INTRODUCTORY and INTERMEDIATE ALGEBRA

K. ELAYN MARTIN-GAY

Introductory and Intermediate Algebra

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To my two brave friends,
Mary Catherine Dooley
and
Donna Phillips Thieme

Preface

Why This Book Was Written

This book is intended for a two-semester course in introductory and intermediate algebra. Specific care has been taken to prepare students to go on to their next course in algebra. I have tried to achieve this by writing a user-friendly text keyed to objectives containing many of worked-out examples. Functions are introduced in this text, and applications and geometric concepts are emphasized throughout the book.

How This Book Was Written

Throughout the writing and developing of this book, I had the help of many people. Seven instructors, who teach courses similar to this one, were involved in the actual writing of the text, contributing their ideas for helpful examples, interesting applications, and useful exercises.

Once the first draft was complete, Prentice Hall held a focus group with four reviewers, the author, and editors from Prentice Hall. We spent many hours going over the manuscript with a fine-toothed comb, refining the project's focus and enhancing its pedagogical value.

Finally, a full-time development editor worked with me to make the writing style as clear as possible while still retaining the mathematical integrity of the content.

Key Content Features

In addition to the traditional topics taught in introductory and intermediate algebra courses, this text contains a strong emphasis of geometric concepts, reading and interpreting graphs, and problem solving integrated throughout. The geometric concepts covered are those that are most important to a student's understanding of algebra, and I have included many applications and exercises devoted to this topic. Also, geometric figures and a review of angles, lines, and special triangles are covered in the appendices. I have also integrated reading and interpreting line and bar graphs throughout much of this text. Not only does this naturally lead to the rectangular coordinate system, but it gives students practice at interpreting real data. Problem solving is, of course, emphasized by devoting single sections to this concept (such as Sections 2.4,

2.5, and 3.3 on formulas and solving problems that lead to linear equations) as well as by including problem-solving exercises throughout this text.

Key Pedagogical Features

Exercise Sets. Each exercise set is divided into two parts. Both parts contain graded problems. The first part is carefully keyed to worked examples in the text. Once a student has gained confidence in a skill, the second part contains exercises not keyed to examples. There are ample exercises throughout this book, including end-of-chapter reviews, tests, and cumulative reviews. In addition, each exercise set contains one or more of the following features.

Mental Mathematics. These problems are found at the beginning of an exercise set. They are mental warmups that reinforce concepts found in the accompanying section and increase students' confidence before they tackle an exercise set. By relying on their own mental skills, students learn not only confidence in themselves, but also number sense and estimation ability.

Skill Review. At the end of each section after Chapter 1, these problems are keyed to earlier sections and review concepts learned earlier in the text.

Writing in Mathematics. These writing exercises can be used to check a student's comprehension of an algebraic concept. They are located at the end of many exercise sets, where appropriate. Guidelines recommended by the National Council of Teachers of Mathematics and other professional groups recommend incorporating writing in mathematics courses to reinforce concepts.

Applications. This book contains a wealth of practical applications found throughout the book in worked-out examples and exercise sets.

A Look Ahead. These are examples and problems similar to those found in college algebra books. "A Look Ahead" is presented as a natural extension of the material and contains an example followed by advanced exercises. I strongly suggest that any student who plans to take another algebra course work these problems.

Graphing Calculator Boxes. Graphing calculator boxes are placed appropriately throughout the text to instruct students on proper use of the graphing calculator. These boxes, entirely optional, contain examples and exercises to reinforce the material introduced.

Helpful Hint Boxes. These boxes contain practical advice on problem solving. Helpful hints appear in the context of material in the chapter and give students extra help in understanding and working problems. They are set off in a box for easy referral.

Chapter Glossary and Summary. Found at the end of each chapter, the chapter glossary contains a list of definitions of new terms introduced in the chapter, and the summary contains a list of important rules, properties, or steps introduced in the chapter.

Chapter Review and Test. The end of each chapter contains a review of topics introduced in the chapter. These review problems are keyed to sections. The chapter test is not keyed to sections.

Cumulative Review. Each chapter after the first contains a cumulative review. Each problem contained in the cumulative review is actually an earlier worked example

in the text that is referenced in the back of the book along with the answer. Students who need to see a complete worked-out solution with explanation can do so by turning to the appropriate example in the text.

Supplements

The following supplements are available to qualified adopters of *Introductory and Intrermediate Algebra*:

For the Instructor

Instructor Solutions Manual provides even-numbered solutions.

