Intermediate Algebra

A Graphing Approach

FIFTH EDITION

Elayn Martin-Gay
Margaret Greene

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Intermediate Algebra: A Graphing Approach

Fifth Edition

Elayn Martin-Gay

University of New Orleans

Margaret Greene

Florida Community College at Jacksonville

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To Elizabeth Ashley, Lockwood Ryan, and
Matthew Patrick Greene. You light up my life!

To Bailey Frances Martin, Ethan Warren, Avery Blythe,
Mia Adelle Barnes, and Madison Jane Martin … ditto.

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Preface

Intermediate Algebra: A Graphing Approach, Fifth Edition, was written to provide a **solid foundation in algebra** for students who might not have had previous experience in algebra. Specific care has been taken to ensure that students have the most **up-to-date and relevant** text preparation for their next mathematics course, as well as to help students succeed in nonmathematical courses that require a grasp of algebraic fundamentals. I have tried to achieve this by writing a user-friendly text that is keyed to objectives and contains many worked-out examples. The basic concepts of graphing and functions are introduced early, and problem solving techniques, real-life and real-data applications, data interpretation, appropriate use of technology, number sense, critical thinking, decision-making, and geometric concepts are emphasized and integrated throughout the book.

The many factors that contributed to the success of the previous editions have been retained. In preparing this edition, I considered the comments and suggestions of colleagues throughout the country, students, and many users of the prior editions. The AMATYC Crossroads in Mathematics: Standards for Introductory College Mathematics before Calculus and the MAA and NCTM standards (plus Addenda), together with advances in technology, also influenced the writing of this text.

Throughout the series, pedagogical features are designed to develop student proficiency in algebra and problem solving and to prepare students for future courses.

What's New in the Fifth Edition?

- **The Martin-Gay Program** has been revised and enhanced with a new design in the text and MyMathLab to actively encourage students to use the text, video program, and Student Organizer as an integrated learning system.
- **The Video Organizer** encourages students to take notes and work practice exercises while watching Elayn Martin-Gay's lecture series (available in MyMathLab and on DVD). All content in the Video Organizer is presented in the same order as it is presented in the videos, making it easy for students to create a course notebook and build good study habits. The Video Organizer provides ample space for students to write down key definitions and rules throughout the lectures, and "Play" and "Pause" button icons prompt students to follow along with Elayn for some exercises while they try others on their own.
- **New Vocabulary, Readiness & Video Check** questions have been added prior to every section exercise set. These exercises quickly check a student's understanding of new vocabulary words. The **readiness** exercises center on a student's understanding of a concept that is necessary in order to continue to the exercise set. **New video check questions for the Martin-Gay Interactive Lecture videos** are now included in every section for each learning objective. **These exercises are all available for assignment in MyMathLab** and are a great way to assess whether students have viewed and understood the key concepts presented in the videos.
- **The Interactive DVD Lecture Series,** featuring your text author (Elayn Martin-Gay), provides students with active learning at their own pace. The videos offer the following resources and more:

  A complete lecture for each section of the text highlights key examples and exercises from the text. New "pop-ups" reinforce key terms, definitions, and concepts.

  An interface with menu navigation features allows students to quickly find and focus on the examples and exercises they need to review.

Interactive Concept Check exercises measure students' understanding of key concepts and common trouble spots.

The Interactive DVD Lecture Series also includes the following resources for test prep:

The Practice Final Exam helps students prepare for an end-of-course final. Students can watch full video solutions to each exercise.

The Chapter Test Prep Videos help students during their most teachable moment–when they are preparing for a test. This innovation provides step-by-step solutions for the Chapter Test exercises found at the end of each chapter in the text. The videos are captioned in English and Spanish. For the Fifth Edition, the chapter test prep videos are also available on YouTube™.

