Algebra for College Students

Allen R. Angel

ALGEBRA FOR COLLEGE STUDENTS

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ALGEBRA FOR COLLEGE STUDENTS

To my mother,

    Sylvia Angel-Baumgarten

And to my step-father,

    Lenny Baumgarten

And to my mother-in-law,

    Ruth Pollinger

Preface

This book was written for college students who have successfully completed a first course in elementary algebra. My primary goal was to write a book that students can read, understand, and enjoy. To achieve this goal I have used short sentences, clear explanations, and many detailed worked-out examples. I have tried to make the book relevant to college students by using practical applications of algebra throughout the text.

Features of the Text

Four-Color Format Color is used pedagogically in the following ways:

- Important definitions and procedures are color screened.
- Color screening or color type is used to make other important items stand out.
- Artwork is enhanced and clarified with use of multiple colors.
- The four-color format allows for easy identification of important features by students.
- The four-color format makes the text more appealing and interesting to students.

Readability One of the most important features of the text is its readability. The book is very readable, even for those with weak reading skills. Short, clear sentences are used and more easily recognized, and easy-to-understand language is used whenever possible.

Accuracy Accuracy in a mathematics text is essential. To ensure accuracy in this book, mathematicians from around the country have read the pages carefully for typographical errors and have checked all the answers.

Connections Many of our students do not thoroughly grasp new concepts the first time they are presented. In this text we encourage students to make connections. That is, we introduce a concept, then later in the text briefly reintroduce it and build upon it. Often an important concept is used in many sections of the text. Students are reminded where the material was seen before, or where it will be used again. This also serves to emphasize the importance of the concept. Important concepts are also reinforced throughout the text in the Cumulative Review Exercises and Cumulative Review Tests.

Chapter Opening Application Each chapter begins with a real-life application related to the material covered in the chapter. By the time students complete the chapter, they should have the knowledge to work the problem.

Preview and Perspective This feature at the beginning of each chapter explains to the students why they are studying the material and where this material will be used again in other chapters of the book. This material helps students see the connections between various topics in the book, and the connection to real-world situations.

Student's Solution Manual, Videotape, and Software Icons At the beginning of each section, Student's Solution Manual, videotape, and tutorial software icons are displayed. These icons tell the student where material in the section can be found in the Student's Solution Manual, on the videotapes, and in the tutorial software, saving your students time when they want to review this material. Small videotape icons are also placed next to exercises that are worked out on the videotapes.

Keyed Section Objectives Each section opens with a list of skills that the student should learn in that section. The objectives are then keyed to the appropriate portions of the sections with symbols such as $1)$.

Problem Solving Polya's five-step problem-solving procedure is discussed in Section 2.2. Throughout the book problem solving and Polya's problem-solving procedure are emphasized.

Practical Applications Practical applications of algebra are stressed throughout the text. Students need to learn how to translate application problems into algebraic symbols. The problem-solving approach used throughout this text gives students ample practice in setting up and solving application problems. The use of practical applications motivates students.

Detailed Worked-Out Examples A wealth of examples have been worked out in a step-by-step, detailed manner. Important steps are highlighted in color, and no steps are omitted until after the student has seen a sufficient number of similar examples.

Now Try Exercise In each section, students are asked to work exercises that parallel the examples given in the text. These Now Try Exercises make the students *active*, rather than passive, learners and they reinforce the concepts as students work the exercises.

Study Skills Section Many students taking this course have poor study skills in mathematics. Section 1.1, the first section of this text, discusses the study skills needed to be successful in mathematics. This section should be very beneficial for your students and should help them to achieve success in mathematics.

Helpful Hints The helpful hint boxes offer useful suggestions for problem solving and other varied topics. They are set off in a special manner so that students will be sure to read them.

Avoiding Common Errors Errors that students often make are illustrated. The reasons why certain procedures are wrong are explained, and the correct procedure for working the problem is illustrated. These Avoiding Common Errors boxes will help prevent your students from making those errors we see so often.

Using Your Calculator The Using Your Calculator boxes, placed at appropriate intervals in the text, are written to reinforce the algebraic topics presented in the section and to give the student pertinent information on using the calculator to solve algebraic problems.

