

ALGEBRA FOR COLLEGE STUDENTS



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HELP YOURSELF

To succeed in mathematics, as in any subject, you must be willing to devote some of your time and attention to complete the homework assignments and prepare for exams. You must set aside time for yourself on a regular basis to put any classroom notes to use and work through homework exercises. As you study your notes and work on homework, you may find that some concepts are easier to understand than others. For this reason, you may need to have a concept explained more than once or in different ways. In addition to the explanations you may receive in the classroom or from tutors, this textbook and its accompanying products will provide you with additional explanations, worked examples, and exercise sets to help you master concepts and practice what you learn. If you use the resources available to you, with a little self-discipline and patience you should find that you achieve a passing grade in the course and build the groundwork necessary for further studies in mathematics.

SUPPLEMENTS

The following products were developed in conjunction with your textbook to offer you additional support in your course.

Student Edition—Online Learning Center

The Student Edition of the Online Learning Center (OLC), located at www.mhhe.com/miller_oneill, contains valuable resources that will help you improve your understanding of the topics presented in your course.

The Student Edition is passcode-protected. A passcode can be found at the front of your text and *is free when you purchase a new book*.

When you enter the Student Edition, you will find practice exercises and self-tests, video clips, animated lessons, access to NetTutor™, materials for a Student Portfolio, a downloadable formula card, and more!

NetTutor

NetTutor is a revolutionary system that enables you to interact with a live tutor over the World Wide Web by using NetTutor's Web-based, graphical chat capabilities. You can also submit questions and receive answers, browse previously answered questions, and view previous live chat sessions. Access to NetTutor can be made from home or school regardless of the type of Internet browser or computer you are using.

To learn more about NetTutor and to register, visit the Student Edition of the Online Learning Center.

Miller/O'Neill Tutorial SMART CD-ROM

The interactive SMART CD-ROM for use with *Algebra for College Students* is a self-paced tutorial specifically linked to the text. The CD reinforces topics through unlimited opportunities to review concepts and practice problem solving. It provides section-specific animated lessons with accompanying audio, practice exercises that enable you to work through problems with step-by-step guidance available, concept-matching problems that test vocabulary skills as well as identification of properties and rules, and more. This browser-based CD requires almost no computer training and will run on both Windows and Macintosh computers. Many of the features found on the SMART CD can also be accessed through the Student Edition of the Online Learning Center.

Miller/O'Neill Video Series (Videotapes or Video CDs)

The video series is based on problems taken directly from the Practice Exercises. The Practice Exercises contain icons that show which problems from the text appear in the video series. A mathematics instructor presents selected problems and works through them, following the solution methodology employed in the text. The video series is also available on video CDs.

Student's Solutions Manual

The *Student's Solutions Manual* provides comprehensive, worked-out solutions to odd-numbered exercises in the Practice Exercise sets, the Midchapter Reviews, the end-of-chapter Review Exercises, the Chapter Tests, and the Cumulative Review Exercises.

PUTTING IT ALL TOGETHER

This text and its accompanying supplements have been designed to offer you the kind of support that will help you succeed in your course. Here are a few suggestions for using the text and its accompanying materials.

To prepare for exams, rework assigned homework problems for practice. Also, work through the Chapter Tests and compare your answers with those in the back of the text. You can use the Student Portfolio, available on the Student Edition of the Online Learning Center, to keep your notes and other class-related papers such as quizzes and tests organized. If you save your tests, you can rework problems from the tests in preparation for other exams. You can also use the Vocabulary Worksheets from the Student Portfolio to review terms that might appear on your quizzes or exams.

If you are looking for extra help and are not able to get help in school due to conflicting schedules with your instructor or tutoring center, you can use NetTutor. The Student Edition of the Online Learning Center contains many other valuable elements such as "e-professors." The e-professors are tutorials based on topics selected from each section of the text. These tutorials present worked-out solutions to problems, similar to those found in your text. Another valuable source of help is the video series. If you cannot attend a class on a particular day or if you would just like more explanation, refer to the selected problems from the Practice Exercises of your text that have a video icon. Once you identify these problems, you can use the videotapes or videos on CD to watch an instructor present the solutions. If you would like a reminder or hint as to how various problems in the text are solved, refer to the solutions manual which offers worked-out solutions.

