLE** Change 45 kilograms to pounds. $45\ \cancel{kg} \times 2.2\ \text{lbs}/\cancel{kg} = 99\ \text{lbs}$

To convert lbs to kg, divide the number of lbs by 2.2 lbs/kg, the constant value.

**EXAMPLE** Change 150 pounds to kilograms. $\dfrac{150\ \cancel{lbs}}{2.2\ \cancel{lbs}/kg} = 68.18\ \text{kg}$

To convert g to oz, divide the number of g by 30 g/oz, the constant value.

**EXAMPLE** Change 90 grams to ounces. $\dfrac{90\ \cancel{g}}{30\ \cancel{g}/oz} = 3\ \text{oz}$

To convert oz to g, multiply the number of ounces by 30 g/oz, the constant value.

**EXAMPLE** Change 6 ounces to grams. $6\ \cancel{oz} \times 30\ \text{g}/\cancel{oz} = 180\ \text{g}$

### PRACTICE PROBLEMS ▶ I CONVERSION BY WEIGHT

*Answers can be found on page 30.*

**1.** 195 lbs = _____ kg

**2.** 184 lbs = _____ kg

**3.** 120 g = _____ oz

**4.** 5 oz = _____ g

**5.** 60 kg = _____ lbs

**6.** 14 kg = _____ lbs

## CONVERSION IN METRIC AND HOUSEHOLD SYSTEMS BY LIQUID VOLUME

### MEMORIZE

**Metric and Household Equivalents**

1 liter (L) = 32 ounces (oz)

30 milliliter (mL) = 1 ounce

To convert liters to ounces, multiply the number of liters by 32 oz/L, the constant value.

**EXAMPLE** Change 3 liters to ounces. $3\ \cancel{L} \times 32\ \text{oz}/\cancel{L} = 96\ \text{oz}$

To convert ounces to liters, divide the number of ounces by 32 oz/L, the constant value.

**EXAMPLE** Change 64 oz to liters. $\dfrac{64\ \cancel{oz}}{32\ \cancel{oz}/\text{L}} = 2\ \text{L (liters)}$

To convert ounces to milliliters, multiply the number of ounces by 30 mL/oz, the constant value.

**EXAMPLE** Change 5 oz to mL. $5\ \cancel{oz} \times 30\ mL/\cancel{oz} = 150\ mL$

To convert milliliters to ounces, divide the number of milliliters by 30 mL/oz, the constant value.

**EXAMPLE** Change 120 mL to ounces. $\dfrac{120\ \cancel{mL}}{30\ \cancel{mL}/oz} = 4\ oz$

## PRACTICE PROBLEMS ▶ II CONVERSION BY LIQUID VOLUME

*Answers can be found on page 30.*

### *Liters and Ounces (Round to the nearest tenths.)*

**1.** 2.5 L = _____ oz
**2.** 0.25 L = _____ oz
**3.** 40 oz = _____ L
**4.** 24 oz = _____ L

### *Ounces and Milliliters*

**1.** 4 oz (fl oz) = _____ mL
**2.** 6½ oz = _____ mL
**3.** ½ oz = _____ mL
**4.** 5 mL = _____ oz
**5.** 150 mL = _____ oz
**6.** 15 mL = _____ oz

## CONVERSION IN METRIC AND HOUSEHOLD SYSTEMS BY LENGTH

**MEMORIZE**

**Metric and Household Equivalents**
0.3048 meter = 1 foot
2.54 centimeters = 1 inch

To convert feet to meters, multiply the number of feet by 0.3048 m/ft, the constant value.

**EXAMPLE** Change 5 feet to meters. $5\ \cancel{ft} \times 0.3048\ m/\cancel{ft} = 1.52\ m$

To convert meters to feet, divide the number of meters by 0.3048 m/ft, the constant value.

**EXAMPLE** Change 2 meters to feet. $\dfrac{2\ \cancel{m}}{0.3048\ \cancel{m}/ft} = 6.56\ ft$

To convert inches to centimeters, multiply the number of inches by 2.54 cm/in, the constant value.

**EXAMPLE** Change 4 inches to centimeters. $4\ \cancel{in} \times 2.54\ cm/\cancel{in} = 10.16\ cm$

To convert centimeters to inches, divide the number of centimeters by 2.54 cm/in, the constant value.