Using Your Graphing Calculator Using Your Graphing Calculator boxes are placed at appropriate locations throughout the text. They reinforce the algebraic topics taught and sometimes offer alternate methods of working problems. This book is designed to give the instructor the option of using or not using a graphing calculator in their course. Many Using Your Graphing Calculator boxes contain graphing calculator exercises, whose answers appear in the answer section of the book. The illustrations shown in the Using Your Graphing Calculator boxes are from a Texas Instrument 83 calculator. The Using Your Graphing Calculator boxes are written assuming that the student has no prior graphing calculator experience.

Exercise Sets

The exercise sets are broken into three main categories: Concept/Writing Exercises, Practice the Skills, and Problem Solving. Many exercise sets also contain Challenge Problems and/or Group Activities. Each exercise set is graded in difficulty. The early problems help develop the student's confidence, and then students are eased gradually into the more difficult problems. A sufficient number and variety of examples are given in each section for the student to successfully complete even the more difficult exercises. The number of exercises in each section is more than ample for student assignments and practice. Many exercise sets contain graphing calculator exercises for instructors who wish to assign them.

Concept/Writing Exercises Most exercise sets include exercises that require students to write out the answers in words. These exercises improve students' understanding and comprehension of the material. Many of these exercises involve problem solving, and conceptualization, and help develop better reasoning and critical thinking skills. Writing exercises are indicated by the symbol ✎ .

Challenge Problems These exercises, which are part of many exercise sets, provide a variety of problems. Many were written to stimulate student thinking. Others provide additional applications of algebra or present material from future sections of the book so that students can see and learn the material on their own before it is covered in class. Others are more challenging than those in the regular exercise set.

Problem Solving Exercises These exercises have been added to help students become better thinkers and problem solvers. Many of these exercises are applied in nature.

Cumulative Review Exercises All exercise sets (after the first two) contain questions from previous sections in the chapter and from previous chapters. These cumulative review exercises will reinforce topics that were previously covered and help students retain the earlier material, while they are learning the new material. For the students' benefit the Cumulative Review Exercises are keyed to the section where the material is covered.

Group Activities Many exercise sets have group activity exercises that lead to interesting group discussions. Many students learn well in a cooperative learning atmosphere, and these exercises will get students talking mathematics to one another.

Chapter Summary At the end of each chapter is a chapter summary which includes a glossary and important chapter facts.

Review Exercises At the end of each chapter are review exercises that cover all types of exercises presented in the chapter. The review exercises are keyed to the sections where the material was first introduced.

Practice Tests The comprehensive end-of-chapter practice test will enable the students to see how well they are prepared for the actual class test. The Test Item File includes several forms of each chapter test that are similar to the student's practice test. Multiple choice tests are also included in the Test Item File.

Cumulative Review Test These tests, which appear at the end of each chapter, test the students' knowledge of material from the beginning of the book to the end of that chapter. Students can use these tests for review, as well as for preparation for the final exam. These exams, like the cumulative review exercises, will serve to reinforce topics taught earlier.

Answers The *odd answers* are provided for the exercise sets. *All answers* are provided for the Using Your Graphing Calculator Exercises, Cumulative Review Exercises, the Review Exercises, Practice Tests, and the Cumulative Practice Test. *Answers* are not provided for the Group Activity exercises since we want students to reach agreement by themselves on the answers to these exercises.

National Standards

Recommendations of the *Curriculum and Evaluation Standards for School Mathematics*, prepared by the National Council of Teachers of Mathematics,

(NCTM) and *Crossroads in Mathematics: Standards for Introductory College Mathematics Before Calculus*, prepared by the American Mathematical Association of Two Year Colleges (AMATYC) are incorporated into this edition.

Prerequisite

The prerequisite for this course is a working knowledge of elementary algebra. Although some elementary algebra topics are briefly reviewed in the text, students should have a basic understanding of elementary algebra before taking this course.

Modes of Instruction

The format and readability of this book lends itself to many different modes of instruction. The constant reinforcement of concepts will result in greater understanding and retention of the material by your students.

The features of the text and the large variety of supplements available make this text suitable for many types of instructional modes including:

- lecture
- self-paced instruction
- modified lecture
- cooperative or group study
- learning laboratory

Contents

This book covers both intermediate algebra material and material from college algebra. The material from some of the later chapters, especially Chapters 10 through 12, is often covered in college algebra.