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Finally, we give special thanks to all the students and instructors who use *Algebra for College Students* in their classes.

Julie Miller and Molly O'Neill

KEY FEATURES

To get the most use out of your textbook, take a few minutes to familiarize yourself with its features.

Chapter Openers

Each chapter opens with an application relating to topics presented in the chapter. The Chapter Openers also contain website references for **Technology Connections**, Internet activities found in the Student Learning Site of the Online Learning Center, which further the scope of the application.

chapter

5

POLYNOMIALS



- 5.1 Properties of Integer Exponents and Scientific Notation
- 5.2 Polynomial Functions and Applications
- 5.3 Addition and Subtraction of Polynomials
- Midchapter Review
- 5.4 Multiplication of Polynomials
- 5.5 Division of Polynomials
- 5.6 Synthetic Division
- Chapter 5 Summary
- Chapter 5 Review Exercises
- Chapter 5 Test
- Cumulative Review Exercises, Chapters 1–5

To plan a vacation overseas, an understanding of currency exchange rates is important. For example, if you visit Frankfurt, Germany, you will need to know how many Euros (the main unit of currency in Germany as well as 11 other European countries) may be exchanged for \$1. If you visit Japan, you will need to know how many Yen may be exchanged for \$1.

Because many countries outside the United States use the metric system, it is also helpful to know unit conversions for some common units of measurement. For example, 1 kilometer (km) is approximately 0.622 miles. Therefore, the distance of 305 km between Frankfurt, Germany, and Munich, Germany, is approximately 190 miles.

A linear function can be used to perform unit conversions. If x is a distance measured in kilometers, then the function defined by

$$m(x) = 0.622x$$

gives the corresponding distance in miles.

For more information about currency exchange and unit conversion, visit currencyx and unitconv at www.mhhe.com/miller_oreill

28 Chapter 1 Review of Basic Algebraic Concepts

section

1.3 SIMPLIFYING EXPRESSIONS

Concepts

1. Recognizing Terms, Factors, and Coefficients
2. Properties of Real Numbers
3. Distributive Property and Clearing Parentheses
4. Combining Like Terms
5. Simplifying Expressions

1. Recognizing Terms, Factors, and Coefficients

An algebraic expression is the sum of one or more terms. A **term** is a constant or the product of a constant and one or more variables. For example, the expression $-6x^2 + 5xyz - 11$ or $-6x^2 + 5xyz + -11$ consists of the terms $-6x^2$, $5xyz$, and -11 .

The terms $-6x^2$ and $5xyz$ are **variable terms**, and the term -11 is called a **constant term**. It is important to distinguish between a term and the **factors** within a term. For example, the quantity $5xyz$ is one term, but the values 5, x , y , and z are factors within the term. The constant factor in a term is called the numerical coefficient (or simply **coefficient**) of the term. In the terms $-6x^2$, $5xyz$, and -11 , the coefficients are -6 , 5, and -11 , respectively.

Terms are called **like terms** if they each have the same variables, and the corresponding variables are raised to the same powers. For example:

Like Terms		Unlike Terms	
$-6t$ and $4t$		$-6t$ and $4s$	(different variables)
$1.8ab$ and $-3ab$		$1.8xy$ and $-3x$	(different variables)
$\frac{1}{2}x^2y^3$ and $-x^2y^3$		$\frac{1}{2}x^2y^3$ and $-x^2y$	(different powers)
4 and 6		$4p$ and 6	(different variables)

example 1

Identifying Terms, Factors, Coefficients, and Like Terms

- a. List the terms of the expression $-4x^2 - 7x + \frac{3}{5}$
- b. Identify the coefficient of the term yz^3
- c. Identify the pair of like terms: $16b$, $4b^2$ or $\frac{1}{2}c$, $-\frac{1}{2}c$

Solution:

- a. The terms of the expression $-4x^2 - 7x + \frac{3}{5}$ are $-4x^2$, $-7x$, and $\frac{3}{5}$.
- b. The term yz^3 can be written as $1yz^3$; therefore, the coefficient is 1.
- c. $\frac{1}{2}c$, $-\frac{1}{2}c$ are like terms because they have the same variable raised to the same power.

