

COLLEGE ALGEBRA

SEVENTH EDITION

Wiley
ometry

THE MCGRAW-HILL COMPANIES
FOR DONATION ONLY
NOT FOR RESALE

MCGRAW-HILL EDUCATION
09-ASA-005
THE MCGRAW-HILL COMPANIES
FOR DONATION ONLY
NOT FOR RESALE

Raymond A. Barnett

Michael R. Ziegler

Karl E. Byleen



SEVENTH EDITION

COLLEGE ALGEBRA

with Trigonometry

RAYMOND A. BARNETT

Merritt College

MICHAEL R. ZIEGLER

Marquette University

KARL E. BYLEEN

Marquette University



Boston Burr Ridge, IL Dubuque, IA Madison, WI New York San Francisco St. Louis
Bangkok Bogotá Caracas Lisbon London Madrid
Mexico City Milan New Delhi Seoul Singapore Sydney Taipei Toronto

McGraw-Hill Higher Education

A Division of The McGraw-Hill Companies

COLLEGE ALGEBRA WITH TRIGONOMETRY, SEVENTH EDITION

Published by McGraw-Hill, an imprint of The McGraw-Hill Companies, Inc., 1221 Avenue of the Americas, New York, NY 10020. Copyright © 2001, 1999, 1993, 1989, 1984, 1979, 1974 by The McGraw-Hill Companies, Inc. All rights reserved. No part of this publication may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written consent of The McGraw-Hill Companies, Inc., including, but not limited to, in any network or other electronic storage or transmission, or broadcast for distance learning.

Some ancillaries, including electronic and print components, may not be available to customers outside the United States.

This book is printed on acid-free paper.

8 9 0 VNH/VNH 0 9 8 7 6 5 4

ISBN 0-07-236869-1

Vice president and editor-in-chief: *Kevin T. Kane*

Publisher: *JP Lenney*

Senior Sponsoring editor: *Maggie Rogers*

Developmental editor: *Michelle Munn*

Editorial assistant: *Allyndreth Cassidy*

Marketing manager: *Mary K. Kittell*

Project manager: *Sheila M. Frank*

Lead producer: *Steve Metz*

Senior production supervisor: *Sandra Hahn*

Designer: *K. Wayne Harms*

Cover/interior designer: *Rokusek Design*

Senior supplement coordinator: *David A. Welsh*

Compositor: *GTS Graphics, Inc.*

Typeface: *10/12 Times Roman*

Printer: *Von Hoffmann Press, Inc.*

Library of Congress Cataloging-in-Publication Data

Barnett, Raymond A.

College algebra with trigonometry / Raymond A. Barnett, Michael R. Ziegler, Karl E.

Byleen. — 7th ed.

p cm. — (Barnett, Ziegler & Byleen's precalculus series)

Includes indexes.

ISBN 0-07-236869-1 (acid-free paper)

1. Algebra. 2. Trigonometry. I. Ziegler, Michael R. II. Byleen, Karl E. III. Title.

QA154.2 .B358 2001

512'.13—dc21

00-035142

CIP

PREFACE

College Algebra with Trigonometry is one of five books in the authors' precalculus series (see page ii for a brief comparison of all five books). The primary goal of this text is student comprehension. Great care has been taken to write a book that is mathematically correct and accessible to all students, regardless of their level of understanding. Emphasis is placed on problem solving, ideas, and computational skills rather than mathematical theory. Unless their inclusion adds significant insight into a particular concept, most derivations and proofs are omitted. The text presents concrete examples first, followed by a discussion of related general concepts and results.


Improvements in this edition evolved from the generous response of a large number of users of the last and previous editions, as well as survey results from instructors, mathematics departments, course outlines, and college catalogs. Fundamental to a book's growth and effectiveness is classroom use and feedback. Now in its seventh edition, *College Algebra with Trigonometry* has had the benefit of having a substantial amount of both. The most significant change in this seventh edition is the extensive updating of end-of-section and end-of-chapter problem sets. Continuing in our goal of addressing all levels of students, these new problem sets are appropriately balanced across the routine, easy mechanical problems and the more difficult mechanics with some theory. (See the *Features* section within this preface for further explanation.) Additional Explore-Discuss boxes have also been included where appropriate, further emphasizing the emerging use of technology in mathematics.

Also new to this edition, a free Student tutorial CD-ROM accompanies every copy of this text. This text-specific SMART-CD includes an extended real-world application video to begin each chapter. At the section level, this tutorial CD-ROM uses video, descriptive discussion, interactive diagrams, and extended matched problems to reinforce a student's understanding and further exploration of key concepts in the text. Algorithmically generated diagnostic Pre-Tests, Practice, and Post-Tests are also included within each chapter for further reinforcement.

Due to extremely positive feedback from our users, we have continued our emphasis on learning tools that enable a student to easily understand the material being introduced. These tools include Examples with Matched Problems, Explore-Discuss boxes, important student aids such as Think and Caution boxes, and extensive Application problem sets for real-world understanding of concepts. Our Group Activities, Chapter Reviews, and Cumulative Review Exercises continue to reinforce the understanding of critical concepts throughout the text. (See the *Features* section within this preface for further discussion of these tools.)

Technology In the Text


The generic term "graphing utility" is used to refer to any of the various graphing calculators or computer software packages that might be available to a student using this book. TI-83 screen shots are used throughout the text to illustrate graphing principles, but the discussion and explanations lend themselves to any graphing utility being used. Although use of a graphing utility is optional, it is likely that many students and instructors will want to make use of one of these devices. To assist these students and instructors, optional graphing utility activities are included throughout the book beginning in Chapter 3. These activities include brief discussions in the text, examples or portions of examples solved on a graphing utility, and problems for the

students to solve. All of the graphing utility material is optional and is clearly identified by the following symbol  and can be omitted without loss of continuity, if desired.

Technology Support

The Barnett precalculus series provides extensive technology-based support to assist in student comprehension. Each of the following supplements has been created specifically for this series, clarifying and exploring the concepts introduced within the text.

