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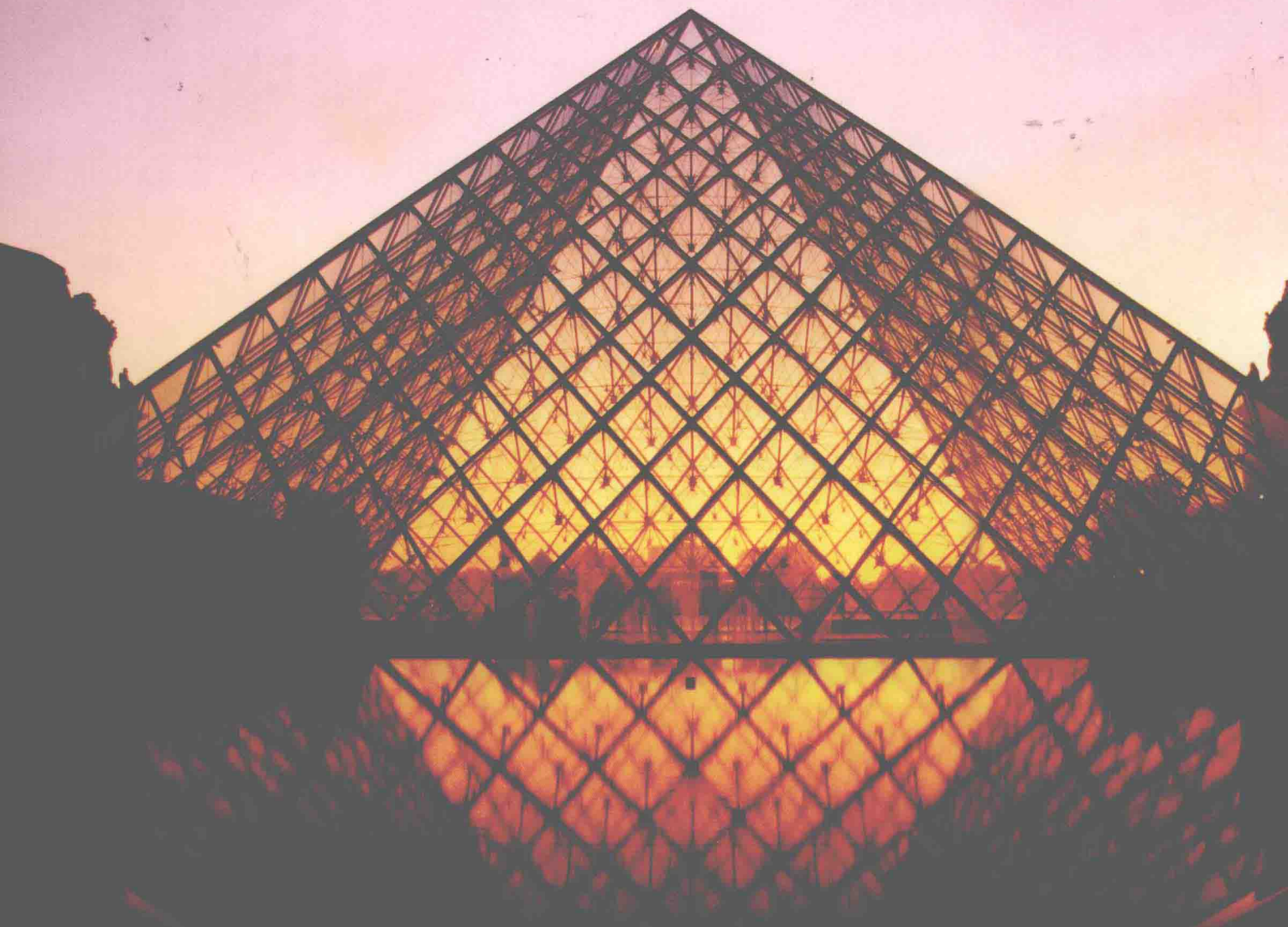

Elementary and Intermediate Algebra

SECOND EDITION

Elementary and Intermediate Algebra

Second Edition

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Preface

Welcome to the second edition of *Elementary and Intermediate Algebra* by Carson, Gillespie, and Jordan! Revising this series has been both exciting and rewarding. It has given us the opportunity to respond to valuable instructor and student feedback and suggestions for improvement. It is with great pride that we share with you both the improvements and additions to this edition as well as the hallmark features and style of the Carson/Gillespie/Jordan series.

Elementary and Intermediate Algebra, Second Edition, is the fourth book in a series that includes *Elementary Algebra,* Second Edition, *Prealgebra,* Second Edition, *Elementary Algebra with Early Systems of Equations,* and *Intermediate Algebra,* Second Edition. This text is designed to be versatile enough for use in a standard lecture format, a self-paced lab, or even in an independent study format. Written in a relaxed, nonthreatening style, *Elementary and Intermediate Algebra* takes great care to ensure that students who have struggled with math in the past will be comfortable with the subject matter. Explanations are carefully developed to provide a sense of why an algebraic process works the way it does, instead of just an explanation of how to follow the process. In addition, problems from science, engineering, accounting, health, the arts, and everyday life link algebra to the real world. A complete study system beginning with a Learning Styles Inventory and supported by frequent Learning Strategy boxes, is also provided to give students extra guidance and to help them be successful. (See page xxiii.)

Changes to the Second Edition

This revision includes refinements to the presentation of the material as well as the addition of many more examples and applications throughout the text. However, the primary focus of this revision is the exercise sets. The section-level exercise sets have been scrutinized and reworked to create a gradation that slowly progresses from easy to more difficult. There is also better pairing between odd and even exercises sets, and many more midlevel problems have been added.