2. Properties of Real Numbers

Simplifying algebraic expressions requires several important properties of real numbers that are stated in Table 1-3. Assume that a , b , and c represent real numbers or real-valued algebraic expressions:

Concepts

A list of important concepts is provided at the beginning of each section. Each concept corresponds to a heading within the section, making it easy to locate topics as you study or work through homework exercises.

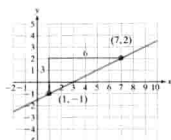


Figure 2-14

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{2 - (-1)}{7 - 1} \quad \text{Apply the slope formula.}$$

$$= \frac{3}{6} \quad \text{or} \quad m = \frac{1}{2} \quad \text{Simplify and reduce.}$$

The slope of the line can be verified from the graph (Figure 2-14).

Tip: The slope formula does not depend on which point is labeled (x_1, y_1) and which point is labeled (x_2, y_2) . For example, reversing the order in which the points are labeled in Example 1 results in the same slope:

$$(1, -1) \quad \text{and} \quad (7, 2)$$

$$(x_2, y_2) \quad (x_1, y_1)$$

$$\text{then } m = \frac{-1 - 2}{1 - 7} = \frac{-3}{-6} = \frac{1}{2}$$

3. Positive, Negative, Zero, and Undefined Slopes

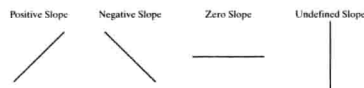
The value of the slope of a line may be positive, negative, zero, or undefined.

Lines that “increase,” or “rise,” from left to right have a **positive slope**.

Lines that “decrease,” or “fall,” from left to right have a **negative slope**.

Horizontal lines have a **zero slope**.

Vertical lines have an **undefined slope**.



example 2

Finding the Slope of a Line Between Two Points

Find the slope of the line passing through the points $(3, -4)$ and $(-5, -1)$.

Solution:

$$(3, -4) \quad \text{and} \quad (-5, -1)$$

$$(x_1, y_1) \quad (x_2, y_2) \quad \text{Label points.}$$

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-1 - (-4)}{-5 - 3} \quad \text{Apply the slope formula.}$$

$$= \frac{3}{-8} = -\frac{3}{8} \quad \text{Simplify.}$$

Avoiding Mistakes

Through marginal notes labeled Avoiding Mistakes you are alerted to common errors and are shown methods to avoid them.

Special Elements

Tips

Tip boxes appear throughout the text and offer helpful hints and insight.

Solution:

$$\begin{aligned} \text{a. } 6\sqrt{11} + 2\sqrt{11} \\ &= (6 + 2)\sqrt{11} \quad \text{Apply the distributive property.} \\ &= 8\sqrt{11} \quad \text{Simplify.} \end{aligned}$$

$$\begin{aligned} \text{b. } \sqrt{3} + \sqrt{3} \\ &= 1\sqrt{3} + 1\sqrt{3} \quad \text{Note that } \sqrt{3} = 1\sqrt{3}. \\ &= (1 + 1)\sqrt{3} \quad \text{Apply the distributive property.} \\ &= 2\sqrt{3} \quad \text{Simplify.} \end{aligned}$$

$$\begin{aligned} \text{c. } -2\sqrt{ab} + 7\sqrt{ab} - \sqrt{ab} \\ &= (-2 + 7 - 1)\sqrt{ab} \quad \text{Apply the distributive property.} \\ &= 4\sqrt{ab} \quad \text{Simplify.} \end{aligned}$$

$$\begin{aligned} \text{d. } \frac{1}{4}x\sqrt{3y} - \frac{3}{2}x\sqrt{3y} \\ &= \left(\frac{1}{4} - \frac{3}{2}\right)x\sqrt{3y} \quad \text{Apply the distributive property.} \\ &= \left(\frac{1}{4} - \frac{6}{4}\right)x\sqrt{3y} \quad \text{Get a common denominator.} \\ &= -\frac{5}{4}x\sqrt{3y} \quad \text{Simplify.} \end{aligned}$$