- **The Martin-Gay MyMathLab course** has been updated and revised to provide more exercise coverage, including assignable video check questions, and an expanded video program. There are lecture videos for every section, students can also access at the specific objective level, and there are an increased number of watch clips at the exercise level to help students while doing homework in MathXL. Suggested homework assignments have been premade for assignment at the instructor's discretion.
- **New MyMathLab Ready to Go courses** (access code required) provide students with all the same great MyMathLab features that you're used to, but make it easier for instructors to get started. Each course includes preassigned homework and quizzes to make creating your course even simpler. Ask your Pearson representative about the details for this particular course or to see a copy of this course.
- **A new section** (9.4) devoted specifically to exponential growth and decay and applications has been added. This section includes the definition and examples of half-life.
- **The new Student Resources** section, located in the back of the text, gives students a variety of tools that are conveniently located in one place to help them achieve success in math.
  - **Study Skills Builders** give students tips and suggestions on successful study habits and help them take responsibility for their learning. Assignable exercises check students' progress in improving their skills.
  - The **Bigger Picture—Study Guide Outline** covers key concepts of the course—simplifying expressions and solving equations and inequalities—to help students transition from thinking section-by-section to thinking about how the material they are learning fits into mathematics as a whole. This outline provides a model for students on how to organize and develop their own study guide.
  - The **Practice Final Exam** helps students prepare for the end-of-the-course exam. Students can also watch the step-by-step solutions to all the Practice Final Exam exercises on the new Interactive DVD Lecture Series and in MyMathLab.
  - The **Answers to Selected Exercises** section allows students to check their answers for all Practice exercises; odd-numbered Vocabulary, Readiness & Video Check exercises; odd-numbered section exercises; Chapter Review and Cumulative Review exercises; and all Integrated Review and Chapter Test exercises.
- **New guided application exercises** appear in many sections throughout the text, beginning with Section 1.6. These applications prompt students on how to set up the application and get started with the solution process. These guided exercises will help students prepare to solve application exercises on their own.

- **Enhanced emphasis on Study Skills** helps students develop good study habits and makes it more convenient for instructors to incorporate or assign study skills in their courses. The following changes have been made in the Fifth Edition:

  Section 1.1, Tips for Success in Mathematics, has been updated to include helpful hints for doing homework online in MyMathLab. Exercises pertaining to doing homework online in MyMathLab are now included in the exercise set for 1.1.

  The Study Skills Builders, formerly located at the end of select exercise sets, are now included in the new **Student Resources** section at the back of the book and organized by topic for ease of assignment. This section now also includes new Study Skills Builders on doing homework online in MyMathLab.
- All exercise sets have been reviewed and updated to ensure that even- and odd-numbered exercises are paired.

Key Pedagogical Features

The following key features have been retained and/or updated for the Fifth Edition of the text:

Problem-Solving Process This is formally introduced in Chapter 1 with a four-step process that is integrated throughout the text. The four steps are **Understand, Translate, Solve,** and **Interpret.** The repeated use of these steps in a variety of examples shows their wide applicability. Reinforcing the steps can increase students' comfort level and confidence in tackling problems.

Exercise Sets Revised and Updated The exercise sets have been carefully examined and extensively revised. Special focus was placed on making sure that even- and odd-numbered exercises are paired.

Examples Detailed, step-by-step examples were added, deleted, replaced, or updated as needed. Many of these reflect real life. Additional instructional support is provided in the annotated examples.

Practice Exercises Throughout the text, each worked-out example has a parallel Practice Exercise. These invite students to be actively involved in the learning process. Students should try each Practice Exercise after finishing the corresponding example. Learning by doing will help students grasp ideas before moving on to other concepts. Answers to the Practice Exercises are provided in the back of the text.

Helpful Hints Helpful Hints contain practical advice on applying mathematical concepts. Strategically placed where students are most likely to need immediate reinforcement, Helpful Hints help students avoid common trouble areas and mistakes.

Discover the Concept These explorations help students recognize patterns or discover a concept on their own immediately before the concept is introduced.

Technology Notes These notes contain specific suggestions for problem solving with technology.

Concept Checks This feature allows students to gauge their grasp of an idea as it is being presented in the text. Concept Checks stress conceptual understanding at the point-of-use and help suppress misconceived notions before they start. Answers appear at the bottom of the page. Exercises related to Concept Checks are included in the exercise sets.

Mixed Practice Exercises Found in the section exercise sets, each requires students to determine the problem type and strategy needed to solve it just as they would need to do on a test.

Integrated Reviews A unique, mid-chapter exercise set that helps students assimilate new skills and concepts that they have learned separately over several sections. These reviews provide yet another opportunity for students to work with "mixed" exercises as they master the topics.

Vocabulary Check Provides an opportunity for students to become more familiar with the use of mathematical terms as they strengthen their verbal skills. These appear at the end of each chapter before the Chapter Highlights. Vocabulary, Readiness & Video Check exercises also provide vocabulary practice at the section level.

Chapter Highlights Found at the end of every chapter, these contain key definitions and concepts with examples to help students understand and retain what they have learned and help them organize their notes and study for tests.

Chapter Review The end of every chapter contains a comprehensive review of topics introduced in the chapter. The Chapter Review offers exercises keyed to every section in the chapter, as well as Mixed Review exercises that are not keyed to sections.

Chapter Test and Chapter Test Prep Video The Chapter Test is structured to include those problems that involve common student errors. The **Chapter Test Prep Videos** give students instant access to a step-by-step video solution of each exercise in the Chapter Test.