SMART-CD Student Tutorial

This CD-ROM tutorial is included with every copy of the text. In recognition of the visual, auditory, and interactive aspects of individual learning styles, this tutorial makes use of video, descriptive discussion, interactive diagrams, and extended matched problems. Each chapter on the CD-ROM begins with an extended real-world application video designed to convince even the most skeptical of students that mathematics is important. Algorithmically generated diagnostic Pre-Test, Practice, and Post-Test sections are included to direct students to particular sections where further practice is needed. Key concepts from each section have been identified in the tutorial portion of the CD-ROM, and interactive Matched Problems are included for concept mastery. This tutorial portion also includes forty-five Interactive Diagrams developed by Jere Confrey and Alan Maloney of Quest Math and Science Multimedia, Inc., designed specifically for use with the Barnett series. Each Interactive Diagram (ID) is a separate Java Applet that contains an illustration that can be manipulated by the user for further conceptual understanding of the topic presented. For each section of the text where an ID has been created, an icon  has been placed in the margin.

The SMART CD-ROM is available in both Windows and Macintosh platforms.

Website and Online Learning Center

In addition to the SMART-CD, an extensive text-specific website has been created to further enhance the technological support for this series. A visit to the website at www.mhhe.com/barnett will prove our commitment to supporting the ever-changing technology needs in mathematical instruction and learning. The following features are only a few of the many technological supplements available to students that can be accessed through this site:

- **NetTutor-Your Online Tutorial Service:** McGraw-Hill is proud to offer this web-based “homework hotline” via an Internet whiteboard. NetTutor provides live “office hours” with mathematics tutors every weekday, as well as a 24-hour response posting service for students accessing the service during off hours.
- **Graphing Calculator Workshops:** Keystroke guides have been created for each of the main calculators in use today. We will continue to update these guides as new calculators are introduced into the market.
- **Explore the Web Exercises, Additional Applications and Answers, and Practice Quizzes** are also available for further practice of the mathematical concepts being introduced.

The Barnett series website continues in its support of instructors using this text by providing PageOut for course-specific website creation, access to the course solutions consultants for the series, and extended instructor materials such as PowerPoint presentations and solutions to all even-numbered problems online.


FEATURES

The following pages serve as an introduction to the specific features included within this text.

Examples and Matched Problems

Integrated throughout the text, completely worked examples and practice problems are used to introduce concepts and demonstrate problem-solving techniques. Each Example is followed by a similar Matched Problem for the student to work through while reading the material. Answers to the matched problems are located at the end of each section, for easy reference. This active involvement in the learning process helps students develop a more thorough understanding of algebraic concepts and processes.

Technology

The generic term “graphing utility” is used to refer to any of the various graphing calculators or computer software packages that might be available to students using this book. The use of a graphing utility is optional within this text. To assist those that choose to use a graphing utility, optional activities are included throughout the book beginning in Chapter 3. These include brief discussions in the text, examples or portions of examples solved on a graphing utility, and problems for the student to solve. All optional graphing material is clearly identified by the following symbol  and can

be omitted without loss of continuity, if desired.

The **graph of an equation in two variables** is the graph of its solution set. In equation (1), we find that its solution set will have infinitely many elements and its graph will extend off any paper we might choose, no matter how large. Thus, to **sketch the graph of an equation**, we include enough points from its solution set so that the total graph is apparent. This process is called **point-by-point plotting**.

EXAMPLE 1 Graphing an Equation Using Point-by-Point Plotting

Sketch a graph of $y = x^2 - 4$.

We make up a table of solutions—ordered pairs of real numbers that satisfy the given equation.

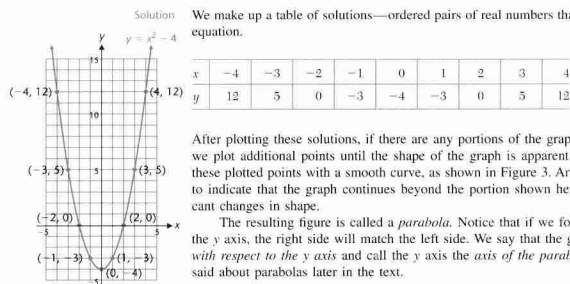


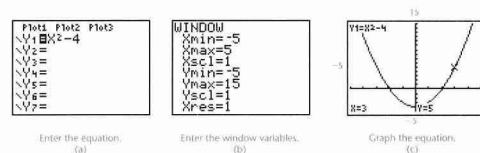
FIGURE 3

Matched Problem 1 Sketch a graph of $y^2 = x$.



We now use an electronic graphing device to check Example 1. We will refer to any electronic device capable of displaying graphs as a **graphing utility**. The two most common graphing utilities are hand-held graphing calculators and computers with appropriate software. This book contains a number of activities that use graphing utilities to emphasize the connection between graphic, numeric, and algebraic viewpoints. All these activities are clearly marked and easily omitted if no such device is available. Figure 4 shows the steps necessary to reproduce the graph in Figure 3 on a graphing utility.

FIGURE 4



Exploration and Discussion

Interspersed at appropriate places in every section, Explore/Discuss boxes encourage students to think critically about mathematics and to explore key concepts in more detail. Verbalization of mathematical concepts, results, and processes is encouraged in these Explore/Discuss boxes, as well as in some matched problems, and in particular problems in almost every exercise set. Explore/Discuss material can be used in class or as an out-of-class activity.

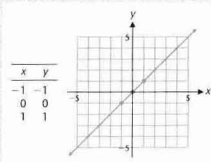
Balanced Exercise Sets

College Algebra with Trigonometry contains over 5600 problems. Each Exercise Set is designed so that an average or below-average student will experience success and a very capable student will be challenged. Exercise Sets are found at the end of each section in the text, and are divided into A (routine, easy mechanics), B (more difficult mechanics), and C (difficult mechanics and some theory) levels of difficulty so that students at all levels can be challenged. Problem numbers that appear in blue indicate exercises that require the students to apply their reasoning and writing skills to the solution of the problem.

3-1 Basic Tools; Circles
177

EXPLORE-DISCUSS 1 To graph the equation $y = -x^2 + 2x$, we use point-by-point plotting to obtain the graph in Figure 5.

FIGURE 5



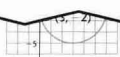
x	y
-1	-1
0	0
1	1

(A) Do you think this is the correct graph of the equation? If so, why? If not, why?

(B) Add points on the graph for $x = -2, -0.5, 0.5$, and 2 .