Avoiding Mistakes

The process of adding like radicals with the distributive property is similar to adding like terms. The end result is that the numerical coefficients are added and the radical factor is unchanged.

$$\sqrt{3} + \sqrt{3} = 1\sqrt{3} + 1\sqrt{3} = 2\sqrt{3} \quad \text{(correct)}$$

Be careful! $\sqrt{3} + \sqrt{3} \neq \sqrt{10}$

In general: $\sqrt{x} + \sqrt{y} \neq \sqrt{x + y}$

Sometimes it is necessary to simplify radicals before adding or subtracting.

example 2

Adding and Subtracting Radicals

Simplify the radicals and add or subtract as indicated.

$$\text{a. } 3\sqrt{8} + \sqrt{2} \quad \text{b. } 8\sqrt{x^3y^2} - 3y\sqrt{x^2}$$

$$\text{c. } \sqrt{50x^3y^2} - 13y\sqrt{2x^3y^2} + xy\sqrt{98y^2}$$

Solution:

$$\begin{aligned} \text{a. } 3\sqrt{8} + \sqrt{2} \\ &= 3 \cdot 2\sqrt{2} + \sqrt{2} \\ &= 6\sqrt{2} + \sqrt{2} \\ &= (6 + 1)\sqrt{2} \\ &= 7\sqrt{2} \end{aligned} \quad \begin{aligned} &\text{The radicands are different. Try} \\ &\text{simplifying the radicals first.} \\ &\text{Simplify: } \sqrt{8} = 2\sqrt{2} \\ &\text{Apply the distributive property.} \\ &\text{Simplify.} \end{aligned}$$

Graphing Calculator Boxes

Optional Graphing Calculator Boxes appear throughout the text. These boxes appear for your reference and may be included as part of your reading assignment, depending on the amount of emphasis your instructor places on the graphing calculator in your course. The boxes include screen captures and show how various techniques, such as analyzing and evaluating functions, can be performed.

Graphing Calculator Box

Consider the equation $x(x + 7) + 4 = 0$ from Example 2. In standard form, this equation is $x^2 + 7x + 4 = 0$. Using the quadratic formula, we have

$$x = \frac{-(7) \pm \sqrt{(7)^2 - 4(1)(4)}}{2(1)}$$

A calculator can be used to apply the quadratic formula directly; however, each solution must be entered separately. The solution can be checked on the calculator by using the *Ans* variable. This contains the result of the calculator's most recent computation.

$$x = \frac{-(7) + \sqrt{(7)^2 - 4(1)(4)}}{2(1)} \approx -0.6277186767$$

$$\frac{(-7) + \sqrt{(7)^2 - 4 * 1 * 4}}{2 * 1}$$

Ans \div 7 Ans $+$ 4 ← Solution

0 ← Check

$$x = \frac{-(7) - \sqrt{(7)^2 - 4(1)(4)}}{2(1)} \approx -6.372281323$$

$$\frac{(-7) - \sqrt{(7)^2 - 4 * 1 * 4}}{2 * 1}$$

Ans \div 7 Ans $+$ 4 ← Solution

0 ← Check

example 3

Solving a Quadratic Equation Using the Quadratic Formula

Solve the quadratic equation using the quadratic formula.

$$\frac{1}{4}z^2 + \frac{1}{4}z = -\frac{1}{2}$$

Solution:

$$\frac{1}{4}z^2 + \frac{1}{4}z = -\frac{1}{2}$$

$$4\left(\frac{1}{4}z^2 + \frac{1}{4}z\right) = 4\left(-\frac{1}{2}\right)$$

Multiply by 4 to clear fractions.