Cumulative Review Follows every chapter in the text (except Chapter 1). Each odd-numbered exercise contained in the Cumulative Review is an earlier worked example in the text that is referenced in the back of the book along with the answer.

Writing Exercises ✎ These exercises occur in almost every exercise set and require students to provide a written response to explain concepts or justify their thinking.

Applications Real-world and real-data applications have been thoroughly updated and many new applications are included. These exercises occur in almost every exercise set and show the relevance of mathematics and help students gradually, and continuously, develop their problem-solving skills.

Review and Preview Exercises These exercises occur in each exercise set (except in Chapter 1) and are keyed to earlier sections. They review concepts learned earlier in the text that will be needed in the next section or chapter.

Exercise Set Resource Icons Located at the opening of each exercise set, these icons remind students of the resources available for extra practice and support:

See Student Resources descriptions on page xiii for details on the individual resources available.

Exercise Icons These icons facilitate the assignment of specialized exercises and let students know what resources can support them.

- Video icon: exercise worked on the Interactive DVD Lecture Series and in MyMathLab.
- △ Triangle icon: identifies exercises involving geometric concepts.
- ✎ Pencil icon: indicates a written response is needed.

Student and Instructor Resources

STUDENT RESOURCES

Video Organizer

The **Video Organizer** encourages students to take notes and work practice exercises while watching Elayn Martin-Gay's lecture series (available in MyMathLab and on DVD). All content in the Video Organizer is presented in the same order as it is presented in the videos, making it easy for students to create a course notebook and build good study habits. The Video Organizer provides ample space for students to write down key definitions and rules throughout the lectures, and "Play" and "Pause" button icons prompt students to follow along with Elayn for some exercises while they try others on their own.

Student Solutions Manual

Provides complete worked-out solutions to:

- The odd-numbered section exercises; all Practice Exercises; all exercises in the Integrated Reviews, Chapter Reviews, Chapter Tests, and Cumulative Reviews

Interactive DVD Lecture Series

Provides students with active learning at their pace. The videos offer:

- A complete lecture for each text section. The interface allows easy navigation to examples and exercises students need to review.
- Interactive Concept Check exercises
- Study Skills Builders
- Practice Final Exam
- Chapter Test Prep Videos

Chapter Test Prep Videos

- Step-by-step solutions to every exercise in each Chapter Practice Test.
- Available in MyMathLab® and on YouTube, and in the Interactive DVD Lecture Series.

INSTRUCTOR RESOURCES

Annotated Instructor's Edition

Contains all the content found in the student edition, plus the following:

- Answers to exercises on the same text page
- Answers to graphing exercises and all video exercises
- Teaching Tips throughout the text placed at key points.
- Classroom Examples in the margin paired to each example in the text.

Instructor's Resource Manual with Tests and Mini-Lectures

- Mini-lectures for each text section
- Additional Practice worksheets for each section
- Several forms of test per chapter—free response and multiple choice
- Group activities
- Video key to the example number in the video questions and section exercises worked in the videos
- Answers to all items

Instructor's Solutions Manual

TestGen® (Available for download from the IRC)

Online Resources

MyMathLab® (access code required)

MathXL® (access code required)

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Carole Shapero, *Oakton Community College*
Janet Sibol, *Hillsborough Community College*
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Elayn Martin-Gay

About the Author

Elayn Martin-Gay has taught mathematics at the University of New Orleans for more than 25 years. Her numerous teaching awards include the local University Alumni Association's Award for Excellence in Teaching and Outstanding Developmental Educator at University of New Orleans, presented by the Louisiana Association of Developmental Educators.

Prior to writing textbooks, Elayn Martin-Gay developed an acclaimed series of lecture videos to support developmental mathematics students in their quest for success. These highly successful videos originally served as the foundation material for her texts. Today, the videos are specific to each book in the Martin-Gay series. The author has also created Chapter Test Prep Videos to help students during their most "teachable moment"—as they prepare for a test—along with Instructor-to-Instructor videos that provide teaching tips, hints, and suggestions for each developmental mathematics course, including basic mathematics, prealgebra, beginning algebra, and intermediate algebra.

Elayn is the author of 12 published textbooks as well as interactive multimedia mathematics, all specializing in developmental mathematics courses. She has participated as an author across the broadest range of educational materials: textbooks, videos, tutorial software, and courseware. This provides the opportunity of various combinations for an integrated teaching and learning package that offers great consistency for the student.