**EXAMPLE** Change 60 centimeters to inches. $\dfrac{60\ \cancel{cm}}{2.54\ \cancel{cm}/in} = 23.6\ inches$

## PRACTICE PROBLEMS ▶ III CONVERSION BY LENGTH

*Answers can be found below.*

| Feet to meters | Meters to feet | Inches to centimeters | Centimeters to inches |
|---|---|---|---|
| **1.** 6 ft __ m | **4.** 1.88 m __ ft | **7.** 2.5 in __ cm | **10.** 3.8 cm __ in |
| **2.** 5 ft __ m | **5.** 1.575 m __ ft | **8.** 5 in __ cm | **11.** 2.6 cm __ in |
| **3.** 4 ft __ m | **6.** 0.864 m __ ft | **9.** 10 in __ cm | **12.** 4.2 cm __ in |

# ANSWERS

## I Conversion by Weight

**1.** $\frac{195\ \cancel{lbs}}{2.2\ kg/\cancel{lbs}} = 88.6\ kg$

**2.** $\frac{184\ \cancel{lbs}}{2.2\ kg/\cancel{lbs}} = 83.6\ kg$

**3.** $\frac{120\ \cancel{g}}{30\ g/oz} = 4\ oz$

**4.** 5 ~~oz~~ × 30 g/~~oz~~ = 150 g

**5.** 60 ~~kg~~ × 2.2 lbs/~~kg~~ = 132 lbs

**6.** 14 ~~kg~~ × 2.2 lbs/~~kg~~ = 30.8 lbs

## II Conversion by Liquid Volume

### Liters and Ounces

**1.** 2.5 ~~L~~ × 32 oz/~~L~~ = 80 oz
**2.** 0.25 ~~L~~ × 32 oz/~~L~~ = 8 oz
**3.** 40 ~~oz~~ ÷ 32 ~~oz~~/L = 1.25 L or 1.3 L
**4.** 24 ~~oz~~ ÷ 32 ~~oz~~/L = 0.75 L or 0.8 L

### Ounces and Milliliters

**1.** 4 ~~oz~~ × 30 mL/~~oz~~ = 120 mL
**2.** 6.5 ~~oz~~ × 30 mL/~~oz~~ = 195 mL
**3.** 0.5 ~~oz~~ × 30 mL/~~oz~~ = 15 mL
**4.** 45 ~~mL~~ ÷ 30 ~~mL~~/oz = 1½ oz or 1.5 oz
**5.** 150 ~~mL~~ ÷ 30 ~~mL~~/oz = 5 oz
**6.** 15 ~~mL~~ ÷ 30 ~~mL~~/oz = ½ oz or 0.5 oz

## III Conversion by Length

**1.** 6 ~~ft~~ × 0.3048 m/~~ft~~ = 1.82 or 1.8 m
**2.** 5 ~~ft~~ × 0.3048 m/~~ft~~ = 1.52 or 1.5 m
**3.** 4 ~~ft~~ × 0.3048 m/~~ft~~ = 1.22 or 1.2 m
**4.** $\frac{1.88\ \cancel{m}}{0.3048\ \cancel{m}/ft} = 6.18$ or 6.2 ft
**5.** $\frac{1.575\ \cancel{m}}{0.3048\ \cancel{m}/ft} = 5.16$ or 5.2 ft
**6.** $\frac{0.864\ \cancel{m}}{0.3048\ \cancel{m}/ft} = 2.83$ or 2.8 ft
**7.** 2.5 ~~in~~ × 2.54 cm/~~in~~ = 6.35 or 6.4 cm
**8.** 5 ~~in~~ × 2.54 cm/~~in~~ = 12.7 or 13 cm
**9.** 10 ~~in~~ × 2.54 cm/~~in~~ = 25.4 cm
**10.** $\frac{3.8\ \cancel{cm}}{2.54\ \cancel{cm}/in} = 1.49$ or 1.5 in
**11.** $\frac{2.6\ \cancel{cm}}{2.54\ \cancel{cm}/in} = 1.02$ or 1 in
**12.** $\frac{4.2\ \cancel{cm}}{2.54\ \cancel{cm}/in} = 1.65$ or 1. 7 in

# SUMMARY PRACTICE PROBLEMS

*Answers can be found on page 32.*

May refer to Table 2.1

## Weight: Metric and Household Conversion

**a.** To convert kg to pounds, multiply/divide by _____.
**b.** To convert pounds to kg, multiply/divide by _____.

**1.** 60 kg to _____ lbs
**2.** 75 kg to _____ lbs
**3.** 1.75 kg to _____ lbs
**4.** 12 kg to _____ lbs
**5.** 373 lbs to _____ kg
**6.** 196 lbs to _____ kg
**7.** 2.7 lbs to _____ kg
**8.** 22 lbs to _____ kg

**a.** To convert grams to ounces, multiply/divide by _____.
**b.** To convert ounces to grams, multiply/divide by _____.