(C) Now, what do you think the graph looks like? Sketch your version of the graph, adding more points as necessary.

(D) Write a short statement explaining any conclusions you might draw from parts A, B, and C.



6. $(x - 4)^2 + (y + 5)^2 = 16$; radius: 4, center: (4, -5)

EXERCISE 3-1

A

In Problems 1–10, give a verbal description of the indicated subset of the plane in terms of quadrants and axes.

- $\{(x, y) \mid x = 0\}$
- $\{(x, y) \mid x > 0, y > 0\}$
- $\{(x, y) \mid x < 0, y < 0\}$
- $\{(x, y) \mid y = 0\}$
- $\{(x, y) \mid x > 0, y < 0\}$
- $\{(x, y) \mid y < 0, x \neq 0\}$
- $\{(x, y) \mid xy < 0\}$
- $\{(x, y) \mid x < 0, y > 0\}$
- $\{(x, y) \mid x > 0, y \neq 0\}$
- $\{(x, y) \mid xy > 0\}$

In Problems 11–18, determine symmetry with respect to the x axis, y axis, or origin, if any exists, and graph.

- $y = 2x - 4$
- $y = \frac{1}{2}x + 1$
- $y = \frac{1}{2}x$
- $y = 2x$
- $|y| = x$
- $|y| = -x$
- $|x| = |y|$
- $y = -x$

Find the distance between the points.

- $(-5, -3), (4, 2)$
- $(-6, 4), (2, -1)$
- $(3, 5), (2, -4)$
- $(2, -5), (-3, 1)$

In Problems 23–28, indicate center and radius.

- $C(0, 0), r = 4$
- $C(0, 0), r = 6$
- $C(3, -2), r = 5$
- $C(-4, 2), r = 5$
- $C(2, 6), r = \sqrt{5}$
- $C(-1, -3), r = 2$

188
3 Graphs and Functions

In Problems 29 and 30, use the graph to estimate to the nearest integer the missing coordinates of the indicated points. (Be sure you find all possible answers.)

29. (A) $(-3, 7)$
(B) $(2, 7)$
(C) $(2, 3)$
(D) $(7, -1)$

30. (A) $(-4, 7)$
(B) $(-1, 7)$
(C) $(7, 1)$
(D) $(2, 4)$

The figures in Problems 31 and 32 show a portion of a graph. Extend the given graph to one that exhibits the indicated type of symmetry.

31. (A) x axis only
(B) y axis only
(C) origin only
(D) x and y axes

32. (A) x axis only
(B) y axis only
(C) origin only
(D) x and y axes

B

In Problems 33–48, determine symmetry with respect to the x axis, y axis, or origin, if any exists, and graph.

* Check your graphs in Problems 33–48 by graphing on a graphing utility.

- $y^2 = x + 2$
- $y^2 = x - 2$
- $y = x^2 + 1$
- $y + 2 = x^2$
- $x^2 + 4y^2 = 4$
- $x^2 + 9y^2 = 9$
- $4x^2 - y^2 = 1$
- $4x^2 - y^2 = 1$
- $y^3 = x$
- $y = 0.6x^2 - 4.5$
- $y = \sqrt{17 - x^2}$
- $y = x^{2/3}$
- $y^{2/3} = x$

In Problems 49 and 50, use the Pythagorean theorem to show that the given points are the vertices of a right triangle. Find the area and the perimeter (to two decimal places) of the triangle. (Formulas related to triangles can be found in Appendix B.)

49. $(-3, 2), (1, -2), (8, 5)$

50. $(-4, -1), (0, 7), (6, -6)$

51. Find x such that $(x, 7)$ is 10 units from $(-4, 1)$.

52. Find x such that $(x, 2)$ is 4 units from $(3, -3)$.

53. Find y such that $(2, y)$ is 3 units from $(-1, 4)$.

54. Find y such that $(3, y)$ is 13 units from $(-9, 2)$.

In Problems 55–60, find the center and radius of the circle with the given equation. Graph the equation.

- $(x + 4)^2 + (y - 2)^2 = 7$
- $(x - 5)^2 + (y + 7)^2 = 15$
- $x^2 + y^2 - 6x - 4y = 36$
- $x^2 + y^2 - 2x - 10y = 55$
- $x^2 + y^2 + 8x - 6y + 8 = 0$
- $x^2 + y^2 + 4x + 10y + 15 = 0$

In Problems 61–64, graph the triangle with vertices A, B, and C and the triangle with vertices A', B', and C' in the same coordinate system. Describe the relationship between the graphs of these triangles in terms of reflections.

- A(1, 1), B(7, 2), C(4, 6)
A'(-1, 1), B'(7, -2), C'(-4, -6)
- A(1, 1), B(7, 2), C(4, 6)
A'(-1, 1), B'(-7, 2), C'(-4, 6)
- A(1, 1), B(7, 2), C(4, 6)
A'(-1, -1), B'(-7, -2), C'(-4, -6)
- A(1, 2), B(1, 4), C(3, 4)
A'(2, 1), B'(4, 1), C'(4, 3)
Hint: Add the graph of $y = x$ to your graph.

In Problems 65–68, solve for x , producing two equations, and then graph both of these equations in the same viewing window.

- $x^2 + y^2 = 3$
- $x^2 + y^2 = 5$
- $(x + 3)^2 + (y + 1)^2 = 2$
- $(x - 2)^2 + (y - 1)^2 = 3$

*Please note that use of a graphing utility is not required to complete these exercises. Checking with a g.u. is optional. If you do not have a g.u., you should still work these exercises.

Applications

One of the primary objectives of this book is to give the student substantial experience in modeling and solving real-world problems. Over 600 application exercises help convince even the most skeptical student that mathematics is relevant to everyday life. The most difficult application problems are marked with two stars (**), the moderately difficult application problems with one star (*), and the easier application problems are not marked. An **Applications Index** is included in the back of this textbook to help locate particular applications.

Functional Use of Four Colors

The functional use of four colors improves the clarity of many illustrations, graphs, and developments, and guides students through certain critical steps.

222 3 Graphs and Functions

- 89. Physics—Rate.** The distance in feet that an object falls in a vacuum is given by $s(t) = 16t^2$, where t is time in seconds. Find:

(A) $s(0)$, $s(1)$, $s(2)$, $s(3)$

(B) $\frac{s(2+h) - s(2)}{h}$

- (C) What happens in part B when h tends to 0? Interpret physically.