$$z^2 + z = -2$$

section 2.4 PRACTICE EXERCISES

1. True or false. If an answer is false, explain why.
 - a. The graph of a linear equation always has an x -intercept.
 - b. The graph of a linear equation always has a y -intercept.
2. True or false. If an answer is false, explain why.
 - a. The x - and y -intercepts of a linear equation are always different points.
 - b. Every graph of a line must have an x -intercept or a y -intercept or both.
3. $2x - 2y - 4 = 0$
4. $2x + 3y = -12$
5. $2x - 4 = 6$
6. $3 - 2y = -6$
7. Given the two points $(-3, -4)$ and $(3, -6)$:
 - a. Find the slope of the line passing through the two points.
 - b. Find an equation of the line passing through the two points. Write the answer in slope-intercept form and graph the line.
 - c. Find an equation of any line parallel to the line found in part (b). (Answers may vary.)

EXPANDING YOUR SKILLS

37. Loraine is enrolled in an algebra class that meets 5 days per week. Her instructor gives a test every Friday. Loraine has a study plan and keeps a portfolio with notes, homework, test corrections, and vocabulary. She also records the amount of time per day that she studies and does homework. The following data represent the amount of time she studied per day and her weekly test grades.

Time Studied per Day (minutes)	Weekly Test Grade (percent)
x	y
60	69
70	74
80	79
90	84
100	89

Table for Exercise 37

- a. Graph the points on a rectangular coordinate system. Use appropriate scaling for the x - and y -axes. Do the data points appear to follow a linear trend?
- b. Find a linear equation that relates Loraine's



38. $(3, -4)$, $(0, -5)$, $(9, -2)$
39. $(4, 3)$, $(-4, -1)$, $(2, 2)$
40. $(0, 2)$, $(-2, 12)$, $(-1, 6)$
41. $(-2, -2)$, $(0, -3)$, $(-4, -1)$

GRAPHING CALCULATOR EXERCISES

42. a. Graph the equation $y = 0.2x$ (Hint: Use a window defined by $0 \leq x \leq 25$ and $0 \leq y \leq 5$).
b. Use an *Eval* or *Table* feature to confirm your answers to Exercise 15.
43. a. Graph the equation $y = 2.5x$ (Hint: Use a window defined by $0 \leq x \leq 12$ and $0 \leq y \leq 30$).
b. Use an *Eval* or *Table* feature to confirm your answers to Exercise 16.
44. a. Graph the equation $y = 5.3x + 63.4$ (Hint: Use a window defined by $0 \leq x \leq 15$ and $0 \leq y \leq 150$).
b. Use an *Eval* or *Table* feature to confirm your answers to Exercise 17.
45. a. Graph the equation $y = 142x + 9060$ (Hint: Use a window defined by $0 \leq x \leq 15$ and $0 \leq y \leq 15,000$).

Practice Exercises

The Practice Exercises contain a variety of problem types.

- **Applications** are based on real-world facts and figures. Working through these problems will help you improve your problem-solving skills.
- **Exercises keyed to video**  are labeled with an icon to help you identify those exercises that appear in the video series that accompanies this text.
- **Calculator Exercises**  cover situations when a calculator can be used to help you perform calculations that might be overly time-consuming if done by hand. They are designed for use with either a scientific or a graphing calculator.
- **Expanding Your Skills**, found near the end of most Practice Exercise sets, are exercises that challenge your knowledge of the concepts presented.
- **Graphing Calculator Exercises**, also found at the end of appropriate exercise sets, offer you an opportunity to use a graphing calculator to explore concepts.

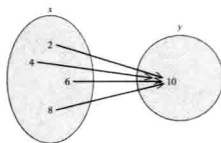
chapter 4 MIDCHAPTER REVIEW

For Exercises 1–6, list the domain and range of each relation. Then determine if the relation defines y as a function of x .

1.

State x	Percent Change in Population Since 1990 y
Colorado	16
Rhode Island	-1.3
Kentucky	5.3
Alabama	5.8

2.