**1.** 40 g to _____ oz
**2.** 100 g to _____ oz
**3.** 75 g to _____ oz
**4.** 200 g to _____ oz
**5.** 6 oz to _____ g
**6.** 10 oz to _____ g
**7.** 2 oz to _____ g
**8.** 4 oz to _____ g

## Volume: Metric and Household Conversion

**a.** To convert liters to ounces, multiply/divide by_____.
**b.** To convert ounces to liters, multiply/ divide by_____.

**1.** 3 L =_____oz
**2.** 48 oz =_____L
**3.** 64 oz =_____L
**4.** 0.5 L =_____oz
**5.** 8 oz =_____L
**6.** 24 oz =_____L

**a.** To convert ounces to milliliters, multiply/divide by_____.
**b.** To convert milliliters to ounces, multiply/divide by_____.

**1.** 1.5 oz =_____mL
**2.** 15 mL =_____oz
**3.** 60 mL =_____oz
**4.** 75 mL =_____oz
**5.** 3 oz =_____mL
**6.** 8 oz =_____mL

## Length: Metric and Household Conversion

**a.** To convert meters to feet, multiply/divide by _____.
**b.** To convert feet to meters, multiply/divide by_____.

**1.** 10 m to _____ ft
**2.** 1.2 m to _____ ft
**3.** 2 m to _____ ft
**4.** 6.2 m to _____ ft
**5.** 15 ft to _____ m
**6.** 1.5 ft to _____ m
**7.** 20 ft to _____ m
**8.** 50 ft to _____ m

**a.** To convert centimeters to inches, multiply/divide by_____.
**b.** To convert inches to centimeters, multiply/divide by_____.

**1.** 7 in to _____ cm
**2.** 3 in to _____ cm
**3.** 40 in to _____ cm
**4.** 52 in to _____ cm
**5.** 75 cm to _____ in
**6.** 2 cm to _____ in
**7.** 36 cm to _____ in
**8.** 40 cm to _____ in

# ANSWERS SUMMARY PRACTICE PROBLEMS

## Weight

**a.** multiply 2.2 kg/lbs
**b.** divide 2.2 kg/lbs
**1.** 60 ~~kg~~ × 2.2 ~~kg~~/lbs = 132 lbs
**2.** 75 ~~kg~~ × 2.2 ~~kg~~/lbs = 165 lbs
**3.** 1.75 ~~kg~~ × 2.2 ~~kg~~/lbs = 3.85 lbs
**4.** 12 ~~kg~~ × 2.2 ~~kg~~/lbs = 26.4 lbs
**5.** $\frac{373\ \cancel{lbs}}{2.2\ \cancel{lbs}\ /\ kg} = 169.5\text{kg}$
**6.** $\frac{196\ \cancel{lbs}}{2.2\ \cancel{lbs}\ /\ kg} = 89\ \text{kg}$
**7.** $\frac{2.7\ \cancel{lbs}}{2.2\ \cancel{lbs}\ /\ kg} = 1.2\text{kg}$
**8.** $\frac{22\ \cancel{lbs}}{2.2\ \cancel{lbs}\ /\ kg} = 10\ \text{kg}$

**a.** divide 30 g/oz
**b.** multiply 30 g/oz
**1.** $\frac{40\ \cancel{g}}{30\ \cancel{g}\ /\ oz} = 1.3\ \text{oz}$
**2.** $\frac{100\ \cancel{g}}{30\ \cancel{g}\ /\ oz} = 3.3\ \text{oz}$
**3.** $\frac{75\ \cancel{g}}{30\ \cancel{g}\ /\ oz} = 2.5\ \text{oz}$
**4.** $\frac{200\ \cancel{g}}{30\ \cancel{g}\ /\ oz} = 6.7\ \text{oz}$
**5.** 6 ~~oz~~ × 30 g/~~oz~~ = 180 g
**6.** 10 ~~oz~~ × 30 g/~~oz~~ = 300 g
**7.** 2 ~~oz~~ × 30 g/~~oz~~ = 60 g
**8.** 4 ~~oz~~ × 30 g/~~oz~~ = 120 g

