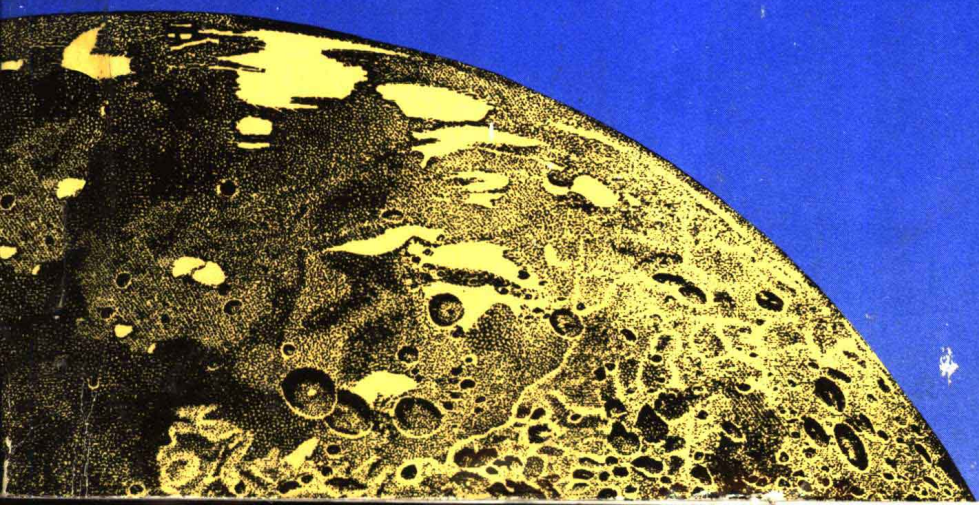
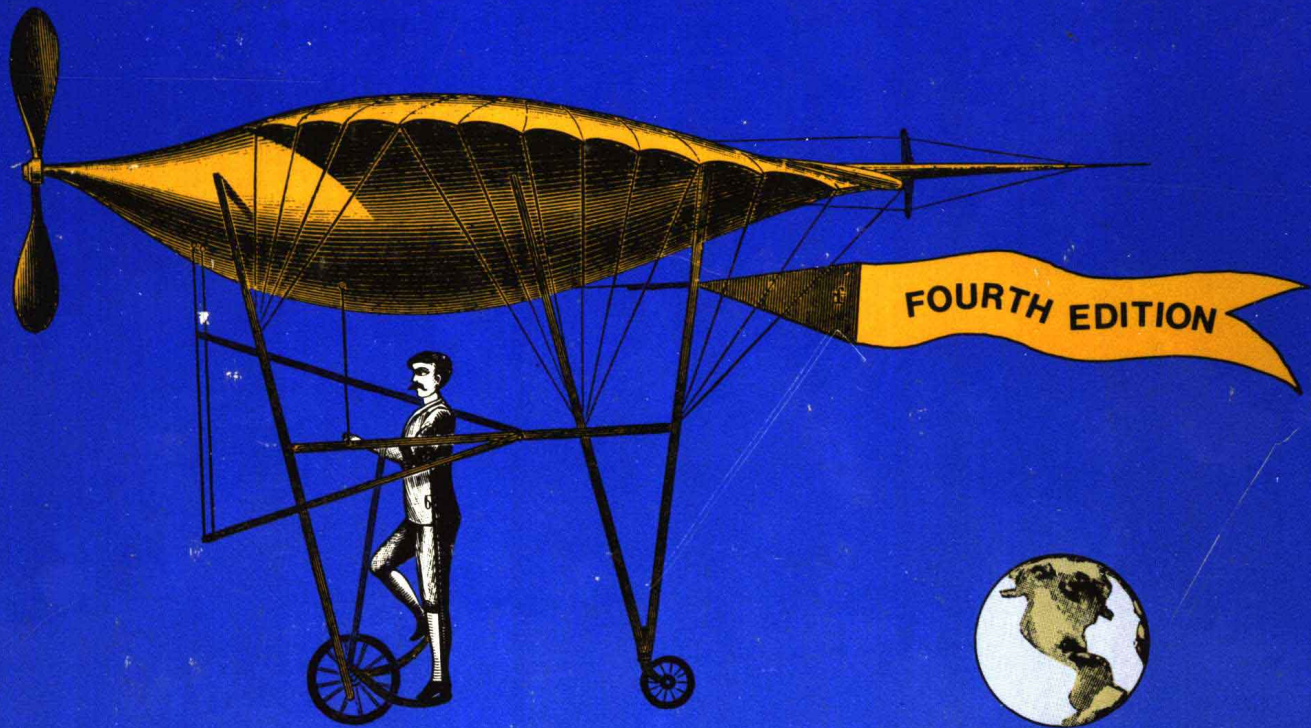