- 90. Physics—Rate.** An automobile starts from rest and travels along a straight and level road. The distance in feet traveled by the automobile is given by $s(t) = 10t^2$, where t is time in seconds. Find:

(A) $s(8)$, $s(9)$, $s(10)$, $s(11)$

(B) $\frac{s(11+h) - s(11)}{h}$

- (C) What happens in part B as h tends to 0? Interpret physically.

- 91. Manufacturing.** A candy box is to be made out of a piece of cardboard that measures 8 by 12 inches. Squares, x inches on a side, will be cut from each corner, and then the ends and sides will be folded down (see the figure). Find a formula for the volume of the box $V(x)$ in terms of x . From practical considerations, what is the domain of the function V ?



- 92. Construction.** A rancher has 20 miles of fencing to fence a rectangular piece of grazing land along a straight river. If no fence is required along the river and the sides perpendicular to the river are x miles long, find a formula for the area $A(x)$ of the rectangle in terms of x . From practical considerations, what is the domain of the function A ?

- 93. Construction.** The manager of an animal clinic wants to construct a kennel with four individual pens, as indicated in the figure. State law requires that each pen have a gate 3 feet wide and an area of 50 square feet. If x is the width of one pen, express the total amount of fencing $F(x)$ (excluding the gates) required for the construction of the kennel as a function of x . Complete the following table [round values of $F(x)$ to one decimal place]:

x	4	5	6	7
$F(x)$				

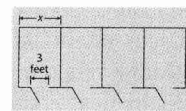
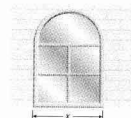


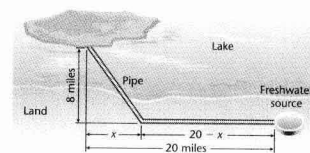
Figure for 93

- 94. Architecture.** An architect wants to design a window with an area of 24 square feet in the shape of a rectangle surmounted by a semicircle, as indicated in the figure. If x is the width of the window, express the perimeter $P(x)$ of the window as a function of x . Complete the table below [round each value of $P(x)$ to one decimal place]:

x	4	5	6	7
$P(x)$				




- 95. Construction.** A freshwater pipeline is to be run from a source on the edge of a lake to a small resort community on an island 8 miles offshore, as indicated in the figure. It costs \$10,000 per mile to lay the pipe on land and \$15,000 per mile to lay the pipe in the lake. Express the total cost $C(x)$ of constructing the pipeline as a function of x . From practical considerations, what is the domain of the function C ?



- 96. Weather.** An observation balloon is released at a point 10 miles from the station that receives its signal and rises vertically, as indicated in the figure. Express the distance $d(h)$ between the balloon and the receiving station as a function of the altitude h of the balloon.

Foundation for Calculus

As many students will use this book to prepare for a calculus course, examples and exercises that are especially pertinent to calculus are marked with an icon. 

204 3 Graphs and Functions

B

In Problems 25–28, find the equation of the line passing through the given point with the given slope. Write the final answer in the slope-intercept form $y = mx + b$.

25. $(0, 3)$; $m = -2$

26. $(4, 0)$; $m = 3$

27. $(-5, 4)$; $m = \frac{3}{2}$

28. $(2, -3)$; $m = -\frac{4}{3}$

In Problems 29–34, find the equation of the line passing through the two given points. Write the final answer in the slope-intercept form $y = mx + b$ or in the form $x = c$.

29. $(2, 5)$; $(4, -3)$

30. $(-1, 4)$; $(3, 2)$

31. $(-3, 2)$; $(-3, 5)$

32. $(0, 5)$; $(2, 5)$

33. $(-4, 2)$; $(0, 2)$

34. $(5, -4)$; $(5, 6)$

In Problems 35–46, write an equation of the line that contains the indicated point and meets the indicated condition(s). Write the final answer in the standard form $Ax + By = C$, $A \geq 0$.

35. $(2, -1)$; parallel to $y = -3x + 7$

36. $(-3, 2)$; parallel to $y = 4x - 5$

37. $(0, -4)$; parallel to $2x + 3y = 9$

Problems 53–58 are calculus-related. Recall that a line tangent to a circle at a point is perpendicular to the radius drawn to that point (see the figure). Find the equation of the line tangent to the circle at the indicated point. Write the final answer in the standard form $Ax + By = C$, $A \geq 0$. Graph the circle and the tangent line on the same coordinate system.



53. $x^2 + y^2 = 25$, $(3, 4)$

54. $x^2 + y^2 = 100$, $(-8, -6)$

55. $x^2 + y^2 = 50$, $(5, -5)$

56. $x^2 + y^2 = 80$, $(-4, -8)$

57. $(x - 3)^2 + (y + 4)^2 = 169$, $(8, -16)$

58. $(x + 5)^2 + (y - 9)^2 = 289$, $(-13, -6)$

Group Activities

A Group Activity is located at the end of each chapter and involves many of the concepts discussed in that chapter. These activities strongly encourage the verbalization of mathematical concepts, results, and processes. All of these special activities are highlighted to emphasize their importance.

CHAPTER 3 GROUP ACTIVITY Mathematical Modeling in Business*

This group activity is concerned with analyzing a basic model for manufacturing and selling a product by using tables of data and linear regression to determine appropriate values for the constants a , b , m , and n in the following functions:

TABLE 1 Business Modeling Functions

Function	Definition	Interpretation
Price-demand	$p(x) = m - nx$	x is the number of items that can be sold at $\$p$ per item
Cost	$C(x) = a + bx$	Total cost of producing x items
Revenue	$R(x) = xp$ $= x(m - nx)$	Total revenue from the sale of x items
Profit	$P(x) = R(x) - C(x)$	Total profit from the sale of x items

A manufacturing company manufactures and sells mountain bikes. The management would like to have price-demand and cost functions for break-even and profit-loss analysis. Price-demand and cost functions may be established by collecting appropriate data at different levels of output, and then finding a model in the form of a basic elementary function (from our library of elementary functions) that “closely fits” the collected data. The financial department, using statistical techniques, arrived at the price-demand and cost data in Tables 2 and 3, where p is the wholesale price of a bike for a demand of x thousand bikes and C is the cost, in thousands of dollars, of producing and selling x thousand bikes.