## Volume

**a.** multiply, 32 oz/L
**b.** divide, 32 oz/L
**1.** 3 ~~L~~ × 32 oz/~~L~~ = 96 oz
**2.** $\frac{48\ \cancel{oz}}{32\ \cancel{oz}\ /L} = 1.5\ \text{L}$
**3.** $\frac{64\ \cancel{oz}}{32\ \cancel{oz}\ /L} = 2\ \text{L}$
**4.** 0.5 ~~L~~ × 32 oz/~~L~~ = 16 oz
**5.** $\frac{8\ \cancel{oz}}{32\ \cancel{oz}\ /L} = 0.25\ \text{L}$
**6.** $\frac{24\ \cancel{oz}}{32\ \cancel{oz}\ /L} = 0.75\ \text{L}$

**a.** multiply, 30 mL/oz
**b.** divide, 30 mL/oz
**1.** 1.5 ~~oz~~ × 30 mL/~~oz~~ = 45 mL
**2.** $\frac{15\ \cancel{mL}}{30\ \cancel{mL}\ /oz} = 0.5\ \text{oz}$
**3.** $\frac{60\ \cancel{mL}}{30\ \cancel{mL}\ /oz} = 2\ \text{oz}$
**4.** $\frac{75\ \cancel{mL}}{30\ \cancel{mL}\ /oz} = 2.5\ \text{oz}$
**5.** 3 ~~oz~~ × 30 mL/~~oz~~ = 90 mL
**6.** 8 ~~oz~~ × 30 mL/~~oz~~ = 240 mL

## Length

**a.** divide by 0.3048 m/ft
**b.** multiply by 0.3048 m/ft
**1.** 10 ~~m~~ × 0.3048 ~~m~~/ft = 3.048 or 3.05 ft
**2.** 1.2 ~~m~~ × 0.3048 ~~m~~/ft = 0.365 or 0.37 ft
**3.** 2 ~~m~~ × 0.3048 ~~m~~/ft = 0.609 or 0.61 ft
**4.** 6.2 ~~m~~ × 0.3048 ~~m~~/ft = 1.889 or 1.89 ft
**5.** $\frac{15\ \cancel{ft}}{0.3048\ m\ /\ \cancel{ft}} = 49.2\ \text{m}$
**6.** $\frac{1.5\ \cancel{ft}}{0.3048\ m\ /\ \cancel{ft}} = 4.92\ \text{m}$
**7.** $\frac{20\ \cancel{ft}}{0.3048\ m\ /\ \cancel{ft}} = 65.6\ \text{m}$
**8.** $\frac{50\ \cancel{ft}}{0.03048\ m\ /\ \cancel{ft}} = 164\ \text{m}$

**a.** divide 2.54 inches/cm
**b.** multiply 2.54 inches/cm
**1.** 7 ~~in~~ × 2.54 ~~in~~/cm = 17.78 or 17.8 cm
**2.** 3 ~~in~~ × 2.54 ~~in~~/cm = 7.62 or 7.6 cm
**3.** 40 ~~in~~ × 2.54 ~~in~~/cm = 101.6 cm
**4.** 52 ~~in~~ × 2.54 ~~in~~/cm = 132 cm
**5.** $\frac{75\ \cancel{cm}}{2.54\ in\ /\ \cancel{cm}} = 29.5\ \text{in}$
**6.** $\frac{2\ \cancel{cm}}{2.54\ in\ /\ \cancel{cm}} = 0.78\ \text{in}$
**7.** $\frac{36\ \cancel{cm}}{2.54\ in\ /\ \cancel{cm}} = 91.4\ \text{in}$
**8.** $\frac{40\ \cancel{cm}}{2.54\ in\ /\ \cancel{cm}} = 15.7\ \text{in}$