ESSENTIAL ARITHMETIC

Johnston / Willis / Hughes



ESSENTIAL ARITHMETIC

FOURTH EDITION

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Wadsworth Publishing Company

Belmont, California

A division of Wadsworth, Inc.

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BOOK PRODUCTION: Bookman Productions

TYPING: Susan Rogan and Jackie Georges

COVER DESIGN: Bookman Productions

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ISBN 0-534-03240-0

Printed in the United States of America

4 5 6 7 8 9 10---88 87 86 85

Library of Congress Cataloging in Publication Data

Johnston, C. L. (Carol Lee), 1911-
Essential arithmetic.

Includes index.

1. Arithmetic--1961- . I. Willis, Alden T.
II. Hughes, Gale M. III. Title.
QA107.J64 1984 513'.142 83-21921
ISBN 0-534-03240-0

Preface

This fourth edition reflects many helpful comments from users of previous editions as well as our own classroom experience in teaching from the book.

Following are the major changes in the fourth edition:

1. A separate set of Cumulative Review Exercises appears immediately following the Chapter Review Exercises for Chapters 2 through 6.
2. The percent chapter, Chapter 6, now includes changing a fraction to a percent and changing a percent to a fraction. Word problems involving percents receive special attention. Percent of increase and decrease problems now are covered in Section 611.
3. NOW accounts are covered in Section 802.
4. The Austrian Subtraction Method is deleted.
5. The notation on the Metric System now corresponds with the notation used in the SI system.
6. More word problems appear throughout the book.

Following are some of the major features of this book:

1. The book is divided into two parts:

Part I includes topics in arithmetic that are "essential" to daily living. This part constitutes a minimum course in arithmetic. It includes operations with whole numbers, fractions, decimals, ratio, proportion, and percent.

Part II includes applications of arithmetic in daily living, the use of calculators, the metric and English systems of measurement, arithmetic in geometry, and an introduction to algebra.

2. The contents are arranged in small sections, each with its own examples and exercises.
3. Between each topic explanation and the exercises are many completely worked examples.
4. There are over 4,000 exercises in this book.

Set I Exercises: The *complete* solutions for all odd-numbered Set I exercises are included in the back of this text, together with the answers for all even-numbered Set I exercises. In most cases the even-numbered exercises provide practice on problems analogous to the odd-numbered exercises. Students can use the solutions for the odd-numbered Set I exercises as a study aid in doing the even Set I exercises, as well as all Set II exercises.

Set II Exercises: The level of difficulty of Set II exercises is the same as that of Set I. Answers to all Set II exercises appear in the Instructor's Manual. No answers for Set II exercises appear in the text.

5. A diagnostic test follows each chapter. *Complete* solutions to all problems on these diagnostic tests, together with section references, appear in the answer section.
6. A cumulative diagnostic test covers Part I: Chapters 1-6. This examination can be used as a pretest to determine whether a student needs to take a course in arithmetic, or it can be used as an achievement test or midterm exam after a student has completed Part I.
7. An instructor's manual contains four different tests for each chapter that may be easily removed and duplicated for class use. In addition, there are two different tests covering the material in the first six chapters (Part I). These tests are prepared with adequate space for students to work the problems. Answer keys for these tests are provided in the manual.
8. A comprehensive treatment of the metric system is included.
9. For quick reference, English and metric tables, together with conversions, and a list of symbols appear inside the front and back covers of the book.
10. The exercises throughout the book include interesting information and everyday problems.