TABLE 2 Price-Demand

x (thousand)	p (\$)
7	530

TABLE 3 Cost

x (thousand)	C (thousand \$)
5	2,100
12	2,940

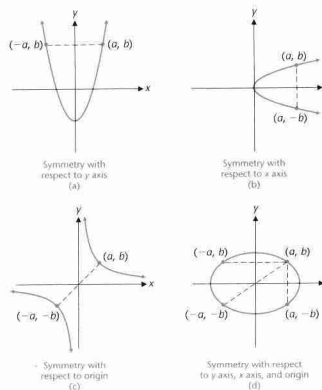
Graphs and Illustrations

All graphs in this text are computer generated to ensure mathematical accuracy. Graphing utility screens displayed in the text are actual output from a graphing calculator.

3. The origin if $(-a, -b)$ is on the graph whenever (a, b) is on the graph—the two points are equidistant from the origin on a line through the origin.

Figure 8 illustrates these three types of symmetry.

FIGURE 8 Symmetry.



EXPLORE-DISCUSS 2 If a graph possesses two of the three types of symmetry in Definition 1, must it also possess the third? Explain.

Boldface Type

Boldface type is used to introduce new terms and highlight important comments.

Think Boxes

Think boxes are dashed boxes used to enclose steps that are usually performed mentally.

Caution Boxes

Caution boxes appear throughout the text to indicate where student errors often occur.

Annotation

Annotation of examples and developments, in small colored type, is found throughout the text to help students through critical stages.

In addition to evaluating functions at specific numbers, it is important to be able to evaluate functions at expressions that involve one or more variables. For example, the **difference quotient**

$$\frac{f(x+h) - f(x)}{h} \quad x \text{ and } x+h \text{ in the domain of } f, h \neq 0$$

is studied extensively in a calculus course.

EXAMPLE 6 Evaluating and Simplifying a Difference Quotient

For $f(x) = x^2 + 4x + 5$, find and simplify:

$$(A) f(x+h) \quad (B) \frac{f(x+h) - f(x)}{h}, h \neq 0$$

Solution (A) To find $f(x+h)$, we replace x with $x+h$ everywhere it appears in the equation that defines f and simplify:

$$\begin{aligned} f(x+h) &= (x+h)^2 + 4(x+h) + 5 \\ &= x^2 + 2xh + h^2 + 4x + 4h + 5 \end{aligned}$$

(B) Using the result of part A, we get

$$\begin{aligned} \frac{f(x+h) - f(x)}{h} &= \frac{x^2 + 2xh + h^2 + 4x + 4h + 5 - (x^2 + 4x + 5)}{h} \\ &= \frac{x^2 + 2xh + h^2 + 4x + 4h + 5 - x^2 - 4x - 5}{h} \\ &= \frac{2xh + h^2 + 4h}{h} = \frac{h(2x + h + 4)}{h} = 2x + h + 4 \end{aligned}$$

Matched Problem 6 Repeat Example 6 for $f(x) = x^2 + 3x + 7$.

CAUTION

1. If f is a function, then the symbol $f(x+h)$ represents the value of f at the number $x+h$ and must be evaluated by replacing the independent variable in the equation that defines f with the expression $x+h$, as we did in Example 6. Do not confuse this notation with the familiar algebraic notation for multiplication:

$$f(x+h) \neq fx + fh \quad f(x+h) \text{ is function notation.}$$

$$4(x+h) = 4x + 4h \quad 4(x+h) \text{ is algebraic multiplication notation.}$$

Screened Boxes

Screened boxes are used to highlight important definitions, theorems, results, and step-by-step processes.

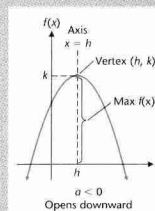
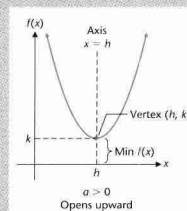
Properties of a Quadratic Function and Its Graph

Given a quadratic function and the form obtained by completing the square

$$f(x) = ax^2 + bx + c = a(x-h)^2 + k \quad a \neq 0$$

we summarize general properties as follows:

1. The graph of f is a parabola:



2. Vertex: (h, k) (Parabola rises on one side of the vertex and falls on the other.)
3. Axis (of symmetry): $x = h$ (Parallel to y axis)

Chapter Review

Chapter Review sections are provided at the end of each chapter and include a thorough review of all the important terms and symbols. This recap is followed by a comprehensive set of review exercises.

5. Find a and b for $r = 0.\overline{19}$ and then find a terminating decimal expansion for r .

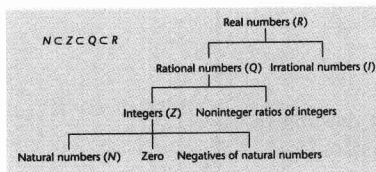
Chapter 1 Review

1-1 ALGEBRA AND REAL NUMBERS

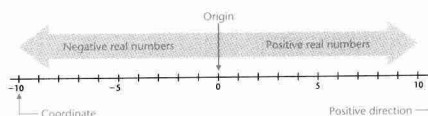
A **set** is a collection of objects called **elements** or **members** of the set. Sets are usually described by **listing** the elements or by stating a **rule** that determines the elements. A set may be **finite** or **infinite**. A set with no elements is called the **empty set** or the

null set and is denoted \emptyset . A **variable** is a symbol that represents unspecified elements from a **replacement set**. A **constant** is a symbol for a single object. If each element of set A is also in set B , we say A is a **subset** of B and write $A \subset B$.

Real numbers:



Real number line:



Cumulative Review Exercise

A Cumulative Review Exercise is provided after every second or third chapter, for additional reinforcement.

Cumulative Review Exercise Chapters 1 and 2

Work through all the problems in this cumulative review and check answers in the back of the book. Answers to all review problems are there, and following each answer is a number in *italics* indicating the section in which that type of problem is discussed. Where weaknesses show up, review appropriate sections in the text.