Here are some content features of this book.

- Real-life chapter-opening applications are used.
- Using Your Graphing Calculator boxes are placed throughout the text. They are used to provide information on using a graphing calculator. The text is designed so that instructors have the opportunity of using, or not using, a graphing calculator with this book.
- The table of contents has been organized to reduce the overlap between the material covered in an elementary algebra course and this book.

- Functions are integrated throughout the text to help better prepare your students for additional mathematics courses.
- The exercise sets start with Concept/Writing Exercises, followed by Practice the Skills Exercises, followed by Problem Solving Exercises.
- Problem Solving and George Polya's problem-solving procedure are stressed throughout the book. Problem-solving examples are worked using the following steps: Understand, Translate, Carry out, Check, and Answer.
- Cumulative Review Tests are at the end of every chapter.
- Many exercise sets contain Challenge Problem and/or Group Activity exercises.
- The exercise sets have a great variety of exercises, and many challenging exercises have been included for those instructors who wish to assign them. The exercise sets are graded in level of difficulty.
- Many problem solving, and thought provoking, exercises are included in the exercise sets throughout the book.
- Although functions are presented early, certain function topics such as inverse and composite functions are introduced later. This gives students the opportunity to learn and understand functions before being introduced to these more complex topics.
- In the graphing chapters, emphasis is placed on understanding the meaning of graphs.
- Many graphing calculator exercises are included in the exercise sets for those who wish to assign them.
- The Using Your Calculator and Using Your Graphing Calculator boxes are colored differently for easy identification.
- The exercise sets contain many real-life applications.
- A colorful and appealing design results in distinct features being more recognizable. The exciting design also results in students being more willing to read the text.
- Graphing AIE answers appear in an appendix in the back of the text. This results in the students' text not having large blocks of empty space in their text.
- Definitions are given in Definition Boxes and Procedures are given in Procedure Boxes.

- In the AIE, Teaching Tips are included to provide ideas for exploration.
- All Chapter Tests have 25 problems, and all Cumulative Review Tests have 20 problems.
- Now Try Exercises are included in each section after many examples. Students are asked to work specific exercises after they read specific examples. Working these exercises reinforces what the student has just learned, and also serves to make students active, rather than passive, learners. The Now Try Exercises are marked in green in the Exercise Sets for easy identification by the student.
- Exercises that are worked on the videotapes are indicated by an ▇ icon next to the exercises.
- There are many writing exercises, that is, exercises that require a written answer. Writing exercises are indicated with a pencil icon ✎ .

Supplements to the Book

The author has personally coordinated the development of the *Student's Solution Manual* and the *Instructor's Solution Manual*. Experienced mathematics professors who have prior experience in writing supplements, and whose works have been of superior quality, have been carefully selected for authoring the supplements.

For Instructors

Printed Supplements
Annotated Instructor's Edition

- Contains all of the content found in the student edition.
- Answers to all exercises are printed on the same text page (graphed answers are in a special graphing answer section at the back of the text).
- Teaching Tips throughout the text are placed at key points in the margin.

Instructor's Solutions Manual

- Solutions to even-numbered section exercises.
- Solutions to every (even and odd) exercise found in the Chapter Reviews, Chapter Tests, and Cumulative Reviews.

Instructor's Test Manual

- Two free-response Pretests per chapter.

- Eight Chapter Tests per chapter (3 multiple choice, 5 free response).
- Two Cumulative Review Tests (one multiple choice, one free response) every two chapters.
- Eight Final Exams (3 multiple choice, 5 free response).
- Twenty additional exercises per section for added test exercises if needed.

Media Supplements

TestPro4 Computerized Testing

- Algorithmically driven, text-specific testing program.
- Networkable for administering tests and capturing grades on-line.
- Edit and add your own questions—create nearly unlimited number of tests and drill worksheets.

Companion Web site

- www.prenhall.com/angel
- Links related to the chapter openers at the beginning of each chapter allow students to explore related topics and collect data needed in order to complete application problems.
- Additional links to helpful, generic sites include Fun Math and For Additional Help.
- Syllabus builder management program allows instructor to post course syllabus information and schedule on the Web site.