In addition to the exercise sets, the Learning Strategy boxes and Algebra Pyramid references have been enhanced and increased in number to provide students with even more guidance.

Interval notation is introduced in Section 2.6 instead of Section 8.1 and is now used throughout the text.

A review chapter called Chapter R, which reviews basic Elementary Algebra concepts, has been added.

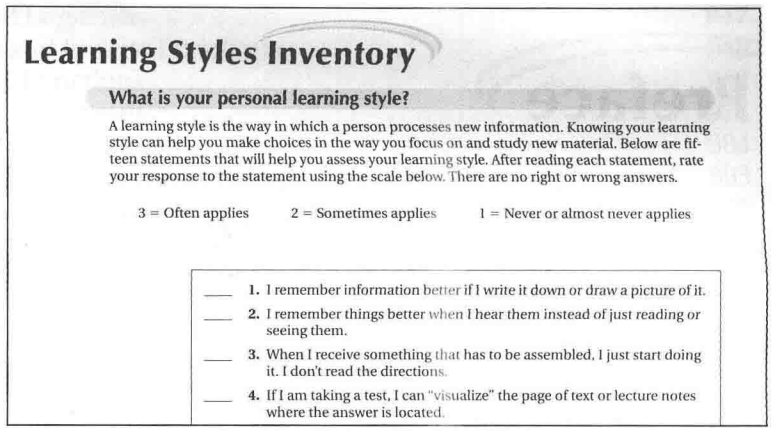
Small versions of the Algebra Pyramid have been added to the Chapter Review Exercises and the Cumulative Review Exercises to help students distinguish groups of expression exercises from groups of equation or inequality exercises.

Finally, the number of exercises included in MyMathLab and MathXL has been increased dramatically for an even stronger correlation between the book and the technology that supports it.

Key Features

Study System A study system is presented in the *To the Student* section on pages xvii–xxii. This system is then reinforced throughout the text. The system recommends color codes for taking notes. The color codes are consistent in the text itself: red for definitions, blue for procedures and rules, and black for notes and examples. In addition, the study system presents strategies for succeeding in the course. These learning strategies have been expanded and are revisited in the chapter openers and throughout the body of the text.

Learning Styles Inventory A Learning Styles Inventory is presented on page xxiii to help students assess their particular learning style. Learning Strategy boxes are then presented throughout the book with different learning styles in mind.



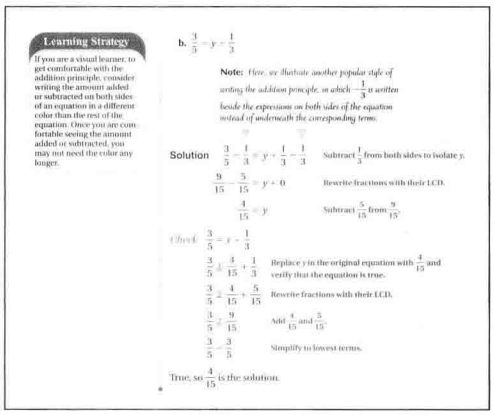
Learning Styles Inventory

What is your personal learning style?

A learning style is the way in which a person processes new information. Knowing your learning style can help you make choices in the way you focus on and study new material. Below are fifteen statements that will help you assess your learning style. After reading each statement, rate your response to the statement using the scale below. There are no right or wrong answers.

3 = Often applies 2 = Sometimes applies 1 = Never or almost never applies

1. I remember information better if I write it down or draw a picture of it.
2. I remember things better when I hear them instead of just reading or seeing them.
3. When I receive something that has to be assembled, I just start doing it. I don't read the directions.
4. If I am taking a test, I can "visualize" the page of text or lecture notes where the answer is located.



Learning Strategy

If you are a visual learner, to get comfortable with the addition principle, consider writing the amount added or subtracted on both sides of an equation in a different color than the rest of the equation. Once you are comfortable seeing the amount added or subtracted, you may not need the color any longer.

b. $\frac{3}{5} = y - \frac{1}{3}$

Note: *Here, we illustrate another popular style of writing the addition principle, in which $-\frac{1}{3}$ is written beside the expressions on both sides of the equation instead of underneath the corresponding terms.*

Solution

$\frac{3}{5} - \frac{1}{3} = y + \frac{1}{3} - \frac{1}{3}$ Subtract $\frac{1}{3}$ from both sides to isolate y.

$\frac{9}{15} - \frac{5}{15} = y + 0$ Rewrite fractions with their LCD.

$\frac{4}{15} = y$ Subtract $\frac{5}{15}$ from $\frac{9}{15}$.

Check $\frac{3}{5} = y - \frac{1}{3}$

$\frac{3}{5} \stackrel{?}{=} \frac{4}{15} - \frac{1}{3}$ Replace y in the original equation with $\frac{4}{15}$ and verify that the equation is true.

$\frac{3}{5} \stackrel{?}{=} \frac{4}{15} - \frac{5}{15}$ Rewrite fractions with their LCD.

$\frac{3}{5} \stackrel{?}{=} -\frac{9}{15}$ Add $\frac{4}{15}$ and $\frac{5}{15}$.

$\frac{3}{5} = -\frac{3}{5}$ Simplify to lowest terms.