This textbook can be used in three types of instructional programs:

1. The conventional lecture course. This book is particularly easy to fit into a program of regular assignments because it is divided into many small, self-contained units. Examinations that can be given for each chapter appear in the instructor's manual. Following each chapter in the textbook is a diagnostic test, which students may use for review and diagnostic purposes. This textbook has been class-tested by the authors and by many other instructors in the conventional lecture-course program.
2. The learning laboratory class. Because of the format of explanation, example, and exercise in each section of the book, together with the diagnostic tests and solutions for each chapter, this book offers a wide degree of latitude in the pace at which students may progress in the learning laboratory.

3. Self-study. This textbook lends itself to self-study because (a) each new topic is short enough to be mastered before continuing, and (b) almost 800 examples are solved and over 1,600 complete solutions are given for the odd-numbered Set I exercises, together with 1,600 answers for the even-numbered Set I exercises. To use this book for self-study, students could begin by taking the diagnostic test for Chapter 1. When correcting this test themselves, they would be directed to specific sections of the book that explain the particular problems worked out incorrectly. Students can continue in this manner at their own pace through the book.

We wish to thank our many friends for their valuable suggestions. In particular, we are deeply grateful to Merrill F. Hale, Roosevelt High School, Los Angeles; Heschel Shapiro, Los Angeles Trade Technical College; Edward Rosenberg and Merwin L. Waite, East Los Angeles College; Robert T. Stephens, Moorpark College, California; E. B. Hoff, Glendale Community College, Arizona; and James N. Tipton, Mesa Community College, Arizona, for their thorough reading and useful criticism of the original manuscript. Of special help with the second edition have been Bryn Gary and Clifton Gary, Oscar Rose College, Midwest City, Oklahoma; George L. Holloway, Los Angeles Valley College, California; Samuel Waltmire, Goddard Junior High School, Glendora, California; Jeannie Lazaris and Tom Drouet, East Los Angeles College, California; Susan A. Barker, Atlantic Community College, Mays Landing, New Jersey; and Bill Orr, San Bernardino Valley College, California. Of special help with the third edition have been Ruth Flournoy, Anchorage Community College; John Mowbray, Kapiolani Community College; Jane Murphy, Middlesex Community College; Kay Hudspeth, Pennsylvania State University; Judy Cain, Tompkins-Courtlant Community College; Raymond Boersema, Community College of Denver; Gus Pekara, South Oklahoma City Junior College; Ara Sullenberger, Tarrant County Junior College; Genie Trow, Antelope Valley College; Lee Marsh, Kalamazoo Valley Community College; and Don Brashear, Lees College. Of special help with the fourth edition have been Sharon W. Bird, Richland College; Ray Boersema, Front Range Community College; Daniel L. Buchanan, Henry Ford Community College; Gayle F. Childers, J. Sargeant Reynolds Community College; Ray E. Collings, Tri-County Technical College; Richard R. Conley, University of Kentucky - Ashland Community College; Helen Joan Dykes, Northern Virginia Community College; Allen Epstein, West Los Angeles College; Harold N. Hauser, Mt. Hood Community College; Pauline Jenness, Harper College; Pamela E. Matthews, Chabot College; Sue Miller, Coppin State College; David Price, Tarrant County Junior College; David D. Quarles, St. Petersburg Junior College; Charles D. Reinauer, San Jacinto College; Larysa T. Shmorhay, San Diego Mesa College; Linda Trice, J. Sargeant Reynolds Community College.

This book is dedicated to our students, who inspired us to do our best to produce a book worthy of their time.

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PART I

ESSENTIAL ARITHMETIC

Part I of this book includes topics in arithmetic "essential" to daily living and constitutes a minimum course in arithmetic. This includes operations with whole numbers, fractions, decimals, ratio, proportion, and percent.

- Chapter 1 WHOLE NUMBERS: Addition, Multiplication, and Powers
- 2 WHOLE NUMBERS: Subtraction, Division, and Roots
- 3 Fractions
- 4 Decimal Fractions
- 5 Ratio and Proportion
- 6 Percent

ONE

Whole Numbers: Addition, Multiplication, and Powers

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101

Basic Definitions

In this section we introduce some of the names and definitions of numbers and number relations.

NATURAL NUMBERS. The set of numbers

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and so on,

are called the *natural numbers* (or *counting numbers*). These were probably the first numbers* invented by man and used to count his possessions, such as sheep, goats, etc.