For Students

Printed Supplements

Student Solution Manual

- Solutions to odd-numbered section exercises.
- Solutions to every (even and odd) exercise found in the Chapter Reviews, Chapter Tests, and Cumulative Reviews.

Student Study Guide

- Includes additional worked-out examples, additional exercises, practice tests and answers.
- Includes information to help students study and succeed in mathematics class.
- Emphasizes important concepts.

New York Times *Themes of the Times*

- Contact your local Prentice Hall sales representative.

How to Study Mathematics

- Contact your local Prentice Hall sales representative.

Internet Guide

- Contact your local Prentice Hall sales representative.

Media Supplements

MathPro4 Computerized Tutorial

- Keyed to each section of the text for text specific tutorial exercises and instruction.
- Includes Warm up exercises and graded Practice Problems.
- Includes video Watch screens.
- Take chapter quizzes.
- Send and receive e-mail from and to your instructor.
- Algorithmically driven and fully networkable.

Videotape Series

- Keyed to each section of the text.
- Step by step solutions to exercises from each section of the text. Exercises from the text that are worked in the videos are marked with a video icon.

Companion Web site

- www.prenhall.com/angel
- Links related to the chapter openers at the beginning of each chapter allow students to explore related topics and collect data needed in order to complete application problems.
- Additional links to helpful, generic sites include Fun Math and For Additional Help.
- Syllabus builder management program allows instructor to post course syllabus information and schedule on the Web site.

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EMPHASIS ON *Problem Solving*

The fifth edition of the Angel series places a stronger emphasis on problem solving than ever before. Problem solving is now introduced early and incorporated as a theme throughout the texts.

Five-Step Problem-Solving Procedure

The in-text examples demonstrate how to solve each exercise based on Polya's five-step problem-solving procedure: **Understand, Translate, Carry Out, Check,** and **State Answer.**

EXAMPLE 4 Only two-axle vehicles are permitted to cross a bridge that leads to Honeymoon Island State Park. The toll for the bridge is 50 cents for motorcycles and $1.00 for cars and trucks. On Saturday, the toll booth attendant collected a total of $150, and the vehicle counter recorded 170 vehicles crossing the bridge. How many motorcycles and how many cars and trucks crossed the bridge that day?

Solution **Understand and Translate**

$$\text{Let } x = \text{number of motorcycles}$$
$$y = \text{number of cars and trucks}$$

Since a total of 170 vehicles crossed the bridge, one equation is $x + y = 170$. The second equation comes from the tolls collected.

Tolls from motorcycles	+	tolls from cars and trucks	= 150
$0.50x$	+	$1.00y$	= 150

System of equations $\begin{cases} x + y = 170 \\ 0.50x + 1.00y = 150 \end{cases}$

Carry Out Since the first equation can be easily solved for y, solve this system by substitution. Solving for y in $x + y = 170$ gives $y = 170 - x$. Substitute $170 - x$ for y in the second equation and solve for x.

$$0.50x + 1.00y =$$

To Solve a System of Equations by the Addition (or Elimination) Method

1. If necessary, rewrite each equation so that the terms containing variables appear on the left side of the equal sign and any constants appear on the right side of the equal sign.
2. If necessary, multiply one or both equations by a constant(s) so that when the equations are added the resulting sum will contain only one variable.
3. Add the equations. This will result in a single equation containing only one variable.
4. Solve for the variable in the equation in step 3.
5. Substitute the value found in step 4 into either of the original equations. Solve that equation to find the value of the remaining variable.
6. Check the values obtained in all original equations.

    In step 2 we indicate it may be necessary to multiply one or both equations by a constant. In this text we will use brackets [ ], to indicate that both sides of the equation within the brackets are to be multiplied by some constant.

Procedure Boxes

Important procedures are highlighted and boxed throughout the text, making them easy for students to read and review.

Problem-Solving Exercises

These exercises are designed to help students become better thinkers.

Problem Solving

63. Is the point represented by the ordered pair $\left(\frac{1}{2}, -\frac{2}{23}\right)$ on the graph of the equation $y = \dfrac{x}{x^2 - 6}$? Explain.