## APPLICATION: INTAKE PRACTICE PROBLEMS

*Answers can be found below.*

1. Patient intake for lunch included a carton of milk (8 oz), cup of coffee (6 oz), small glass of apple juice (4 oz), and gelatin (4 oz). How many milliliters (mL) did the patient consume for lunch? _____ mL
2. Add 8-hour intake: IV/30 mL/hr, 230 mL in IV medications. PO intake: juice (4 oz), tea (6 oz), water (3 oz), gelatin (4 oz), ginger ale (5 oz), and milk (8 oz). What was the patient's intake (IV and PO) in 8 hours? _____ mL
3. Add 8-hour intake: IV/ 60 mL/hr; 250 mL in IV medications. PO intake: juice 4 oz, water 3 oz, gelatin 2 oz, and broth 4 oz. What was the patient's intake (IV and PO) in 8 hours? _____ mL

## ANSWERS APPLICATION: INTAKE PRACTICE PROBLEMS

**1.**
Milk = 240 mL
Coffee = 180 mL
Apple juice = 120 mL
Gelatin = 120 mL
660 mL

The patient's intake for lunch is 660 mL.

**2.**
IV: 30 mL × 8 hr = 240 mL
IV medications = 230 mL
Juice (4 oz × 30 mL) = 120 mL
Tea = 180 mL
Water = 90 mL
Gelatin = 120 mL
Ginger ale = 150 mL
Milk = 240 mL
1370 mL

The patient's intake in 8 hours (IV and PO) is 1370 mL.

**3.**
IV: 60 mL/hr × 8 hr = 480 mL
IV medications = 250 mL
Juice = 120 mL
Water = 90 mL
Gelatin = 60 mL
Broth = 120 mL
1120 mL

The patient's intake in 8 hours (IV and PO) is 1120 mL.

For additional practice problems, refer to the Conversions and Equivalents section of the Elsevier's Interactive Drug Calculation Application, version 1 on Evolve.

## NGN® PREP

**1.** A post-partum new mother is breast feeding her newborn. To ensure her milk supply, she should consume at least 2 liters of fluid/day. This amount in household measure would be _A_ or _B_.

| Option A | Option B |
|---|---|
| 64oz | 8 - 8 oz cups |
| 32oz | 10 - 8oz cups |
| 16oz | 16 - 8 oz cups |

**2.** A newborn infant at his first well baby visit weighs 6 ½ lbs. His birth weight was 8lbs. The infant's current weight in kg is _A_ and his weight loss in kg is _B_.

| Option A | Option B |
|---|---|
| 3.64kg | 0.82kg |
| 2.95kg | 0.68kg |
| 3.24kg | 0.49kg |

**3.** Patient admitted to Emergency Department with two lacerations of the right lower leg from a construction accident. The lateral proximal laceration is 3 inches long and the distal posterior laceration is 6 inches long. The length of the proximal wound in centimeters is _A_ and the length of the distal laceration is _B_.

| Option A | Option B |
|---|---|
| 8.5cm | 15.2cm |
| 6.5cm | 10.2cm |
| 5.5cm | 14cm |
| 7.6cm | 12.5cm |

**4.** Mr. Smith is receiving a bladder irrigation thru a 3-way foley catheter after a transurethral resection of the prostate to control for bleeding. The irrigation was run at 100ml/hr for 4 hours then reduced to 75ml/hr for the next 4 hours. Patient's total output, irrigation and urine, was 1940ml. The total amount of irrigating solution was _A_ and the total amount of urine was _B_.

| Option A | Option B |
|---|---|
| 800mL | 1240mL |
| 900mL | 1140mL |
| 1000mL | 940mL |
| 700mL | 1040mL |

## ANSWERS - NGN® PREP

1. **Option A:** 2L × 32 oz/L = 64oz
   **Option B:** 64oz ÷ 8oz cups = 8 cups
2. **Option A:** 6.5lbs ÷ 2.2lbs/kg = 2.95kg
   **Option B:** 8 lbs ÷ 2.2lbs/kg = 3.63kg
   3.63kg − 2.95kg = 0.68kg
3. **Option A:** 3 inches × 2.54cm/inch = 7.6cm
   **Option B:** 6 inches × 2.54cm/inch = 15.2cm
4. **Option A:** Irrigation solution 100mL/hr × 4hr = 400mL
   75mL/hr × 4hr = 300mL
   Total irrigation solution 400mL + 300mL = 700 mL
   **Option B:** Total output 1940ml − 700ml = 1240 urine output

# CHAPTER 3

# Interpretation of Drug Labels, Drug Orders, Bar Codes, MAR and eMAR, Automation of Medication Dispensing Administration, and Abbreviations

**Objectives**

- Identify brand names, generic names, drug forms, dosages, expiration dates, and lot numbers on drug labels.
- Explain difference between military and traditional time.
- Give examples of drugs with "look-alike" drug names.
- Name the components of a drug order.
- Explain the computer-based medication administration system.
- Explain the use of the bar code for unit dose drug.
- Identify drug information for charting.
- Provide meanings of abbreviations: drug form, drug measurement, and routes and times of drug administration.