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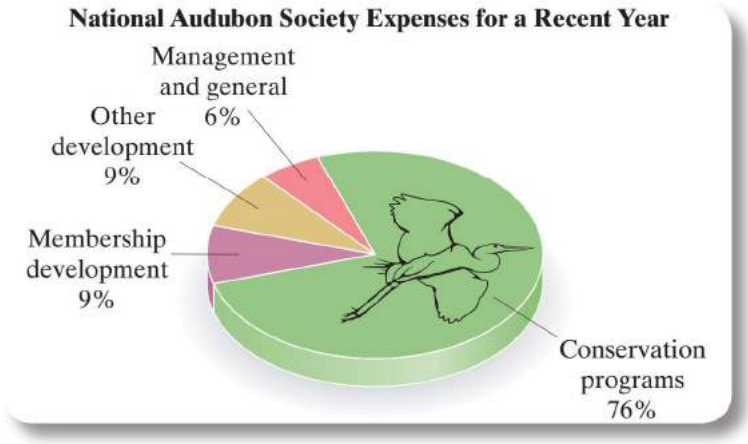
CHAPTER 1 Real Numbers, Algebraic Expressions, and Equations



1.1 Tips for Success in Mathematics

1.2 Algebraic Expressions and Sets of Numbers

1.3 Operations on Real Numbers and Order of Operations

1.4 Properties of Real Numbers and Algebraic Expressions

Integrated Review—Algebraic Expressions, Operations on Real Numbers, and Properties

1.5 Solving Linear Equations Algebraically

1.6 An Introduction to Problem Solving

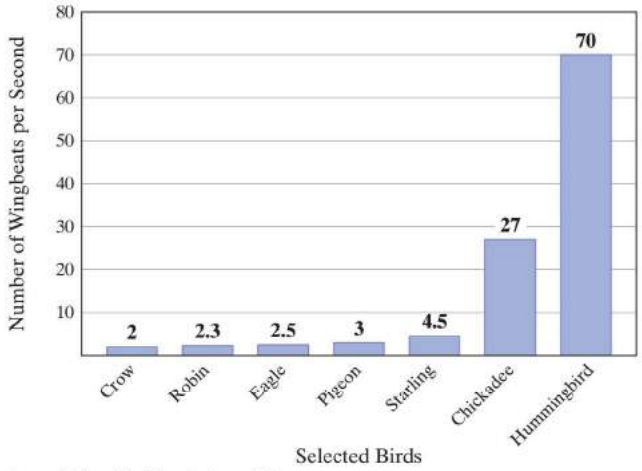
1.7 A Numerical Approach: Modeling with Tables

1.8 Formulas and Problem Solving

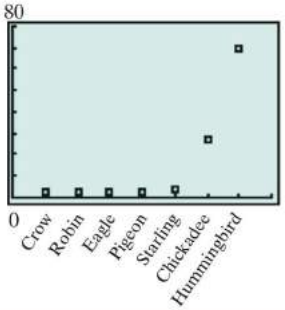
The National Audubon Society is a U.S. nonprofit organization dedicated to conservation. It is named in honor of John James Audubon, a Franco-American naturalist who painted and described the birds of North America in his famous book *Birds of America* published in sections between 1827 and 1838.

The Audubon Society is over a century old and funds conservation programs focusing on birds.

The bar graph below shows the differing wingbeats per second for selected birds. In the Chapter 1 Review, Exercises 3 and 4, we study the hummingbird wingbeats per second further.



Source: National Audubon Society website



Same data shown on a graphing calculator screen

Mathematics is a tool for solving problems in such diverse fields as transportation, engineering, economics, medicine, business, and biology. We solve problems using mathematics by modeling real-world phenomena with mathematical equations or inequalities. Our ability to solve problems using mathematics, then, depends in part on our ability to solve equations and inequalities. In this chapter, we review operations on and properties of real numbers. We then solve linear equations and problems that can be modeled by linear equations.

1.1 Tips for Success in Mathematics

OBJECTIVES

1. Get Ready for This Course.
2. Understand Some General Tips for Success.
3. Understand How to Use This Text.
4. Get Help as Soon as You Need It.
5. Learn How to Prepare for and Take an Exam.
6. Develop Good Time Management.

Before reading this section, remember that your instructor is your best source of information. Please see your instructor for any additional help or information.

OBJECTIVE 1 Getting Ready for This Course

Now that you have decided to take this course, remember that a *positive attitude* will make all the difference in the world. Your belief that you can succeed is just as important as your commitment to this course. Make sure you are ready for this course by having the time and positive attitude that it takes to succeed.