64. Is the point represented by the ordered pair $\left(\frac{1}{2}, \frac{3}{2}\right)$ on the graph of the equation $y = \dfrac{x^2 - 4}{x - 2}$? Explain.

65. **a)** Plot the points $A(2, 7), B(2, 3),$ and $C(6, 3),$ and then draw $\overline{AB}, \overline{AC},$ and $\overline{BC}.$ ($\overline{AB}$ represents the line segment from A to B.)
    b) Find the area of the figure.

66. Plot the points $A(-4, 5), B(2, 5), C(2, -3),$ and

b) Estimate the total sales of the three items listed in 1999.
c) In which years were the sales of low/nonfat ice cream greater than $2.5 billion?
d) Does the decrease in the sales of frozen yogurt from 1995 through 2000 appear to be approximately linear? Explain.

68. The following graph shows unemployment rates in Washington, D.C, Maryland, and Virginia from 1990 through 1996.

Unemployment Rates

EMPHASIS ON *Applications*

Each chapter begins with an illustrated, real-world application to motivate students and encourage them to see algebra as an important part of their daily lives. Problems based on real data from a broad range of subjects appear throughout the text, in the end-of-chapter material, and in the exercise sets.

GRAPHS AND FUNCTIONS

CHAPTER

3

3.1) Graphs

3.2) Functions

3.3) Linear Functions: Graphs and Applications

3.4) The Slope–Intercept Form of a Linear Equation

3.5) The Point–Slope Form of a Linear Equation

3.6) The Algebra of Functions

3.7) Graphing Linear Inequalities

Summary
Review Exercises
Practice Test
Cumulative Review Test

Use the Angel Web site at www.prenhall.com/angel to be linked to an internet resource that will help you further explore the following application.

Have you ever dreamed of starting your own business? Before starting it, you should write a business plan which includes, among other things, a projection of the profits of your business. The gross annual profit can be estimated by subtracting your annual expenses from your annual income. On page 172, we project the annual profit of a tire store as a function of the number of tires sold.

Chapter-Opening Applications

New **chapter-opening applications** emphasize the use of mathematics in everyday life, and in the workplace giving students an applied, real-world introduction to the chapter material. The applications are often tied to examples presented in the section, and links in the chapter openers direct students to the Angel Web site.

Real-World Applications

An abundance of wonderfully updated, **real-world applications** gives students needed practice with practical applications of algebra. Real data is used, and real-world situations emphasize the relevance of the material being covered to students' everyday lives.

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64. Is the point represented by the ordered pair $\left(\frac{1}{2}, \frac{3}{2}\right)$ on the graph of the equation $y = \frac{x^2 - 4}{x - 2}$? Explain.
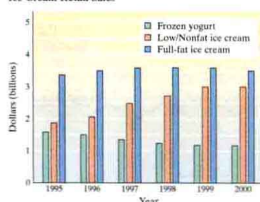
65. a) Plot the points $A(2, 7)$, $B(2, 3)$, and $C(6, 3)$, and then draw $\overline{AB}$, $\overline{AC}$, and $\overline{BC}$. ($\overline{AB}$ represents the line segment from A to B.)
    b) Find the area of the figure.

66. a) Plot the points $A(-4, 5)$, $B(2, 5)$, $C(2, -3)$, and $D(-4, -3)$, and then draw $\overline{AB}$, $\overline{BC}$, $\overline{CD}$, and $\overline{DA}$.
    b) Find the area of the figure.

67. The following graph shows retail sales up to 1998 and projected retail sales up to 2000 for frozen yogurt, low/nonfat ice cream, and full-fat ice cream.
   a) Estimate the sales in 1999 of frozen yogurt, low/non-fat ice cream, and full-fat ice cream.

Ice Cream Retail Sales

☐ Frozen yogurt
☐ Low/Nonfat ice cream
☐ Full-fat ice cream

Source: FIND/SVP, Inc.

...zen yogurt from 1995 through 2000 appear to be approximately linear? Explain.