Midchapter Reviews

The Midchapter Reviews are provided to help you strengthen your understanding of concepts learned in the beginning of a chapter before you move on to new ideas presented later in the chapter.

End of Chapter Summary and Exercises

The **Summary**, found at the end of each chapter, outlines key concepts and terms for each section and illustrates concepts with examples. With this list, you can quickly identify important ideas and vocabulary to be reviewed before quizzes or exams. Following the Summary is a set of **Review Exercises** that are organized by section. A **Chapter Test** appears after each set of Review Exercises.

Chapters 2–13 also include a **Cumulative Review** that follows the Chapter Test. These end-of-chapter materials are useful resources that will help you prepare for quizzes or exams.

chapter 6 SUMMARY

SECTION 6.1—DEFINITION OF AN n TH ROOT

KEY CONCEPTS:

b is an n th root of a if $b^n = a$.

The expression $\sqrt[n]{a}$ represents the principal square root of a .

The expression $\sqrt[n]{a}$ represents the principal n th root of a .

$\sqrt[n]{a^n} = |a|$ if n is even.

$\sqrt[n]{a^n} = a$ if n is odd.

$\sqrt[n]{a}$ is not a real number if $a < 0$ and n is even.

$f(x) = \sqrt[n]{x}$ defines a radical function.

EXAMPLES:

2 is a square root of 4.

-2 is a square root of 4.

-3 is a cube root of -27.

$$\sqrt{36} = 6$$

$$\sqrt{-64} = -4$$

$$\sqrt{(x+3)^4} = |x+3| \quad \sqrt{(x+3)^2} = x+3$$

$\sqrt[4]{-16}$ is not a real number.

For $g(x) = \sqrt{x}$ the domain is $[0, \infty)$.

For $h(x) = \sqrt[3]{x}$ the domain is $(-\infty, \infty)$.

chapter 6 REVIEW EXERCISES

For the exercises in this set, assume that all variables represent positive real numbers unless otherwise stated.

Section 6.1

1. True or false:

- The principal n th root of an even indexed root is always positive.
- The principal n th root of an odd indexed root is always positive.

2. Explain why $\sqrt{(-3)^2} = 3$ and $\sqrt{(-3)^2} \neq -3$.

3. Are the following statements true or false?

- $\sqrt{a^2 + b^2} = a + b$
- $\sqrt{(a+b)^2} = a + b$

For Exercises 4–6, simplify the radicals.

- $\sqrt{\frac{50}{32}}$
- $\sqrt[3]{625}$
- $\sqrt{(-6)^2}$

chapter 6 TEST

- What is the principal square root of 36?
 - What is the negative square root of 36?
- Which of the following are real numbers?
 - $-\sqrt{100}$
 - $\sqrt{-100}$
 - $-\sqrt[3]{1000}$
 - $\sqrt[3]{-1000}$
- Simplify.
 - $\sqrt[3]{y^3}$
 - $\sqrt[4]{y^4}$

For Exercises 4–11, simplify the radicals. Assume that all variables represent positive numbers.

- $\sqrt[3]{81}$
- $\sqrt{\frac{16}{9}}$
- $\sqrt[3]{32}$
- $\sqrt{a^4 b^2 c^8}$
- $\sqrt{3x} \cdot \sqrt{6x^2}$
- $\sqrt{\frac{32x^6}{3w}}$

CUMULATIVE REVIEW EXERCISES, CHAPTERS 1–6

- Simplify the expression:
 $6^2 - 2[5 - 8(3 - 1) + 4 + 2]$
- Simplify the expression:
 $3x - 3(-2x + 5) - 4y + 2(3x + 5) - y$
- Solve the equation: $9(2y + 8) = 20 - (y + 5)$
- Solve the inequality. Write the answer in interval notation. $2a - 4 < -14$
- Write an equation of the line that is parallel to the line $2x + y = 9$ and passes through the point $(3, -1)$. Write the answer in slope-intercept form.
- On the same coordinate system, graph the line $2x + y = 9$ and the line that you derived in Exercise 5. Verify that these two lines are indeed parallel.

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