TestPro (IBM, Mac) generates test questions and drill worksheets from algorithms keyed to the learning objectives in the book and allows you to edit and add your own questions. Available free upon adoption in 3.5″ and 5.25″ formats.

Test Item File contains a hard copy of test questions on TestPro.

For the Student

Student Solutions Manual contains odd-numbered solutions and solutions to all chapter tests and cumulative tests.

Math Master Tutor software (IBM, Mac) provides text-specific, tutorial exercises graduated in difficulty that are generated new each time, fully worked-out examples, and a timed quiz.

Videotapes with class lectures by the author are closely keyed to the book itself.

Acknowledgments

Writing this book has been a humbling experience, an effort requiring the help of many more people than I originally imagined. I will attempt to thank them here.

First, I would like to thank my husband, Clayton. Without his constant encouragement, this project would not have become a reality. I would also like to thank my children, Eric and Bryan, for continuing to eat my burnt bacon. Writing a book while raising two small children is an experience that requires an infinite amount of patience and a good sense of humor.

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K. Elayn Martin-Gay

About the Author

Elayn Martin-Gay has taught mathematics at the University of New Orleans for 16 years and has received numerous teaching awards, including the local University Alumni Association's Award for Excellence in Teaching.

Over the years, Elayn has developed videotaped lecture series to help her students understand algebra material better. This highly successful video material is the basis for the three-book series, *Prealgebra, Beginning Algebra,* and *Intermediate Algebra.*

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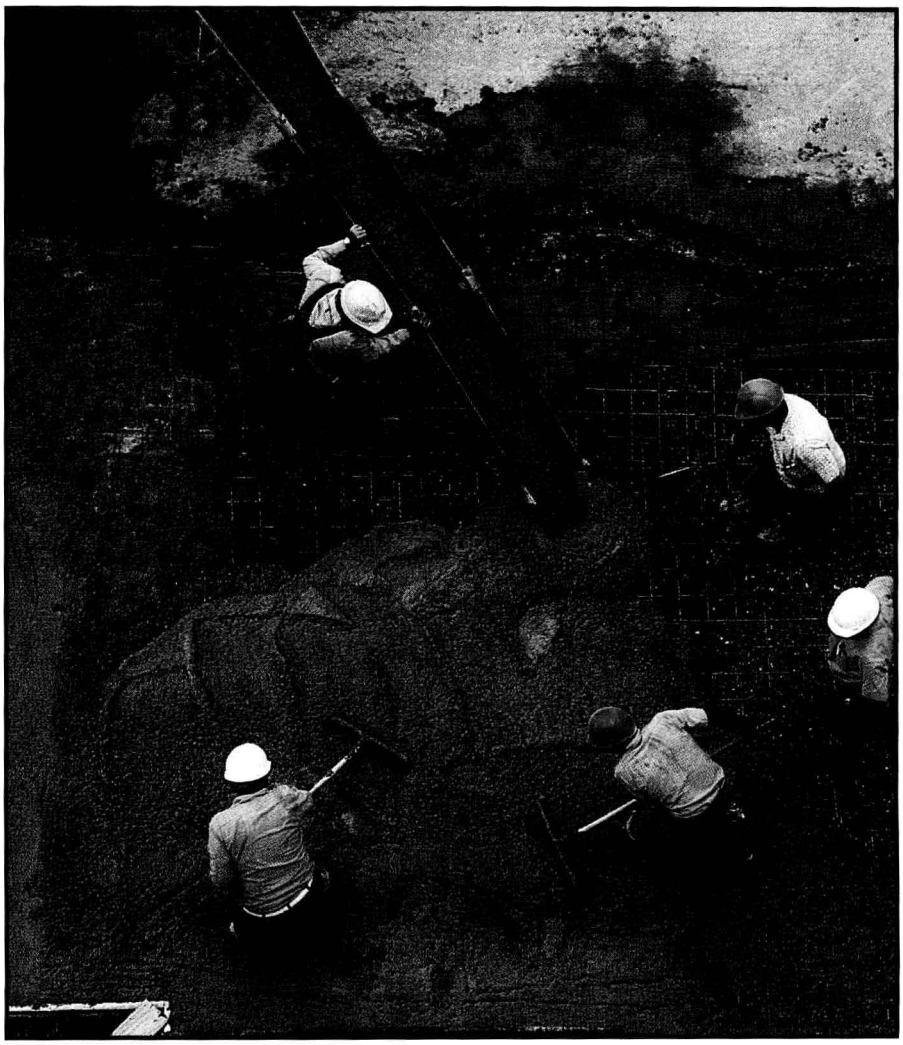
Introductory and Intermediate Algebra

CHAPTER 1

Review of Real Numbers



Sidewalks are constructed from separate concrete blocks rather than one continuous concrete slab, because concrete expands in the heat of the sun. Engineers must account for this expansion when planning the dimensions of the blocks.