68. The following graph shows unemployment rates in Washington, D.C., Maryland, and Virginia from 1990 through 1996.

Unemployment Rates

Washington, D.C.
Maryland
Virginia
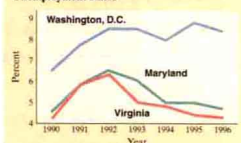
Source: Maryland Department of Labor, Licensing and Regulations; Virginia Employment Commission; Washington, D.C. government

a) In which year(s) was the unemployment rate in Maryland at 5%?
b) When was the unemployment rate in Virginia at its maximum value? What was that value?
c) In which years was the unemployment rate in Washington greater than 8%?
d) Between which years did the unemployment rate decrease in Virginia while the unemployment rate increased in Washington?
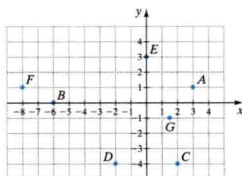
EMPHASIS ON *Exercises*

End-of-section exercise sets provide a thorough review of the section material. Each set progresses in difficulty to help students gain confidence and succeed with more difficult exercises.

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Practice the Skills

List the ordered pairs corresponding to the indicated points.

5.

6.

7. Graph the following points on the same axes.
$A(4, 2)$ $B(-6, 2)$ $C(0, -1)$ $D(-2, 0)$

8. Graph the following points on the same axes.
$A(-4, -2)$ $B(3, 2)$ $C(2, -3)$ $D(-3, 3)$

Determine the quadrant in which each point is located.

9. $(1, 6)$ **10.** $(-2, 3)$ **11.** $(5, -9)$ **12.** $(24, 116)$
13. $(-35, 18)$ **14.** $(-24, -8)$ **15.** $(-6, -19)$ **16.** $(8, -120)$

Practice the Skills Exercises

Practice the Skills exercises cover all types of exercises presented in the chapter.

Problem-Solving Exercises

These exercises are designed to help students become better thinkers.

Problem Solving

63. Is the point represented by the ordered pair $\left(\frac{1}{2}, -\frac{2}{23}\right)$ on the graph of the equation $y = \frac{x}{x^2 - 6}$? Explain.

64. Is the point represented by the ordered pair $\left(\frac{1}{2}, \frac{3}{2}\right)$ on the graph of the equation $y = \frac{x^2 - 4}{x - 2}$? Explain.

65. a) Plot the points $A(2, 7)$, $B(2, 3)$, and $C(6, 3)$, and then draw $\overline{AB}$, $\overline{AC}$, and $\overline{BC}$. ($\overline{AB}$ represents the line segment from A to B.)
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Unemployment Rates

Concept/Writing Exercises

New Concept/Writing Exercises encourage students to analyze and write about the concepts they are learning, improving their understanding and comprehension of the material.

Exercise Set 3.1
Concept/Writing Exercises

1. a) What does the graph of any linear equation look like?
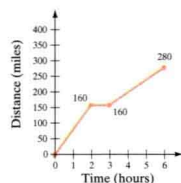**b)** How many points are needed to graph a linear equation? Explain.
2. What does it mean when a set of points is collinear?

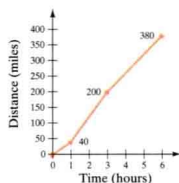**3.** When graphing the equation $y = \frac{1}{x}$, what value cannot be substituted for x? Explain.
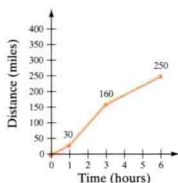**4.** What is another name for the Cartesian coordinate system?
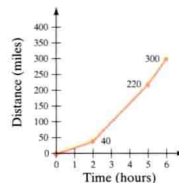
EMPHASIS ON *Exercises*

(a)   (b)   (c)   (d)

Use a graphing calculator to graph each function. Make sure you select values for the window that will show the curvature of the graph. Then, if your calculator can display tables, display a table of values in which the x-values extend by units, from 0 to 6.

85. $y = 3x + 5$

86. $y = \frac{1}{2}x - 4$

87. $y = x^2 + x + 6$

88. $y = x^2 - 12$

89. $y = x^3 - 2x + 4$

90. $y = 2x^3 - 6x^2 - 1$

Challenge Problems

Graph each equation.

91. $y = |x - 2|$

92. $x = y^2 + 2$

◯ Group Activity

Discuss and work Exercises 93–94 as a group.