A

1. Solve for x : $\frac{7x}{5} - \frac{3+2x}{2} = \frac{x-10}{3} + 2$

2. Replace each question mark with an appropriate expression that will illustrate the use of the indicated real number property:

- (A) Distributive: $c(a+b) = ?$
 (B) Associative (+): $(a+b)+c = ?$
 (C) Commutative (\cdot): $(a+b)c = ?$

3. Solve for x and y : $2x - 3y = 8$
 $4x + y = 2$

In Problems 4–8, perform the indicated operation and simplify.

4. $4x(x-3) + 2(3x+5)$ 5. $3x(x-7) - (5x-9)$

6. $(2x-5y)(3x+4y)$ 7. $(2a-3b)(2a+3b)$

8. $(5m+2n)^2$

Solve and graph Problems 9–11.

9. $2(3-y) + 4 \leq 5-y$ 10. $|x-2| < 7$

11. $x^2 + 3x \geq 10$

In Problems 12 and 13, write each polynomial in a completely factored form relative to the integers. If the polynomial is prime relative to the integers, say so.

12. $x^2 - 3x + 10$

13. $6t^2 + 7t - 5$

In Problems 14 and 15, perform the indicated operations and reduce to lowest terms. Represent all compound fractions as simple fractions reduced to lowest terms.

14. $\frac{6}{x^2-3x} - \frac{4}{x^2-2x}$ 15. $\frac{\frac{4-y}{2}}{\frac{y}{y^2}-\frac{1}{2}}$

16. Perform the indicated operations and write the answer in standard form:

(A) $(2-3i) - (-5+7i)$

(B) $(1+4i)(3-5i)$

(C) $\frac{5+i}{2+3i}$

Simplify Problems 17–19 and write answers using positive exponents only. All variables represent positive real numbers.

17. $3x^2(xy^2)^5$ 18. $\frac{(2xy^2)^3}{4x^2y^4}$ 19. $(a^4b^{-6})^{3/2}$

Solve Problems 20–23.

20. $3x^2 = -12x$ 21. $4x^2 - 20 = 0$

22. $x^2 - 6x + 2 = 0$ 23. $x - \sqrt{12-x} = 0$

24. Change to radical form: $5a^{3/4}$

25. Change to rational exponent form: $2\sqrt[3]{x^2y^3}$

SUPPLEMENTS

A comprehensive set of ancillary materials for both the student and the instructor is available for use with this text.

Student's Solutions Manual

This supplement is available for sale to the student, and includes detailed solutions to all odd-numbered problems and most review exercises.

Instructor's Solutions Manual

This manual provides solutions to even-numbered problems and answers to all problems in the text.

Instructor's Resource Manual

This supplement provides transparency masters and sample tests for each chapter in the text.

Print and Computerized Testbanks

A Computerized Testbank is available that provides a variety of formats to enable the instructor to create tests using both algorithmically generated test questions and those from a static testbank. This testing system enables the instructor to choose questions either manually or randomly by section, question types, difficulty level, and other criteria. This testing software supports online testing and is available for PC and Macintosh computers. A softcover print version of the testbank includes the static questions found in the computerized version.

Barnett/Ziegler/Byleen Video Series


Course videotapes, created specifically for this series, provide students with additional reinforcement of the topics presented in the book. These videos are keyed to the text and feature an effective combination of learning techniques, including personal instruction, state-of-the-art graphics, and real-world applications.

Course Solutions

Fully integrated multimedia, a full-scale Online Learning Center, and a Course Integration Guide are designed specifically to help you with your individual college algebra with trigonometry course needs. Assembled by an expert in your field of study, this printed manual fully integrates the numerous products available to accompany *College Algebra with Trigonometry*. The Course Integration Guide will also contain detailed solutions for the Group Activities found in the text, a description of each Interactive Diagram, and detailed solutions to the exploratory questions that accompany each Interactive Diagram.

SMART-CD Student Tutorial

This CD-ROM tutorial is included with every copy of the text. In recognition of the

visual, auditory, and interactive aspects of individual learning styles, this tutorial makes use of video, descriptive discussion, interactive diagrams, and extended matched problems. Each chapter on the CD-ROM begins with an extended real-world application video designed to convince even the most skeptical of students that mathematics is important. Algorithmically generated diagnostic Pre-Test, Practice, and Post-Test sections are included to direct students to particular sections where further practice is needed. Key concepts from each section have been identified in the tutorial portion of the CD-ROM, and interactive Matched Problems are included for concept mastery. This tutorial portion also includes forty-five Interactive Diagrams developed by Jere Confrey and Alan Maloney of Quest Math and Science Multimedia, Inc., designed specifically for use with the Barnett series. Each Interactive Diagram (ID) is a separate Java Applet that contains an illustration that can be manipulated by the user for further conceptual understanding of the topic presented. For each section of the text where an ID has been created, an icon  has been placed in the margin. The SMART-CD is available in both Windows and Macintosh platforms.

Website and Online Learning Center

An extensive text-specific website has been created to further enhance the technological support for this series. Visit the site at www.mhhe.com/barnett to explore the numerous features available to both students and instructors. Among the many tools available to students is NetTutor-Your Online Tutorial Service, a “homework hotline” via an Internet whiteboard. NetTutor provides live “office hours” with mathematics tutors every weekday, as well as a 24-hour response posting service for students accessing the service during off hours. The Graphing Calculator Workshop features keystroke guides for each of the main calculators in use today. Instructors have access to PageOut for course-specific website creation, extended instructor materials such as PowerPoint presentations, and solutions to all even-numbered problems online, and access to the course solutions consultants for the series.

For further information about these or any supplements, please contact your local McGraw-Hill sales representative, or visit our website at www.mhhe.com/barnett.

Accuracy

Because of the careful checking and proofing by a number of mathematics instructors (acting independently), the authors and publisher believe this book to be substantially error free. For any errors remaining, the authors would be grateful if they were sent to: Karl E. Byleen, 9322 W. Garden Court, Hales Corners, WI 53130; or by email, to byleen@execpc.com.