**Outline**

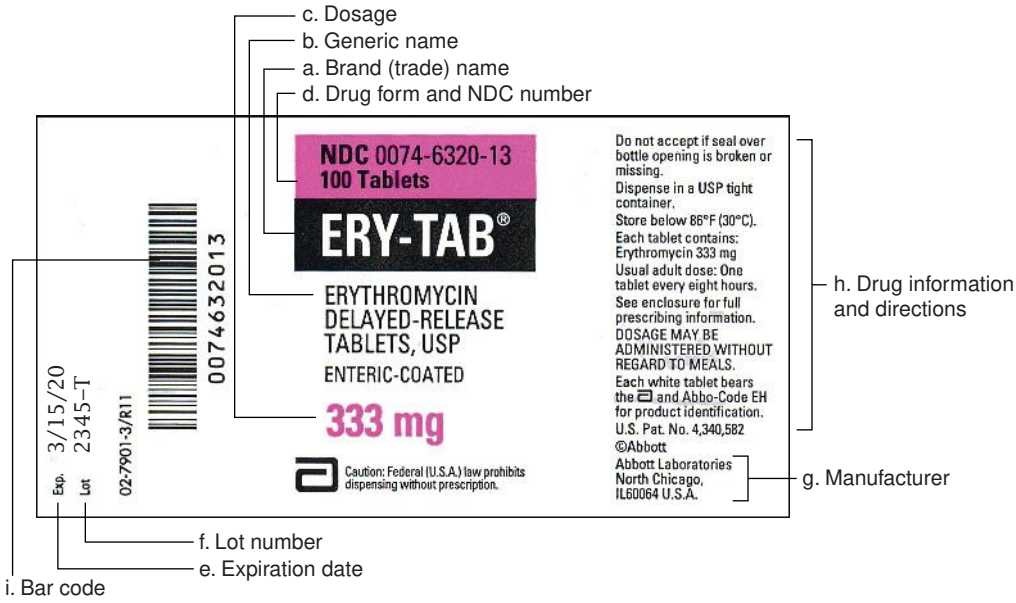


## INTERPRETATION OF DRUG LABELS

Pharmaceutical companies label drugs with their brand name of the drug in large letters and the generic name in smaller letters. The form of the drug (tablet, capsule, liquid, or powder) and dosage are printed on the drug label.

Many of the calculation problems in this book use drug labels. By using drug labels, the student can practice solving drug problems that are applicable to clinical practice. The student should know what information is on a drug label and how this information is used in drug calculations. All drug labels provide eight basic items of data: (1) brand (trade) name, (2) generic name, (3) dosage, (4) form of the drug, (5) expiration date, (6) lot number, (7) name of the manufacturer, and (8) drug information and directions.

### EXAMPLE DRUG LABEL




**a.** The brand (trade) name is the commercial name given by the pharmaceutical company (manufacturer of the drug). It is printed in large, bold letters.

**b.** The generic name is the chemical name given to the drug, regardless of the drug manufacturer. It is printed in smaller letters, usually under the brand name. Drugs are usually referred to by their generic name.

**c.** The dosage strength is the drug dose per drug form (tablet, capsule, liquid) as stated on the label.

**d.** The National Drug Code number (NDC) is the universal product identifier required by the U.S. Food and Drug Administration. The numbers identify the manufacturer, distributor, strength, dosage, formulation (tablets, capsules, liquids), and package size.

**e.** The expiration date refers to the length of time the drug can be used before it loses its potency. Drugs should not be administered after the expiration date. The nurse must check the expiration date of all drugs that he or she administers.

**f.** The lot number identifies the drug batch in which the medication was produced. Occasionally, a drug is recalled according to the lot number.

**g.** The manufacturer is the pharmaceutical company that produces the brand-name drug.

**h.** Specific drug-related information and directions. This information along with more detail can be found in the package insert.

**i.** The bar code contains all drug identifiers, such as control lot, batch number, NDC number, and expiration date. This is on all prescription and nonprescription medications.

Examples of drug labels are given, and practice problems for reading drug labels follow the examples.