93. a) Group member 1: Plot the points $(-2, 4)$ and $(6, 8)$. Determine the *midpoint* of the line segment connecting these points.
Group member 2: Follow the above instructions for the points $(-3, -2)$ and $(5, 6)$.
Group member 3: Follow the above instructions for the points $(4, 1)$ and $(-2, 4)$.

b) As a group, determine a formula for the midpoint of the line segment connecting the points (x_1, y_1) and (x_2, y_2). (Note: We will discuss the midpoint formula further in Chapter 10.)

94. Three points on a parallelogram are $A(3, 5)$, $B(8, 5)$, and $C(-1, -3)$.

a) Individually determine a fourth point D that completes the parallelogram.

b) Individually compute the area of your parallelogram.

c) Compare your answers. Did you all get the same answers? If not, why not?

d) Is there more than one point that can be used to complete the parallelogram? If so, give the two points and find the corresponding areas of each parallelogram.

Cumulative Review Exercises

[2.2] **95.** Evaluate $\dfrac{-b + \sqrt{b^2 - 4ac}}{2a}$ for $a = 2$, $b = 7$, and $c = -15$.

[2.3] **96.** Hertz Automobile Rental Agency charges a daily fee of $30 plus 14 cents a mile. National Automobile Rental Agency charges a daily fee of $16 plus 24 cents a mile for the same car. What distance would you have to drive in 1 day to make the cost of renting from Hertz equal to the cost of renting from National?

[2.5] **97.** Solve the inequality $-4 \le \dfrac{4 - 3x}{2} < 5$. Write the solution in set builder notation.

[2.6] **98.** Find the solution set for the inequality $|3x + 2| > 5$.

Challenge Problems

Challenge Problems stimulate student interest with problems that are conceptually and computationally more demanding.

Group Activities

Group Activities provide students with opportunities for collaborative learning.

Cumulative Review Exercises

Cumulative Review Exercises reinforce previously covered topics. These exercises are keyed to sections where the material is explained.

EMPHASIS ON *Pedagogy*

Preview and Perspective

Every chapter begins with a **Preview and Perspective** to give students an overview of the chapter. The **Preview and Perspective** shows students the connections between the concepts presented in the text and the real world.

Preview and Perspective

T wo of the primary goals of this book are to provide you with a good understanding of graphing and of functions. Graphing is heavily used in this course and in other mathematics courses you may take. To reinforce your knowledge of this topic we introduce graphing early and discuss it frequently throughout the book. Many of the exercise sets have graphs taken from newspapers or magazines. The material presented in this chapter may help you understand them better.

In Section 3.2 we introduce the concept of *function*. Functions are a unifying concept used throughout all of mathematics. We also use functions throughout the book to reinforce and expand upon what you learn in this chapter.

Most of you have graphed linear equations before. However, you probably have not graphed the nonlinear equations presented in Section 3.1. Make sure you read this section carefully. We will be using the technique presented in this section when we graph other nonlinear equations later in the book.

In Section 3.7 we graph linear inequalities *in two variables*. We will use the procedures for graphing linear inequalities in two variables again when we graph systems of linear inequalities in Section 4.6.

3.1 GRAPHS

SSM VIDEO 2.1 CD Rom

1. **Plot points in the Cartesian coordinate system.**
2. **Draw graphs by plotting points.**
3. **Graph nonlinear equations.**
4. **Use a graphing calculator.**
5. **Interpret graphs.**

1. **Plot Points in the Cartesian Coordinate System**
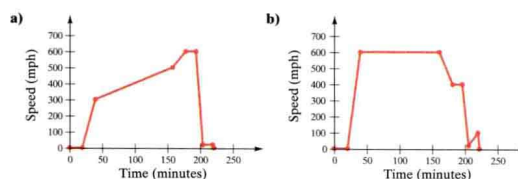
Numbered Section Objectives

Each section begins with a **list of objectives.** Numbered icons connect the objectives to the appropriate sections of the text.

In-Text Examples

An abundance of **in-text examples** illustrate the concept being presented and provide a step-by-step annotated solution.