Acknowledgments

In addition to the authors, many others are involved in the successful publication of a book. We wish to thank personally:

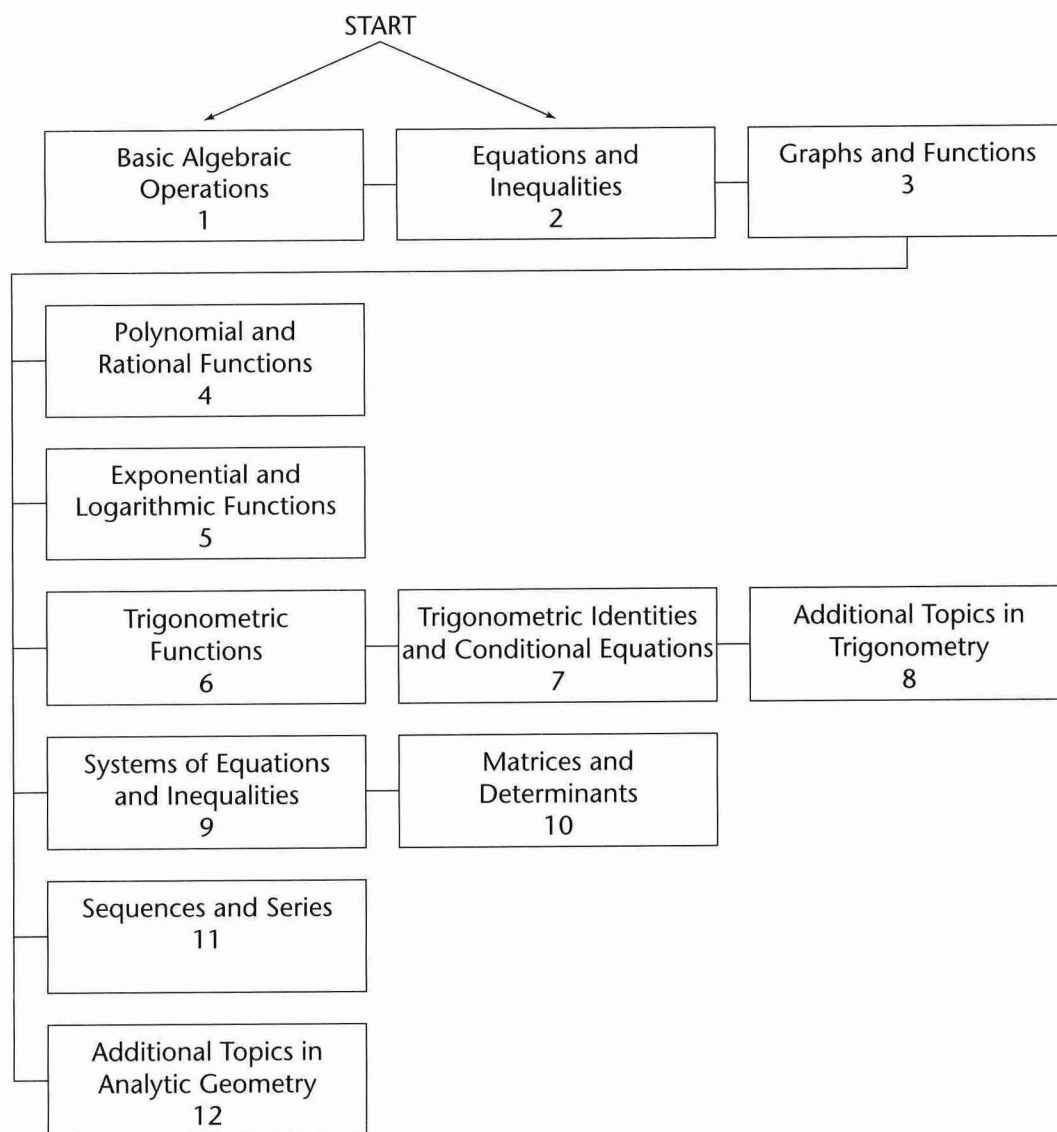
Hossein Hamedani and Caroline Woods for providing a careful and thorough check of all the mathematical calculations in the book, the student solutions manual, and the answer manual (a tedious but extremely important job). All of the supplements authors for developing the supplemental manuals that are so important to the success of a text. Jeanne Wallace for accurately and efficiently producing many of the manuals that supplement the text. George Morris and his staff at Scientific Illustrators for their effective illustrations and accurate graphs. Maggie Rogers, Sheila Frank, Michelle Munn, and all the other people at McGraw-Hill who contributed their efforts to the production of this book. Producing this new edition with the help of all these extremely competent people has been a most satisfying experience.

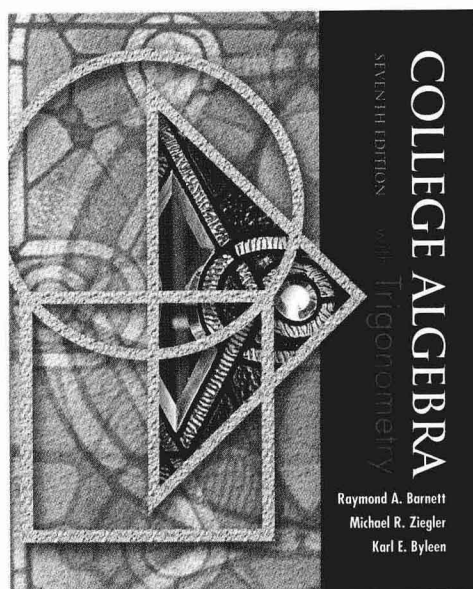
We also wish to thank the following manuscript reviewers: Yungchen Cheng, S.W. Missouri State University; Allan Cochran, University of Arkansas; Wayne Ehler, Anne Arundel Community College; Abdulla Elusta, Broward Community College; Betsy Farber, Bucks County Community College; Jeffrey Graham, Western Carolina University; Selwyn Hollis, Armstrong Atlantic State University; Randal Hoppens, Blinn College; Linda Horner, Broward Community College—N. Campus; Beverly Reed, Kent State University; Mike Rosenthal, Florida International University; Robert Woodside, East Carolina State University; Mary Wright, Southern Illinois University. Chapter reviewers: Diane Abbott, Bowling Green State University; Victor Akatsa, Chicago State University; Judith Beauford, University of the Incarnate Word; George Bradley, Duquesne University; Ronald Brent, University of Massachusetts-Lowell; Jeff Brown, University of North Carolina at Wilmington; Kimberly Brown, Tarrant County Junior College; Ed Buman, Creighton University; Roxanne Byrne, University of Colorado at Denver; Magdalena Caproiu, Antelope Valley College; Harold Carda, South Dakota School of Mines and Technology; Allan Cochran, University of Arkansas; Barbara Cortzen, DePaul University; Patrick Crowe, Johnson City Community College; Elizabeth Chu, Sussex County Community College; Marilyn Danchanko, Camria County Area Community College; Karin Deck, University of North Carolina at Wilmington; Joe Di Costanzo, Johnson County Community College; Michelle Diehl, University of New Mexico; Jeff Dinitz, University of Vermont; Charles Douglas, South Georgia College; Mary Ehlers, Seattle University; Laura Fernelius, University of Wisconsin at Oshkosh; Larry Friesen, Butler County Community College; Doris Fuller, Virginia State University; Dan Gardner, Elgin Community College; Rebecca Gehrke-Griswold, Jefferson Community College-SW; Sheryl Griffith, Iowa Central Community College; Vernon Gwaltney, John Tyler Community College; Rutger Hangelbroek, Western Illinois University; Keith Howell, Southwestern Michigan College; Brian Jackson, Connor's State College; Juan Carlos Jimenez, Springfield Technical Community Col-