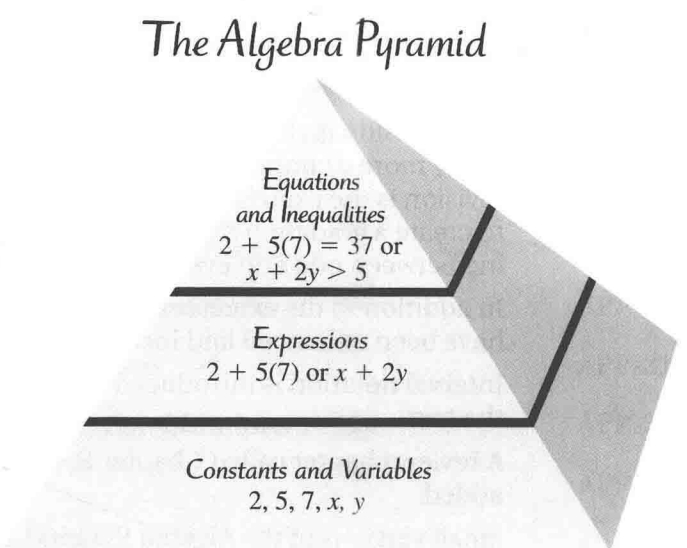
True, so $\frac{4}{15}$ is the solution.

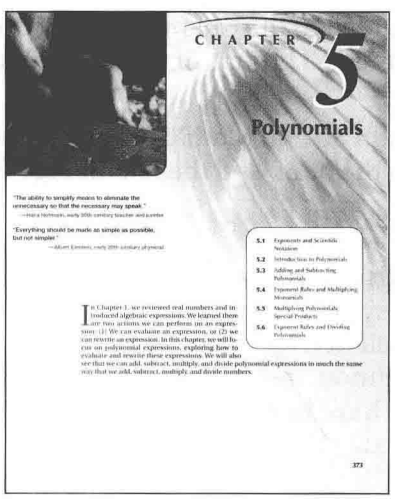
Learning Strategy Boxes Learning Strategy boxes appear where appropriate in the text to offer advice on how to effectively use the study system and how to study specific topics based on a student's individual learning style (see pages 3, 121, and 394).

The Algebra Pyramid An Algebra Pyramid is used throughout the text to help students see how the topic they are learning relates to the big picture of algebra—particularly focusing on the relationship between constants, variables, expressions, and equations (see pages 3, 102, and 387). In Chapter Review Exercises and Cumulative Review Exercises, an Algebra Pyramid icon indicates the level of the pyramid that correlates to a particular group of exercises to help students determine what actions are appropriate with these exercises, for example, whether to "simplify" or "solve" (see pages 265, 364, and 630).

Equations and Inequalities

Exercises 11–16





CHAPTER 5

Polynomials

"The ability to simplify means to eliminate the unnecessary so that the necessary may speak."
—Hans Hofmann, early 20th-century teacher and painter

"Everything should be made as simple as possible, but not simpler."
—Albert Einstein, early 20th-century physicist

5.1 Exponents and Scientific Notation
5.2 Introduction to Polynomials
5.3 Adding and Subtracting Polynomials
5.4 Exponent Rules and Multiplying Monomials
5.5 Multiplying Polynomials; Special Products
5.6 Exponent Rules and Dividing Polynomials

In Chapter 1, we reviewed real numbers and introduced algebraic expressions. We learned there are two actions we can perform on an expression: (1) We can evaluate an expression, or (2) we can rewrite an expression. In this chapter, we will focus on polynomial expressions, exploring how to evaluate and rewrite these expressions. We will also see that we can add, subtract, multiply, and divide polynomial expressions in much the same way that we add, subtract, multiply, and divide numbers.

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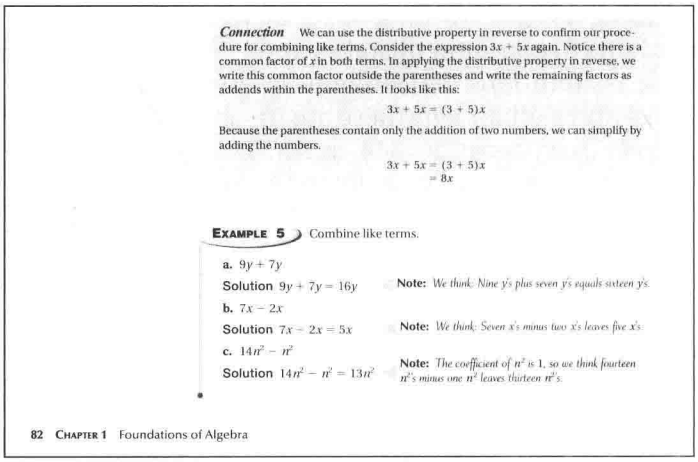
Chapter Openers Like the Algebra Pyramid, chapter openers are designed to help students see how the topics in the upcoming chapter relate to the big picture of the entire course. The chapter openers give information about the importance of the topics in each chapter and how they fit into the overall structure of the course (see pages 1, 101, and 189).

Connection Boxes Connection boxes bridge concepts and ideas that students have learned elsewhere in the text so they see how the concepts are interrelated and build on each other (see pages 102, 237, and 404).