EXAMPLE 8 When Jim Herring went to see his mother in Cincinnati, he boarded a Southwest Airlines plane. The plane sat at the gate for 20 minutes, taxied to the runway, and then took off. The plane flew at about 600 miles per hour for about 2 hours. It then reduced its speed to about 300 miles per hour and circled the Cincinnati Airport for about 15 minutes before it came in for a landing. After landing, the plane taxied to the gate and stopped. Which graph in Figure 3.18a–3.18d best illustrates this situation?

a)

b)

EMPHASIS ON *Pedagogy*

Calculator

Using Your Calculator and **Using Your Graphing Corners** boxes provide more optional exercises for use with technology than in the previous edition as well as keystroke instructions.

Using Your Graphing Calculator

Sometimes it may be difficult to estimate the intercepts of a graph accurately. When this occurs, you might want to use a graphing calculator. We demonstrate how in the following example.

EXAMPLE Determine the x- and y-intercepts of the graph $y = 1.3(x - 3.2)$.

Solution Press the Y= key, then assign 1.3 $(x - 3.2)$ to y. Then p graph the function $y_1 =$ gure 3

how to find the zeros or roots of a function. On a TI-82 or TI-83 you press the keys 2nd TRACE to get to the CALC menu (which stands for calculate). Then you choose option 2, *zero**. Once the zero feature has been selected, the calculator will display
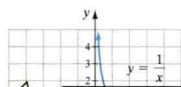
Left bound?**

At this time, move the cursor along the curve until it is to the *left* of the zero. Then press ENTER.

Avoiding Common Errors

Avoiding Common Errors boxes illustrate common mistakes, explain why certain procedures are wrong, and show the correct methods for working the problems.
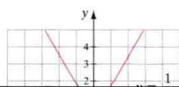
Avoiding Common Errors

When graphing nonlinear equations, many students do not plot enough points to get a true picture of the graph. For example, when graphing $y = \frac{1}{x}$ many students consider only integer values of x. Following is a table of values for the equation and two graphs that contain the points indicated in the table.

x	-3	-2	-1	1	2	3
y	$-\frac{1}{3}$	$-\frac{1}{2}$	-1	1	$\frac{1}{2}$	$\frac{1}{3}$

Correct

Incorrect

$y = \frac{1}{x}$

Helpful Hints

Helpful Hints offer useful suggestions for problem solving and various other topics.

HELPFUL HINT

Linear equations that are not solved for y can be written using function notation by solving the equation for y, then replacing y with f(x). For example, the equation $-9x + 3y = 6$ becomes $y = 3x + 2$ when solved for y. We can therefore write $f(x) = 3x + 2$.

Procedures, Important Facts, and Definitions

Procedures and **Important Facts** are presented in boxes throughout the text to make it easy for students to focus on this material and find it when preparing for quizzes and tests. Definitions are set off in **Definition Boxes** for easy reference and review.
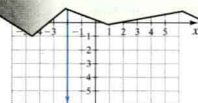
The graph of any equation of the form $x = a$ will always be a vertical line for any real number a.

Notice that the graph of $x = -2$ does not represent a function since it does not pass the vertical line test. For $x = -2$ there is more than one value of

Vertical Line Test

If a vertical line can be drawn through any part of the graph and the line intersects another part of the graph, the graph does not represent a function. If a vertical line cannot be drawn to intersect the graph at more than one point, the graph represents a function.

We use the vertical line test to show that Figure 3.23b represents a function

Notice that the graph of $x = -2$ does not represent a function since it does not pass the vertical line test. For $x = -2$ there is more than one value of y. In fact, when $x = -2$ there are an infinite number of values for y.

FIGURE 3.40

NOW TRY EXERCISE 35.

④ **Study Applications of Functions**

Now Try Exercises

Now Try Exercises appear after selected examples to reinforce important concepts. **Now Try Exercises** also provide students with immediate practice and make the student an active, rather than passive, learner.

Graphs are often used to show the relationship between variables. The axes of a graph do not have to be labeled x and y; they can be any designated variables. Consider the following example.

EXAMPLE 6 The yearly profit, p, of a tire store can be estimated by the function $p(n) = 20n - 30,000$, where n is the number of tires sold per year.

a) Draw a graph of profit versus tires sold for up to and including 6000 tires.

b) Estimate the number of tires that must be sold for the company to break even.

c) Estimate the number of tires sold if the company has a $40,000 profit.

Solution a) **Understand** The profit, p, is a function of the number of tires sold, n. The horizontal axis will therefore be labeled number of tires sold