lege; Nancy Johnson, Manatee Community College; Klaus Kaiser, University of Houston; Rahim Karimpour, Southern Illinois University at Edwardsville; Karla Karstens, University of Vermont; Thomas Keller, Southwest Texas State University; Warren Koepp, Texas A&M at Commerce; Kent Kromarek, University of Wisconsin-Waukesha; Sonja Kung, University of Wisconsin at Stevens Point; Mark Lesperance, Kansas State University; Carol Lucas, University of Kansas; Richard Mason, Indian Hills Community College; Marilyn McCollum, North Carolina State University; Gael Mericle, Minnesota State University-Mankato; Michael Montano, Riverside Community College; Patricia Moreland, Cowley County Community College; Robert Moyer, Fort Valley State University; Arumudam Muhundan, Manatee Community College; Milt Myers, Delaware County Community College; Richard Nadel, Florida International University; Roxie Novak, Radford University; Vicki Partin, Lexington Community College; Gloria Phoenix, North Carolina Agricultural & Technical State University; Donna Russo, Quincy College; Mohammed Saleem, San Jose State University; Donna Salinardi, University of Connecticut; Jean Sanders, University of Wisconsin at Platteville; Radha Sankaran, Passaic County Community College; Ellen Scheiber, Drexel University; Patricia Schmidt, University of Pittsburgh at Greensburg; Samkar Sethuraman, Augusta State University; James Shockley, Virginia Polytechnic Institute; Debbye Stapleton, Georgia Southern University; Lora Stewart, Cosumnes River College; Joseph Sukta, Moraine Valley Community College; Ralph Svetic, Winona State University; Hussain Talibi, Tuskegee University; Stuart Thomas, University of Oregon; Richard Vinson, University of South Alabama; James Ward, Pensacola Junior College; Lyndon Weberg, University of Wisconsin; Chad Wheatley, Delaware Technical & Community College; Edward White, Frostburg State University; Clifton Whyburn, University of Houston; Tom Williams, Rowan-Cabarrus Community College; Terry Wilson, San Jacinto College; Zhanbo Yang, University of the Incarnate Word; George Zazi, Chicago State University; Cathleen Zucco-Teveloff, Rutgers University.

R. A. Barnett
M. R. Ziegler
K. E. Byleen

CHAPTER DEPENDENCIES





McGraw-Hill is proud to offer an exciting new suite of multimedia products and services called *Course Solutions*.

Designed specifically to help you with your individual course needs, **Course Solutions** will assist you in integrating your syllabus with our premier titles and state-of-the-art new media tools that support them.

At the heart of *Course Solutions* you'll find:

- Fully integrated multimedia
- A full-scale Online Learning Center
- A Course Integration Guide

As well as these unparalleled services:

- McGraw-Hill Learning Architecture
- McGraw-Hill Course Consultant Service
- Visual Resource Library (VRL)
- Image Licensing
- McGraw-Hill Student Tutorial Service
- McGraw-Hill Instructor Syllabus Service
- PageOut Lite
- PageOut: The Course Website Development Center
- Other Delivery Options

Course Solutions truly has the solutions to your every teaching need. Read on to learn how we can specifically help you with your classroom challenges.

SPECIAL ATTENTION

to your specific needs.

*These “perks” are all part of the extra service delivered through McGraw-Hill’s **Course Solutions**:*

McGraw-Hill Learning Architecture

Each McGraw-Hill *Online Learning Center* is ready to be ported into our *McGraw-Hill Learning Architecture*—a full course management software system for *Local Area Networks* and *Distance Learning Classes*. Developed in conjunction with Top Class software, *McGraw-Hill Learning Architecture* is a powerful course management system available upon special request.

McGraw-Hill Course Consultant Service

In addition to the *Course Integration Guide*, instructors using **Course Solutions** textbooks can access a special curriculum-based *Course Consultant Service*, via a web-based threaded discussion list within each *Online Learning Center*. A **McGraw-Hill Course Solutions Consultant** will personally help you—as a text adopter—integrate this text and media into your course to fit your specific needs. This content-based service is offered in addition to our usual software support services.

McGraw-Hill Instructor Syllabus Service

For *new* adopters of **Course Solutions** textbooks, McGraw-Hill will help correlate all text, supplement, and appropriate materials and services to your course syllabus. Simply call your McGraw-Hill sales representative for assistance.

PageOut Lite

Free to **Course Solutions** textbook adopters, *PageOut Lite* is perfect for instructors who want to create their own website. In just a few minutes, even novices can turn their syllabus into a website using *PageOut Lite*.

PageOut: The Course Website Development Center

For those who want the benefits of *PageOut Lite*’s no-hassle approach to site development, but with even more features, we offer *PageOut: The Course Website Development Center*.

PageOut shares many of *PageOut Lite*’s features, but its syllabus page lets you create links that will take your students to your original material, other website addresses, and to *McGraw-Hill Online Learning Center* content. This means you can assign *Online Learning Center* content within your syllabus-based website. *PageOut*’s grade book function will tell you when each student has taken a quiz or worked through an exercise, automatically recording his or her scores for you. *PageOut* also features a discussion board list where you and your students can exchange questions