Connection We can use the distributive property in reverse to confirm our procedure for combining like terms. Consider the expression $3x + 5x$ again. Notice there is a common factor of x in both terms. In applying the distributive property in reverse, we write this common factor outside the parentheses and write the remaining factors as addends within the parentheses. It looks like this:

$$3x + 5x = (3 + 5)x$$

Because the parentheses contain only the addition of two numbers, we can simplify by adding the numbers.

$$3x + 5x = (3 + 5)x$$
$$= 8x$$

EXAMPLE 5 Combine like terms.

a. $9y + 7y$

Solution $9y + 7y = 16y$ **Note:** *We think: Nine y's plus seven y's equals sixteen y's.*

b. $7x - 2x$

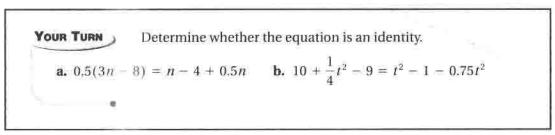
Solution $7x - 2x = 5x$ **Note:** *We think: Seven x's minus two x's leaves five x's.*

c. $14n^2 - n^2$

Solution $14n^2 - n^2 = 13n^2$ **Note:** *The coefficient of n^2 is 1, so we think fourteen n^2's minus one n^2 leaves thirteen n^2's.*

82 CHAPTER 1 Foundations of Algebra

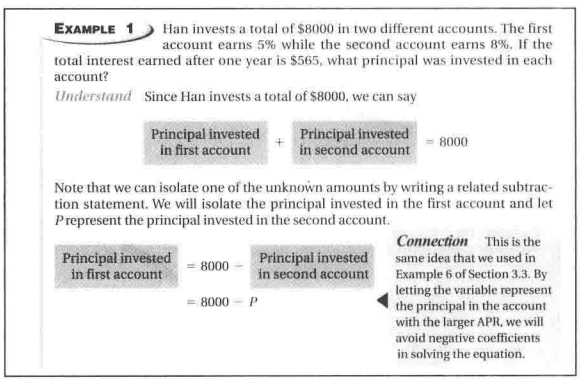
Your Turn Practice Exercises Your Turn practice exercises are found after most examples to give students an opportunity to work problems similar to the examples they have just seen. This practice step makes the text more interactive and provides immediate feedback so students can build confidence in what they are learning (see pages 6, 110, and 331).



YOUR TURN Determine whether the equation is an identity.

a. $0.5(3n - 8) = n - 4 + 0.5n$ **b.** $10 + \frac{1}{4}t^2 - 9 = t^2 - 1 - 0.75t^2$

Real, Relevant, and Interesting Applications A large portion of application problems in examples and exercise sets are taken from real situations in science, engineering, health, finance, the arts, or just everyday life. The real-world applications illustrate the everyday use of basic algebraic concepts and encourage students to apply mathematical concepts to solve problems (see pages 110, 236, and 334).



EXAMPLE 1 Han invests a total of \$8000 in two different accounts. The first account earns 5% while the second account earns 8%. If the total interest earned after one year is \$565, what principal was invested in each account?

Understand Since Han invests a total of \$8000, we can say

Principal invested in first account + Principal invested in second account = 8000

Note that we can isolate one of the unknown amounts by writing a related subtraction statement. We will isolate the principal invested in the first account and let P represent the principal invested in the second account.

Principal invested in first account = 8000 − Principal invested in second account

= 8000 − P

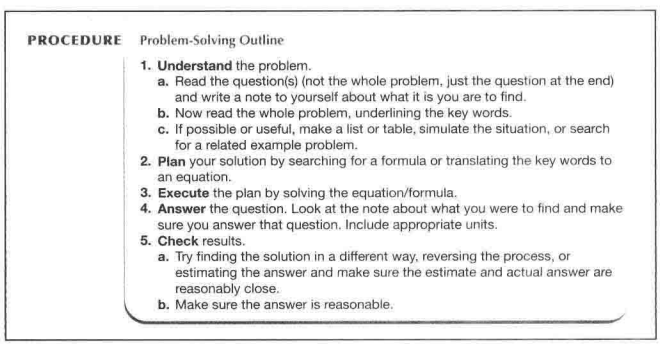
Connection This is the same idea that we used in Example 6 of Section 3.3. By letting the variable represent the principal in the account with the larger APR, we will avoid negative coefficients in solving the equation.

Thorough Explanations Great care is taken to explain not only how to do the math, but also why the math works the way it does, where it comes from, and how it is relevant to students' everyday lives. Knowing all of this gives students a context in which to remember the concept.

Problem-Solving Outline A five-step problem-solving outline is introduced on page 106 of Section 2.1 with the following headings:

1. Understand
2. Plan
3. Execute
4. Answer
5. Check

Application examples throughout the rest of the text follow the steps given in this outline, presenting the headings to model the thinking process clearly (see pages 127, 193, and 212).



PROCEDURE Problem-Solving Outline

1. **Understand** the problem.
   - **a.** Read the question(s) (not the whole problem, just the question at the end) and write a note to yourself about what it is you are to find.
   - **b.** Now read the whole problem, underlining the key words.
   - **c.** If possible or useful, make a list or table, simulate the situation, or search for a related example problem.
2. **Plan** your solution by searching for a formula or translating the key words to an equation.
3. **Execute** the plan by solving the equation/formula.
4. **Answer** the question. Look at the note about what you were to find and make sure you answer that question. Include appropriate units.
5. **Check** results.
   - **a.** Try finding the solution in a different way, reversing the process, or estimating the answer and make sure the estimate and actual answer are reasonably close.
   - **b.** Make sure the answer is reasonable.

Warning Boxes Warning boxes alert students to common mistakes and false assumptions that students often make and explain *why* these are incorrect (see pages 226, 344, and 393).

The word FOIL is a popular way to remember the process of multiplying two binomials. FOIL stands for **F**irst **O**uter **I**nner **L**ast. We will use Example 2 to demonstrate.

Warning: FOIL only helps keep track of products when multiplying two binomials. When multiplying larger polynomials, just remember to multiply every term in the second polynomial by every term in the first polynomial.