NUMBER LINE. Natural numbers can be represented by numbered points equally spaced along a straight line (Figure 101A). Such a line is called a *number line*.

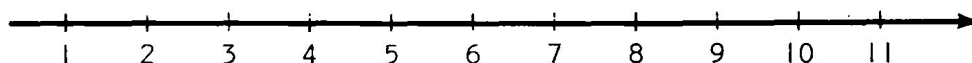


Figure 101A

The arrowhead shows the direction in which numbers get larger. Numbers that follow one another (without interruption) are called *consecutive numbers*. Later we will discuss other kinds of numbers, such as fractions, which can also be placed on the number line.

The smallest natural number is 1. The largest natural number can never be found because no matter how far we count there are always larger natural numbers. Since it is impossible to write all of the natural numbers, it is customary to represent them as follows:

$$\{1, 2, 3, 4, \dots\}$$

↑ read "and so on"

The three dots to the right of the number 4 indicate that the remaining numbers are found by counting in the same way we have begun: Namely, to add 1 to the preceding number to find the next number. We call the set of natural numbers N . So that

$$N = \{1, 2, 3, 4, \dots\}$$

*A number is an idea or thought. It is something in our minds. A *numeral* is the symbol we write on paper to show what number we have in mind. Some examples of symbols used as numerals are; 5, 30, four, ten, VI, and X.

WHOLE NUMBERS. When 0 is included with the natural numbers, we have the set of numbers known as *whole numbers* (Figure 101B).

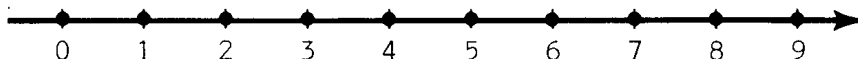


Figure 101B

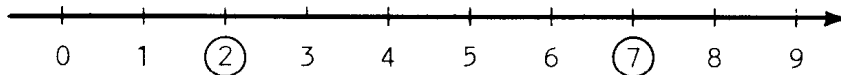
We call the set of whole numbers W . So that

$$W = \{0, 1, 2, 3, \dots\}$$

INEQUALITY SYMBOLS. The symbols $<$ and $>$ are called *inequality symbols*. Let X be any number on the number line. Then numbers to the right of X on the number line are said to be *greater than* X , written " $>X$." Numbers to the left of X on the number line are said to be *less than* X , written " $<X$."

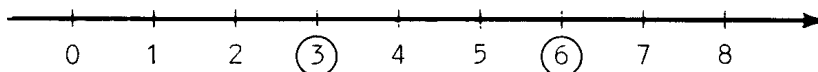
Example 1.

2 is to the left of 7
Written: $2 < 7$
Read: "2 is less than 7"

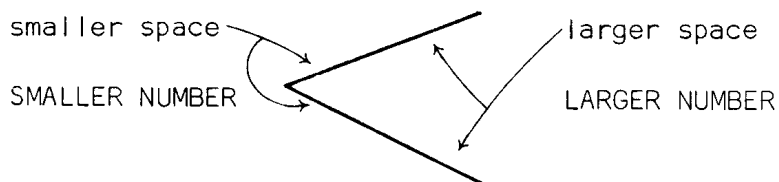


Example 2.

6 is to the right of 3; therefore $6 > 3$



An easy way to remember the meaning of the symbol is to notice that the wide part of the symbol is next to the larger number.



Some people like to think of the symbols $>$ and $<$ as arrowheads that point toward the smaller number.

Example 3.

- (a) $7 > 6$ is read "7 is greater than 6."
- (b) $7 > 1$ is read "7 is greater than 1."
- (c) $5 < 10$ is read "5 is less than 10."
- (d) $3 < 4 < 5$ is read "3 is less than 4 and 4 is less than 5."

Note that $7 > 6$ and $6 < 7$ give the same information even though they are read differently.

Another inequality symbol is \neq . A slash line drawn through a symbol puts a "not" in the meaning of the symbol.

- = is read "is equal to";
- \neq is read "is *not* equal to."
- < is read "is less than";
- \nless is read "is *not* less than."
- > is read "is greater than";
- \ngtr is read "is *not* greater than."