Next, make sure that you have scheduled your math course at a time that will give you the best chance for success. For example, if you are also working, you may want to check with your employer to make sure that your work hours will not conflict with your course schedule.

On the day of your first class period, double-check your schedule and allow yourself extra time to arrive on time in case of traffic problems or difficulty locating your classroom. Make sure that you bring at least your textbook, paper, and a writing instrument. Are you required to have a lab manual, graph paper, calculator, or some other supplies besides this text? If so, also bring this material with you.

OBJECTIVE 2 General Tips for Success

Below are some general tips that will increase your chance for success in a mathematics class. Many of these tips will also help you in other courses you may be taking.

Exchange names and phone numbers or email addresses with at least one other person in class. This contact person can be a great help if you miss an assignment or want to discuss math concepts or exercises that you find difficult.

Choose to attend all class periods. If possible, sit near the front of the classroom. This way, you will see and hear the presentation better. It may also be easier for you to participate in classroom activities.

Do your homework. You've probably heard the phrase "practice makes perfect" in relation to music and sports. It also applies to mathematics. You will find that the more time you spend solving mathematics exercises, the easier the process becomes. Be sure to schedule enough time to complete your assignments before the due date assigned by your instructor.

Helpful Hint

MyMathLab® and **MathXL®** If you are doing your homework online, you can work and rework those exercises that you struggle with until you master them. Try working through all the assigned exercises twice before the due date.

Check your work. Review the steps you made while working a problem. Learn to check your answers in the original problems. You may also compare your answers with the "Answers to Selected Exercises" section in the back of the book. If you have made a mistake, try to figure out what went wrong. Then correct your mistake. If you can't find what went wrong, don't erase your work or throw it away. Bring your work to your instructor, a tutor in a math lab, or a classmate. It is easier for someone to find where you had trouble if he or she looks at your original work.

Helpful Hint

MyMathLab® and **MathXL®** If you are completing your homework online, it's important to work each exercise on paper before submitting the answer. That way, you can check your work and follow your steps to find and correct any mistakes.

Learn from your mistakes and be patient with yourself. Everyone, even your instructor, makes mistakes. (That definitely includes me—Elayn Martin-Gay.) Use your errors to learn and to become a better math student. The key is finding and understanding your errors.

Was your mistake a careless one, or did you make it because you can't read your own math writing? If so, try to work more slowly or write more neatly and make a conscious effort to check your work carefully.

Did you make a mistake because you don't understand a concept? Take the time to review the concept or ask questions to understand it better.

Did you skip too many steps? Skipping steps or trying to do too many steps mentally may lead to preventable mistakes.

Know how to get help if you need it. It's all right to ask for help. In fact, it's a good idea to ask for help whenever there is something that you don't understand.

Make sure you know when your instructor has office hours and how to find his or her office. Find out whether math tutoring services are available on your campus. Check on the hours, location, and requirements of the tutoring service.

Helpful Hint

MyMathLab® and **MathXL®** When assignments are turned in online, keep a hard copy of your complete written work. You will need to refer to your written work to be able to ask questions and to study for tests later.

Organize your class materials, including homework assignments, graded quizzes and tests, and notes from your class or lab. All of these items will make valuable references throughout your course and when studying for upcoming tests and the final exam. Make sure that you can locate these materials when you need them.

Read your textbook before class. Reading a mathematics textbook is unlike reading a novel or a newspaper. Your pace will be much slower. It is helpful to have paper and a pencil with you when you read. Try to work out examples on your own as you encounter them in your text. You should also write down any questions that you want to ask in class. When you read a mathematics textbook, sometimes some of the information in a section will be unclear. But after you hear a lecture or watch a lecture video on that section, you will understand it much more easily than if you had not read your text beforehand.

Don't be afraid to ask questions. You are not the only person in class with questions. Other students are normally grateful that someone has spoken up.

Helpful Hint

MyMathLab® and **MathXL®** Be aware of assignments and due dates set by your instructor. Don't wait until the last minute to submit work online. Allow 6–8 hours before the deadline in case you have technology trouble.

Turn in assignments on time. This way you can be sure that you will not lose points for being late. Show every step of a problem and be neat and organized. Also be sure that you understand which problems are assigned for homework. If allowed, you can always double-check the assignment with another student in your class.

OBJECTIVE

3 Using This Text

Many helpful resources are available to you. It is important to become familiar with and use these resources. They should increase your chances for success in this course.