$(x + 4)(x + 3)$ First terms: $x \cdot x = x^2$

$(x + 4)(x + 3)$ Outer terms: $x \cdot 3 = 3x$

$(x + 4)(x + 3)$ Inner terms: $4 \cdot x = 4x$

$(x + 4)(x + 3)$ Last terms: $4 \cdot 3 = 12$

Of Interest

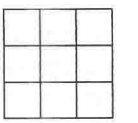
After exiting the plane, a skydiver accelerates from 0 to approximately 110 miles per hour (terminal velocity) in about 10 seconds and falls about 1000 feet. Terminal velocity means that air resistance balances out gravitational acceleration so that the skydiver falls at a constant 110 miles per hour until deploying the parachute. At terminal velocity, the skydiver falls at a rate of about 1000 feet every 6 seconds. Of course, the speed of the fall can be changed by varying body position to increase or decrease air resistance.

Of Interest Boxes Of Interest boxes are positioned throughout the text to offer a unique perspective on content that some students might otherwise consider to be ho-hum mathematics. Sometimes containing trivia and other times historical notes, Of Interest boxes are designed to enhance the learning process by making concepts fun, interesting, and memorable (see pages 23, 145, and 392).

Puzzle Problems These mathematical brainteasers, often solved without a formulaic approach, appear at the end of selected exercise sets to encourage critical thinking (see pages 117, 422, and 450).

PUZZLE PROBLEM

Fill in each square with a number 1 through 9 so that the sum of the numbers in each row, each column, and the two diagonals is the same.



Collaborative Exercises OCCUPATION GROWTH

Complete the following table by calculating the amount of change and the percent of the increase for each occupation, then answer the questions. Round to the nearest tenth of a percent.

The 10 Fastest-Growing Occupations, 2002–2012

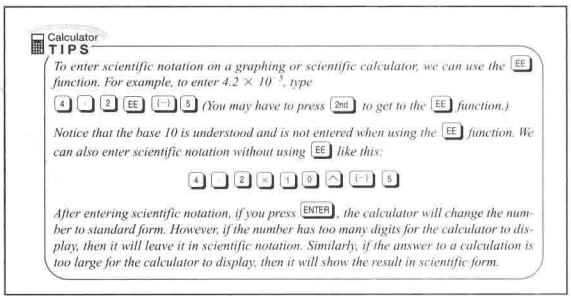
	Employment		Change	
Occupation	2 002	2012	Amount	Percent
Medical assistants	364,600	579,400		
Network systems and data communications analysts	186,000	292,000		
Physician assistants	63,000	93,800		
Social and human service assistants	305,200	453,900		
Home health aides	579,700	858,700		
Medical records and health information technicians	146,900	215,600		
Physical therapist aides	37,000	54,100		
Computer software engineers, applications	394,100	573,400		
Computer software engineers, systems software	281,100	408,900		
Physical therapist assistants	50,200	72,600		

Source: Bureau of Labor Statistics, Office of Occupational Statistics and Employment Projections

1. In 2002, in which occupation were the greatest number of people employed?
2. By 2012, which occupation is projected to have the greatest number of people employed?
3. Explain why the two occupations you listed in Exercises 1 and 2 are not at the top of the list.
4. Which is a better indicator of the demand for people in a particular occupation: the number of people employed in a particular year, the amount of change projected from 2002 to 2012, or the percent of increase in employment from 2002 to 2012?
5. Based on your conclusions in Exercise 4, what occupation will have the greatest demand? What college majors might have the greatest potential for employment in that occupation? Write your conclusions and present them to the class.

Collaborative Exercises These exercises, which appear once per chapter, encourage students to work in groups to discuss mathematics and use the topics from a particular section or group of sections to solve a problem (see pages 152, 220, and 312).

Calculator Tips The relevant functions of calculators (scientific or graphing, depending on the topic) are explained and illustrated throughout the text in the optional Calculator Tips feature. In addition, an occasional calculator icon in the exercise sets indicates that the problem is designed to be solved using a calculator, though one is not required (see pages 18, 49, and 306).



Calculator TIPS

To enter scientific notation on a graphing or scientific calculator, we can use the EE *function. For example, to enter* 4.2×10^{-5}, *type*

4 . 2 EE (−) 5 *(You may have to press* 2nd *to get to the* EE *function.)*

Notice that the base 10 is understood and is not entered when using the EE *function. We can also enter scientific notation without using* EE *like this:*

4 . 2 × 1 0 ^ (−) 5

After entering scientific notation, if you press ENTER, *the calculator will change the number to standard form. However, if the number has too many digits for the calculator to display, then it will leave it in scientific notation. Similarly, if the answer to a calculation is too large for the calculator to display, then it will show the result in scientific form.*

REVIEW EXERCISES

[1.1] **1.** Write a set containing the last names of the first four presidents of the United States.

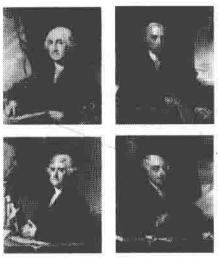
[1.1] **2.** Simplify: $|-7|$

[1.2] **3.** Find the missing number that makes $\frac{40}{48} = \frac{?}{6}$ true.

[1.2] **4.** Use $<$, $>$, or $=$ to make a true statement: $-\frac{4}{5} \blacksquare -\frac{8}{20}$

[1.2] **5.** Find the prime factorization of 100.