INTRODUCTION

In arithmetic, everyday situations are described using numbers. Algebra differs from arithmetic in that letters are used to represent unknown numbers. An important part of learning algebra is learning the symbols and words—the language—of algebra. Much of this language is familiar to you already as the language of arithmetic. We begin our study of algebra with a review of arithmetic: its symbols, words, and patterns. This review is essential in forming the tools needed to learn the language of algebra.

1.1 Symbols

OBJECTIVES

Tape BA 1

1. Identify the symbols used for natural and whole numbers, and picture them on a number line.
2. Define the meaning of the symbols $=$, $\neq$, $<$, $>$, $\leq$, and $\geq$.
3. Translate sentences into mathematical statements.
4. Define the meaning of the symbols used for addition, subtraction, multiplication, and division.

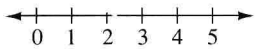
---

1 We begin with a review of natural numbers and whole numbers and how we use symbols to compare these numbers.

The **natural numbers** are 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and so on.

The **whole numbers** are the natural numbers together with zero.

The whole numbers 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and so on can be pictured with a **number line.** We will use the number line often to help us visualize objects and relationships. Visualizing mathematical concepts is an important skill and tool, and later we will develop and explore other visualizing tools.



To draw a number line, first draw a line. Choose a point on the line and label it 0. To the right of 0, label any other point 1. Being careful to use the same distance as from 0 to 1, mark off equally spaced distances. Label these points 2, 3, 4, 5, and so on. Since the whole numbers continue indefinitely, it is not possible to show every whole number on the number line. The arrow at the right end of the line indicates that the pattern continues indefinitely.

2 Picturing whole numbers on a number line helps us to see the order of the numbers. Symbols can be used to concisely describe what we see.

The **equal symbol,** $=$, states that one value "is equal to" another.

The **not equal symbol,** $\neq$, states that one value "is not equal to" another. For example,

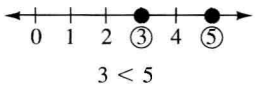
$2 = 2$ states that "two is equal to two"

$2 \neq 6$ states that "two is not equal to six"

We can use these symbols to form a **mathematical statement.** The statement might be true or it might be false. The above two statements are both true.

If two numbers are not equal, then one number is larger than the other. The **greater than symbol,** $>$, states that one value "is greater than" another. For example,

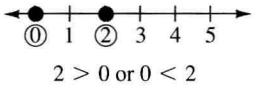
$2 > 0$ states that "two is greater than zero"



$3 < 5$

The **less than symbol,** $<$, states that one value "is less than" another. For example,

$3 < 5$ states that "three is less than five"



$2 > 0$ or $0 < 2$

On the number line, we see that a number **to the right of** another number is **larger.** Similarly, a number **to the left of** another number is smaller. For example, 3 is to the left of 5 on the number line, which means that 3 is less than 5, or $3 < 5$. Similarly, 2 is to the right of 0 on the number line, which means 2 is greater than 0, or $2 > 0$. Since 0 is to the left of 2, we can also say that 0 is less than 2, or $0 < 2$.

HELPFUL HINT

Notice that $2 > 0$ has exactly the same meaning as $0 < 2$. Switching the order of the numbers and reversing the "direction of the inequality symbol" does not change the meaning. For example,

$5 > 3$ has the same meaning as $3 < 5$

Also notice that, when the statement is true, the inequality arrow "points" to the smaller number.

EXAMPLE 1 Insert $<$, $>$, or $=$ in the space between the paired numbers to make each statement true.

a. 2 3 **b.** 7 4 **c.** 72 27

Solution:

a. $2 < 3$ since 2 is to the left of 3 on the number line.

b. $7 > 4$ since 7 is to the right of 4 on the number line.

c. $72 > 27$ since 72 is to the right of 27 on the number line. ■

Two other symbols are used to compare numbers. The **less than or equal to** symbol, $\leq$, states that one value "is less than or equal to" another value. The **greater than or equal to symbol,** $\geq$, states that one value "is greater than or equal to" another value. For example,

$7 \leq 10$ states that "seven is less than or equal to ten"

This statement is true since $7 < 10$. If either $7 < 10$ or $7 = 10$ is true, then $7 \leq 10$ is true.

$3 \geq 3$ states that "three is greater than or equal to three"