- *Practice Exercises.* Each example in every section has a parallel Practice exercise. As you read a section, try each Practice exercise after you've finished the corresponding example. This "learn-by-doing" approach will help you grasp ideas before you move on to other concepts. Answers are at the back of the text.
- *Chapter Test Prep Videos.* These videos provide solutions to all of the Chapter Test exercises worked out by the author. This supplement is very helpful before a test or exam.
- *Interactive DVD Lecture Series.* Exercises marked with a ▶ are fully worked out by the author on the DVDs. The lecture series provides approximately 20 minutes of instruction per section.

Helpful Hint

MyMathLab® In MyMathLab, you have access to the following video resources:

- Lecture Videos for each section
- Chapter Test Prep Videos

Use these videos provided by the author to prepare for class, review, and study for tests.

- *Symbols at the Beginning of an Exercise Set.* If you need help with a particular section, the symbols listed at the beginning of each exercise set will remind you of the numerous supplements available.
- *Examples.* The main section of exercises in each exercise set is referenced by an example(s). There is also often a section of exercises entitled "Mixed Practice," which combines exercises from multiple objectives or sections. These are mixed exercises written to prepare you for your next exam. Use all of this referencing if you have trouble completing an assignment from the exercise set.
- *Icons (Symbols).* Make sure that you understand the meaning of the icons that are beside many exercises. ▶ tells you that the corresponding exercise may be viewed on the video segment that corresponds to that section. ✎ tells you that this exercise is a writing exercise in which you should answer in complete sentences. △ tells you that the exercise involves geometry.
- *Integrated Reviews.* Found in the middle of each chapter, these reviews offer you a chance to practice–in one place–the many concepts that you have learned separately over several sections.
- *End-of-Chapter Opportunities.* There are many opportunities at the end of each chapter to help you understand the concepts of the chapter.

  Vocabulary Checks contain key vocabulary terms introduced in the chapter.

  Chapter Highlights contain chapter summaries and examples.

  Chapter Reviews contain review problems. The first part is organized section by section and the second part contains a set of mixed exercises.

  Chapter Tests are sample tests to help you prepare for an exam. The Chapter Test Prep Videos, found in this text, contain all the Chapter Test exercises worked by the author.

Cumulative Reviews are reviews consisting of material from the beginning of the book to the end of that particular chapter.

- *Student Resources in Your Textbook.* You will find a **Student Resources** section at the back of this textbook. It contains the following to help you study and prepare for tests:

  Study Skill Builders contain study skills advice. To increase your chance for success in the course, read these study tips and answer the questions.

  Bigger Picture–Study Guide Outline provides you with a study guide outline of the course, with examples.

  Practice Final provides you with a Practice Final Exam to help you prepare for a final. The video solutions to each question are provided in the Interactive DVD Lecture Series and within MyMathLab®.

- *Resources to Check Your Work.* The **Answers to Selected Exercises** section provides answers to all odd-numbered section exercises and all chapter test exercises.

> **Helpful Hint**
>
> **MyMathLab®** and **MathXL®**
>
> - Use the **Help Me Solve This** button to get step-by-step help for the exercise you are working. You will need to work an additional exercise of the same type before you can get credit for having worked it correctly.
> - Use the **Video** button to view a video clip of the author working a similar exercise.

OBJECTIVE 4

Getting Help

If you have trouble completing assignments or understanding the mathematics, get help as soon as you need it! This tip is presented as an objective on its own because it is so important. In mathematics, usually the material presented in one section builds on your understanding of the previous section. This means that if you don't understand the concepts covered during a class period, there is a good chance that you will not understand the concepts covered during the next class period. If this happens to you, get help as soon as you can.

Where can you get help? Many suggestions have been made in this section on where to get help, and now it is up to you to get it. Try your instructor, a tutoring center, or a math lab, or you may want to form a study group with fellow classmates. If you do decide to see your instructor or go to a tutoring center, make sure that you have a neat notebook and are ready with your questions.

OBJECTIVE 5

Preparing for and Taking an Exam

Make sure that you allow yourself plenty of time to prepare for a test. If you think that you are a little "math anxious," it may be that you are not preparing for a test in a way that will ensure success. The way that you prepare for a test in mathematics is important. To prepare for a test:

> **Helpful Hint**
>
> **MyMathLab®** and **MathXL®**
>
> Review your written work for previous assignments. Then, go back and rework previous assignments. Open a previous assignment, and click **Similar Exercise** to generate new exercises. Rework the exercises until you fully understand them and can work them without help features.