[1.2] **6.** A company report indicates that 78 employees out of 91 have medical flexible spending accounts. What fraction of the employees have medical flexible spending accounts? Express the fraction in lowest terms.



Review Exercises Since continuous review is important in any mathematics course, this text includes Review Exercises at the end of each exercise set. These exercises review previously learned concepts not only to keep the material fresh for students, but also to serve as a foundational review for the discussion in the upcoming section (see pages 40, 236, and 399).

Chapter Summaries and Review Exercises An extensive Summary at the end of each chapter provides a list of defined terms referenced by section and page number, a two-column summary of key concepts, and a list of important formulas appearing in that chapter. A set of Review Exercises is also provided with answers to all Review Exercises provided in the back of the book (see pages 177–183, 252–261, and 355–369).

Chapter 5 Summary

Defined Terms

Section 5.1
Scientific notation (p. 378)

Section 5.2
Monomial (p. 387)
Coefficient (p. 389)
Degree of a monomial (p. 389)
Polynomial (p. 389)
Polynomial in one variable (p. 390)
Binomial (p. 390)
Trinomial (p. 390)
Degree of a polynomial (p. 391)

Section 5.5
Conjugates (p. 428)

Procedures, Rules, and Key Examples

Procedures/Rules	Key Examples
Section 5.1 Exponents and Scientific Notation	
If the base of an exponential form is a negative number and the exponent is even, then the product is positive.	**Example 1:** Evaluate. **a.** $(-2)^4 = (-2)(-2)(-2)(-2) = 16$
If the base is a negative number and the exponent is odd, then the product is negative.	**b.** $(-2)^5 = (-2)(-2)(-2)(-2)(-2) = -32$
numbers, where $b \neq 0$ and n is a natural number,	**Example 2:** Simplify. **a.** $\left(\frac{3}{4}\right)^2 = \frac{3^2}{4^2} = \frac{9}{16}$
ber and $a \neq 0$, then $a^0 = 1$.	**b.** $7^0 = 1$
ber, where $a \neq 0$ and n is a natural number, then	**c.** $2^{-4} = \frac{1}{2^4} = \frac{1}{16}$
ber, where $a \neq 0$ and n is a natural number, then	**d.** $\frac{1}{3^{-2}} = 3^2 = 9$
	e. $\left(\frac{2}{3}\right)^{-4} = \left(\frac{3}{2}\right)^4 = \frac{81}{16}$
numbers, where $a \neq 0$ and $b \neq 0$ and n is a natural	
$\left.\right)^{-n} = \left(\frac{b}{a}\right)^n$.	

Chapter 5 Review Exercises

For Exercises 1–6, answer true or false.

[5.1] **1.** A negative exponent will always make the coefficient negative.

[5.2] **2.** The degree of a binomial is two.

[5.4] **3.** To raise an exponential form to a power, multiply the exponents.

[5.5] **4.** Conjugates occur when both binomials contain subtraction.

[5.5] **5.** FOIL can be used for all types of polynomial multiplication.

[5.5] **6.** $(x - 4)^2 = x^2 + 16$

For Exercises 7–10, complete the rule.

[5.3] **7.** To add polynomials, _____ like terms.

[5.4] **8.** To multiply monomials:
a. Multiply the _____.
b. Add the _____ of the like bases.
c. Rewrite any unlike bases in the product.

Chapter Practice Tests A Practice Test follows each set of chapter review exercises. The problem types in the practice tests correlate to the short-answer tests in the *Printed Test Bank*. This is especially comforting for students who have math anxiety or who experience test anxiety (see pages 99, 186, and 262).

Chapter 5 Practice Test

For Exercises 1 and 2, evaluate the exponential form.

1. 2^{-3}

2. $\left(\frac{2}{3}\right)^{-2}$

3. Write 6.201×10^{-3} in standard form.

4. Write 275,000,000 in scientific notation.

For Exercises 5 and 6, identify the degree.

5. $-7x^2y$

6. $4x^2 - 9x^1 + 8x - 7$

7. Evaluate $-6mn - n^3$, where $m = 4$ and $n = -2$.

8. Combine like terms and write the resulting polynomial in descending order of degree.
$-5x^4 + 7x^2 + 6x^2 - 5x^4 + 12 - 6x^3 + x^2$

For Exercises 9 and 10, add or subtract and write the resulting polynomial in descending order of degree.

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

10. $(7x^4 - 3x^2 + 4x + 1) - (2x^4 + 5x - 7)$

For Exercises 11–18, multiply.

11. $(4x^2)(3x^5)$

12. $(2ab^3c^2)(-a^5b)$

13. $(4xy^3)^2$

14. $3x(x^2 - 4x + 5)$

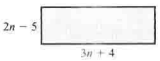
15. $-6t^2u(4t^3 - 8tu^2)$

16. $(n - 1)(n + 4)$

17. $(2x - 3)^2$

18. $(x + 2)(x^2 - 4x + 3)$

19. Write an expression for the area of the shape shown.



For Exercises 20–25, simplify.

20. $x^9 \div x^4$

21. $\frac{(x^3)^{-2}}{x^4 \cdot x^{-5}}$

22. $\frac{(3y)^{-2}}{(x^3y^2)^{-3}}$

24. $\frac{x^2 - x - 12}{x + 3}$

25. $\frac{15x^2 - 22x + 14}{3x - 2}$

Cumulative Reviews Cumulative Review Exercises appear after Chapters 3, 6, 9, and 13. These exercises help students stay current with all the material they have learned and help prepare them for midterm and final exams (see pages 269 and 534).

Chapters 1–6 Cumulative Review Exercises

For Exercises 1–6, answer true or false.