Example 4. Examples showing the use of the slash line:

- (a) $4 \neq 5$ is read "4 is not equal to 5."
- (b) $3 \nless 2$ is read "3 is not less than 2."
- (c) $5 \ngtr 6$ is read "5 is not greater than 6."

DIGITS. In our number system a digit is any one of the first ten whole numbers $\{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$. They are shown on the number line in Figure 101B.

Any number can be written by using some or all of these ten digits. For this reason, the digits are sometimes called the building blocks of our number system.

The word digit comes from the Latin word for finger: *digitus*.

Numbers are often referred to as *one-digit* numbers, *two-digit* numbers, *three-digit* numbers, and so on.

Example 5.

- (a) 35 is a two-digit number.
- (b) 7 is a one-digit number.
- (c) 275 is a three-digit number.
- (d) 100 is a three-digit number.
- (e) The first digit of 785 is 7.
- (f) The second digit of 785 is 8.
- (g) The third digit of 785 is 5.

We show the natural numbers, whole numbers, and digits on the number line in Figure 101C.

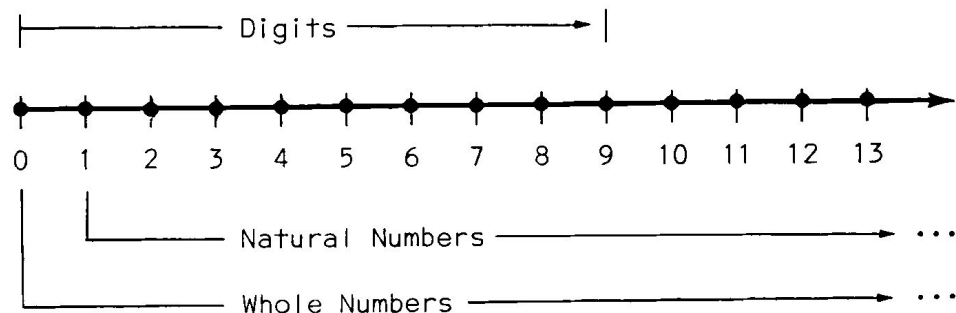


Figure 101C



EXERCISES 101, SET I

1. What is the second digit of the number 159?
2. What is the smallest natural number?
3. What is the smallest digit?
4. What is the smallest whole number?
5. What is the fourth digit of the number 1,975?
6. What is the smallest two-digit natural number?
7. What is the smallest three-digit whole number?
8. What is the largest one-digit number?
9. What is the largest two-digit number?
10. Write two different symbols that tell the number of days in a week.
11. Is 12 a digit?
12. Is 12 a natural number?
13. Is 12 a whole number?
14. What is the largest natural number?
15. What is the largest digit?
16. Write all the whole numbers < 4 .
17. Write all the digits > 5 .
18. Write the consecutive natural numbers > 14 and < 17 .
19. Write in consecutive order all the digits that are < 5 .

In Exercises 20-25, determine which of the two symbols $>$ or $<$ should be used to make each statement true.

20. $8 \underline{\quad ? \quad} 7$.
21. $0 \underline{\quad ? \quad} 1$.
22. $1 \underline{\quad ? \quad} 0$.
23. $5 \underline{\quad ? \quad} 8$.
24. The weight of a man is $\underline{\quad ? \quad}$ the weight of a baby.
25. The distance to the moon is $\underline{\quad ? \quad}$ the distance to a star.

EXERCISES 101, SET II

1. What is the second digit in the number 467?
2. What is the largest digit?
3. What is the fourth digit of 3,852?
4. What is the smallest two-digit whole number?
5. What is the largest three-digit number?
6. Is 10 a digit?
7. Is 10 a whole number?
8. What is the largest whole number?
9. Write all the digits greater than 7.
10. Write in consecutive order all the digits that are less than 4.

In the remaining exercises, determine which of the two symbols $>$ or $<$ should be used to make each statement true.

11. $2 \underline{\quad ? \quad} 0$.
12. $4 \underline{\quad ? \quad} 6$.
13. $0 \underline{\quad ? \quad} 3$.
14. The distance from New York City to Alaska is $\underline{\quad ? \quad}$ the distance from New York City to Boston.