1. Review your previous homework assignments.
2. Review any notes from class and section-level quizzes you have taken. (If this is a final exam, also review chapter tests you have taken.)
3. Review concepts and definitions by reading the Chapter Highlights at the end of each chapter.
4. Practice working out exercises by completing the Chapter Review found at the end of each chapter. (If this is a final exam, go through a Cumulative Review. There is one found at the end of each chapter except Chapter 1. Choose the review found at the end of the latest chapter that you have covered in your course.) *Don't stop here!*
5. It is important to place yourself in conditions similar to test conditions to find out how you will perform. In other words, as soon as you feel that you know the material, get a few blank sheets of paper and take a sample test. A Chapter Test is available at the end of each chapter, or you can work selected problems from the Chapter Review. Your instructor may also provide you with a review sheet. During this sample test, do not use your notes or your textbook. Then check your sample test. If you are not satisfied with the results, study the areas that you are weak in and try again.
6. On the day of the test, allow yourself plenty of time to arrive at where you will be taking your exam.

When taking your test:

1. Read the directions on the test carefully.
2. Read each problem carefully as you take the test. Make sure that you answer the question asked.
3. Watch your time and pace yourself so that you can attempt each problem on your test.
4. If you have time, check your work and answers.
5. Do not turn your test in early. If you have extra time, spend it double-checking your work.

OBJECTIVE 6

Managing Your Time

As a college student, you know the demands that classes, homework, work, and family place on your time. Some days you probably wonder how you'll ever get everything done. One key to managing your time is developing a schedule. Here are some hints for making a schedule:

1. Make a list of all of your weekly commitments for the term. Include classes, work, regular meetings, extracurricular activities, etc. You may also find it helpful to list such things as laundry, regular workouts, grocery shopping, etc.
2. Next, estimate the time needed for each item on the list. Also make a note of how often you will need to do each item. Don't forget to include time estimates for the reading, studying, and homework you do outside of your classes. You may want to ask your instructor for help estimating the time needed.
3. In the exercise set that follows, you are asked to block out a typical week on the schedule grid given. Start with items with fixed time slots like classes and work.
4. Next, include the items on your list with flexible time slots. Think carefully about how best to schedule items such as study time.
5. Don't fill up every time slot on the schedule. Remember that you need to allow time for eating, sleeping, and relaxing! You should also allow a little extra time in case some items take longer than planned.
6. If you find that your weekly schedule is too full for you to handle, you may need to make some changes in your workload, classload, or other areas of your life. You may want to talk to your advisor, manager or supervisor at work, or someone in your college's academic counseling center for help with such decisions.

1.1 Exercise Set

MyMathLab®

1. What is your instructor's name?
2. What are your instructor's office location and office hours?
3. What is the best way to contact your instructor?
4. Do you have the name and contact information of at least one other student in class?
5. Will your instructor allow you to use a calculator in this class?
6. Why is it important that you write step-by-step solutions to homework exercises and keep a hard copy of all work submitted?
7. Is a tutoring service available on campus? If so, what are its hours? What services are available?
8. Have you attempted this course before? If so, write down ways that you might improve your chances of success during this second attempt.
9. List some steps that you can take if you begin having trouble understanding the material or completing an assignment. If you are completing your homework in MyMathLab® and MathXL®, list the resources you can use for help.
10. How many hours of studying does your instructor advise for each hour of instruction?
11. What does the ✎ icon in this text mean?
12. What does the ▶ icon in this text mean?
13. What does the △ icon in this text mean?
14. What are Practice exercises?
15. When might be the best time to work a Practice exercise?
16. Where are the answers to Practice exercises?
17. What answers are contained in this text and where are they?
18. What and where are the study skills builders?

19. What and where are Integrated Reviews?

20. How many times is it suggested that you work through the homework exercises in MathXL® before the submission deadline?

21. How far in advance of the assigned due date is it suggested that homework be submitted online? Why?

22. Chapter Highlights are found at the end of each chapter. Find the Chapter 1 Highlights and explain how you might use it and how it might be helpful.

23. Chapter Reviews are found at the end of each chapter. Find the Chapter 1 Review and explain how you might use it and how it might be useful.

24. Chapter Tests are found at the end of each chapter. Find the Chapter 1 Test and explain how you might use it and how it might be helpful when preparing for an exam on Chapter 1. Include how the Chapter Test Prep Videos may help. If you are working in MyMathLab® and MathXL®, how can you use previous homework assignments to study?