[5.4] **1.** $x^3 \cdot x^4 = x^{12}$

[6.1] **2.** The GCF of 12 and 5 is 1.

[1.3] **3.** The commutative property can be used for both addition and subtraction.

[2.2] **4.** $2x - y^2 = 1$ is a linear equation.

[1.7] **5.** The expression $5 + x$ can be simplified to equal $5x$.

[6.1] **6.** $4x + 12 = 2(2x + 6)$ is factored completely.

For Exercises 7–10, fill in the blank.

[6.3] **7.** To factor a trinomial of the form $ax^2 + bx + c$, where $a \neq 1$, by grouping:

- **a.** Look for a monomial _____ in all the terms. If there is one, factor it out.
- **b.** Multiply a and c.
- **c.** Find two factors of this product whose sum is b.
- **d.** Write a four-term polynomial in which bx is written as the sum of two like terms whose coefficients are the two numbers you found in step c.
- **e.** Factor by _____.

[5.2] **8.** To write a polynomial in descending order, place the _____ degree term first, then the next highest degree, and so on.

[6.4] **9.** To factor a difference of squares, we use the rule $a^2 - b^2 =$ _____.

[6.6] **10.** To solve a quadratic equation:

- **a.** Manipulate the equation as needed so that one side is an expression and the other side is _____.
- **b.** Write the expression in _____ form.
- **c.** Use the zero-factor theorem to solve.

[4.3] **11.** What are the x- and y-intercepts on a graph?

[5.2] **12.** What is a binomial?

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To the Student

Why do I have to take this course?

Often this is one of the first questions students ask when they find out they must take an algebra course, especially when they believe that they will never use the math again. You may think that you will not use algebra directly in daily life, and you may assume that you can get by knowing enough arithmetic to balance a checkbook. So, what is the real point of education? Why don't colleges just train students for the jobs they want? The purpose of education is not just job training but also exercise—mental exercise. An analogy that illustrates this quite well is the physical training of athletes.

During the off-season, athletes usually develop an exercise routine that may involve weight lifting, running, swimming, aerobics, or maybe even dance lessons. Athletes often seek out a professional trainer to push them further than they might push themselves. The trainer's job is not to teach an athlete better technique in his or her sport, but to develop the athlete's raw material—to work the body for more strength, stamina, balance, etc. Educators are like physical trainers, and going to college is like going to the gym. An educator's job is to push students mentally and work the "muscle" of the mind. A college program is designed to develop the raw material of the intellect so the student can be competitive in the job market. After the athlete completes the off-season exercise program, he or she returns to the coach and receives specific technique training. Similarly, when students complete their college education and begin a job, they receive specific training to do that job. If the trainer or teacher has done a good job with hardworking clients, the coaching or job training should be absorbed easily.

Taking this analogy a step further, a good physical trainer finds the athlete's weaknesses and designs exercises that the athlete has never performed before, and then pushes him or her accordingly. Teachers do the same thing—their assignments are difficult in order to work the mind effectively. If you feel "brain-strained" as you go through your courses, that's a good sign that you are making progress, and you should keep up the effort.

The following study system is designed to help you in your academic workouts. As teachers, we find that most students who struggle with mathematics have never really *studied* math. A student may think, "Paying attention in class is all I need to do." However, when you watch a teacher do math, keep in mind that you are watching a pro. Going back to the sports analogy, you can't expect to shoot a score of 68 in golf by watching Tiger Woods. You have to practice golf yourself in order to learn and improve. The study system outlined in the following pages will help you get organized and make efficient use of your time so that you can maximize the benefits of your course work.

What do I need to do to succeed?

We believe there are four prerequisites one must have or acquire in order to succeed in college:

1. **Positive Attitude**
2. **Commitment**
3. **Discipline**
4. **Time**

A **Positive Attitude** is most important because commitment and discipline flow naturally from it. Consider Thomas Edison, inventor of the lightbulb. He tried more than 2000 different combinations of materials for the filament before he found the successful combination. When asked by a reporter about all his failed attempts, Edison replied, "I didn't fail once, I invented the lightbulb. It was just a 2000-step process." Recognize that learning can be uncomfortable and difficult, and mistakes are part of the process. So, embrace the learning process with its discomforts and difficulties, and you'll see how easy it is to be committed and disciplined.

Commitment means giving everything you've got with no turning back. Consider Edison again. Imagine the doubts and frustrations he must have felt trying material after material for the filament of his lightbulb without success. Yet he forged ahead. In Edison's own words, "Our greatest weakness lies in giving up. The most certain way to succeed is always to try just one more time."

Discipline means doing things you should be doing even when you don't want to. According to author W. K. Hope, "Self-discipline is when your conscience tells you to do something and you don't talk back." Staying disciplined can be difficult given all the distractions in our society. The best way to develop discipline is to create a schedule and stick to it.

Make sure you have enough **Time** to study properly, and make sure that you manage that time wisely. Too often, students try to fit school into an already full schedule. Take a moment to complete the exercise that follows under "How do I do it all?" to make sure you haven't overcommitted yourself. Once you have a sense of how much time school requires, read on about the study system that will help you maximize the benefits of your study time.

How do I do it all?

Now that we know a little about what it takes to be successful, let's make sure that you have enough time for school. In general, humans have a maximum of 60 hours of productivity per week. Therefore, as a guide, let's set the maximum number of work hours, which means time spent at your job(s) and at school combined, at 60 hours per week. Use the following exercise to determine the time you commit to your job and to school.

Exercise: Calculate the time that you spend at your job and at school.

1. Calculate the total hours you work in one week.
2. Calculate the number of hours you are in class each week.
3. Estimate the number of hours you should expect to spend outside of class studying.
   A general rule is to double the number of hours spent in class.
4. Add your work hours, in-class hours, and estimated out-of-class hours to get your total time commitment.
5. Evaluate the results. *See below.*

Evaluating the Results

a. If your total is greater than 60 hours, you will probably find yourself feeling overwhelmed. This feeling may not occur at first, but doing that much for an extended period of time will eventually catch up with you, and something may suffer. It is in your best interest to cut back on work or school until you reduce your time commitment to under 60 hours per week.

b. If your total is under 60 hours, good. Be sure you consider other elements in your life, such as your family's needs, health problems, commuting, or anything that could make demands on your time. Make sure that you have enough time for everything you put in your life. If you do not have enough time for everything, consider what can be cut back. It is important to note that it is far better to pass fewer classes than to fail many.

How do I make the best use of my time? How should I study?

We've seen many students who had been making D's and F's in mathematics transform their grades to A's and B's by using the study system that follows.

The Study System

Your Notebook

1. Get a loose-leaf binder so that you can put papers in and take them out without ripping any pages.
2. Organize the notebook into four parts:
   a. Class notes
   b. Homework
   c. Study sheets (a single piece of paper for each chapter onto which you will transfer procedures from your notes)
   d. Practice tests

In Class

Involve your mind completely.

1. **Take good notes.** Use three different colors. Most students like using red, blue, and black (pencil).
   - Use the red pen to write *definitions.* Also, use this color to mark problems or items that the instructor indicates will be covered on a test.
   - Use the blue pen to write procedures and rules.
   - Use the pencil to write problems and explanations.

When taking notes, don't just write the solutions to the problems that the instructor works out, but write the explanations as well. To the side of the problem, make notes about each step so that you remember the significance of the steps. Pay attention to examples or issues the instructor emphasizes: they will usually appear on a test, so make an effort to include them in your notes. Include common errors that the instructor points out or any words of caution. If you find it is difficult to write and pay attention at the same time, ask your instructor if you can record the lectures with a tape recorder. If your instructor follows the text closely, when he or she points out definitions or procedures in the text, highlight them or write a page reference in your notes. You can then write these referenced items in their proper place in your notes after class.

2. **Answer the instructor's questions.** This does not mean you have to answer every question verbally, but you should think through every question and answer in your mind, write an answer in your notes, or answer out loud.
3. **Ask questions.** You may find it uncomfortable to ask questions in front of other people, but keep in mind that if you have a question, then it is very likely that someone else has the same question. If you still don't feel like asking in class, then be sure to ask as soon as class is over. The main thing is to get that question answered as soon as possible because in mathematics, one misconception can grow and cause confusion in the future.

After Class

Prepare for the next class meeting as if you were going to have a test on everything covered so far. To make the most of your time, set aside a specific time that is reserved for math. Since there are often many distractions at home, study math while on campus in a quiet place such as the library

or tutorial lab. Staying on campus also allows you to visit your instructor or tutorial services if you have a question that you cannot resolve. Here is a systematic approach to organizing your math study time outside of class:

1. As soon as possible, go over your notes. Clarify any sentences that weren't quite complete. Fill in any page-referenced material.
2. Read through the relevant section(s) in the text again, and make sure you understand all the examples.
3. Transfer each new procedure or rule to your study sheet for that chapter. You might also write down important terms and their definitions. Make headings for each objective in the section(s) you covered that day. Write the procedures and definitions in your own words.
4. Study the examples worked in class. Transfer each example (without the solution) to the practice test section of your notebook, leaving room to work it out later.
5. Use your study sheet to do the assigned practice problems. As soon as you finish each problem, check your answer in the back of the book or in the *Student's Solutions Manual.* If you did not get it correct, then immediately revisit the problem to determine your error (see the box on troubleshooting). If you are asked to do even-numbered problems, then work odd-numbered problems that mirror the even problems. This way you can check your answers for the odd-numbered problems and then work the even-numbered problems with confidence.
6. After completing the homework, prepare a quiz for yourself. Select one of each type of homework problem. Don't just pick the easy ones! Set the quiz aside for later.
7. After making the quiz, study your study sheet. To test your understanding, write the rules and procedures in your own words. Do not focus on memorizing the wording in the textbook.
8. Now it is time to begin preparing for the next class meeting. Read the next section(s) to be covered. Don't worry if you do not understand everything. The idea is to get some feeling for the topics to be discussed so that the class discussion will actually be the second time you encounter the material, not the first. While reading, you might mark points that you find difficult so that if the instructor does not clear them up, you can ask about them. Also, attempt to work through the examples. The idea is for you to do as much as possible on your own before class so that the in-class discussion merely ties together loose ends and solidifies the material.
9. After you have finished preparing for the next day, go back and take the quiz that you made. If you get all the answers correct, then you have mastered the material. If you have difficulty, return to your study sheet and repeat the exercise of writing explanations for each objective.

Troubleshooting: For the problems that you do not get correct, first look for simple arithmetic errors. If you find no arithmetic errors, then make sure you followed the procedure or rules correctly. If you followed the or rules correctly, then you have likely interpreted something incorrectly, either with the problem or the rules. Read the instructions again carefully and try to find similar examples in your notes or in the book. If you still can't find the mistake, go on to something else for a while. Often after taking a fresh look you will see the mistake right away. If all these tips fail to resolve the problem, then mark it as a question for the next class meeting.