25. Read or reread objective 6 and fill out the schedule grid below.

	Monday	*Tuesday*	*Wednesday*	*Thursday*	*Friday*	*Saturday*	*Sunday*
1:00 a.m.							
2:00 a.m.							
3:00 a.m.							
4:00 a.m.							
5:00 a.m.							
6:00 a.m.							
7:00 a.m.							
8:00 a.m.							
9:00 a.m.							
10:00 a.m.							
11:00 a.m.							
12:00 p.m.							
1:00 p.m.							
2:00 p.m.							
3:00 p.m.							
4:00 p.m.							
5:00 p.m.							
6:00 p.m.							
7:00 p.m.							
8:00 p.m.							
9:00 p.m.							
10:00 p.m.							
11:00 p.m.							
Midnight							

1.2 Algebraic Expressions and Sets of Numbers

OBJECTIVES

1. Identify and Evaluate Algebraic Expressions.
2. Identify Natural Numbers, Whole Numbers, Integers, and Rational and Irrational Real Numbers.
3. Find the Absolute Value of a Number.
4. Find the Opposite of a Number.
5. Write Phrases as Algebraic Expressions.

Technology Note

Throughout this text, we assume that students have access to a graphing utility. Technology notes such as this one will appear often to alert students to possible commands that may be available or to alert students to special considerations that they need to watch for when using a graphing utility.

OBJECTIVE 1

Evaluating Algebraic Expressions

Recall that letters that represent numbers are called **variables.** An **algebraic expression** (or simply **expression**) is formed by numbers and variables connected by the operations of addition, subtraction, multiplication, division, raising to powers, or taking roots. For example,

$$2x, \quad \frac{x+5}{6}, \quad \sqrt{y} - 1.6, \quad \text{and} \quad z^3$$

are algebraic expressions or, more simply, expressions. (Recall that the expression $2x$ means $2 \cdot x$.)

Algebraic expressions occur often during problem solving. For example, the average cost to own and operate a car in the United States for 2009 was \$0.453 per mile. The expression $0.453m$ gives the total cost to operate a car annually for m miles. (*Source:* AAA)

To find the cost of driving a car for 12,000 miles, for example, we replace the variable m with 12,000 and perform the indicated operation. This process is called **evaluating** an expression, and the result is called the **value** of the expression for the given replacement value.

In our example, when $m = 12{,}000$,

$$0.453m = 0.453(12{,}000) = 5436$$

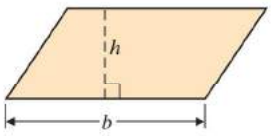
Helpful Hint

Recall that $0.453m$ means $0.453 \times m$.

Thus, it costs \$5436 to own and operate a car for 12,000 miles of driving.

EXAMPLE 1 Finding the Area of a Tile

The research department of a flooring company is considering a new flooring design that contains parallelograms. The area of a parallelogram with base b and height h is bh. Find the area of a parallelogram with base 10 centimeters and height 8.2 centimeters.



Solution We replace b with 10 and h with 8.2 in the algebraic expression bh.

$$bh = 10 \cdot 8.2 = 82$$

The area is 82 square centimeters. □

PRACTICE 1

The tile edging for a bathroom is in the shape of a triangle. The area of a triangle with base b and height h is $A = \frac{1}{2}bh$. Find the area of the tile if the base measures 3.5 cm and the height measures 8 cm.

Algebraic expressions simplify to different values depending on replacement values. (Order of operations is needed for simplifying many expressions. We fully review this in Section 1.3.)

EXAMPLE 2 Evaluate: $3x - y$ when $x = 15$ and $y = 4$.

Solution We replace x with 15 and y with 4 in the expression.

$$3x - y = 3 \cdot 15 - 4 = 45 - 4 = 41$$

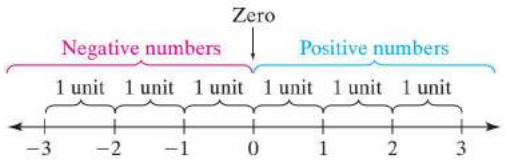
PRACTICE 2 Evaluate: $2p - q$ when $p = 17$ and $q = 3$.

When evaluating an expression to solve a problem, we often need to think about the kind of number that is appropriate for the solution. For example, if we are asked to determine the maximum number of parking spaces for a parking lot to be constructed, an answer of $98\frac{1}{10}$ is not appropriate because $\frac{1}{10}$ of a parking space is not realistic.

OBJECTIVE 2 **Identifying Common Sets of Numbers**

Let's review some common sets of numbers and their graphs on a number line. To construct a number line, we draw a line and label a point 0 with which we associate the number 0. This point is called the **origin.** Choose a point to the right of 0 and label it 1. The distance from 0 to 1 is called the **unit distance** and can be used to locate more points. The **positive numbers** lie to the right of the origin, and the **negative numbers** lie to the left of the origin. The number 0 is neither positive nor negative.

Helpful Hint
0 is neither a positive number nor a negative number.



✓CONCEPT CHECK
Use the definitions of positive numbers, negative numbers, and zero to describe the meaning of *nonnegative numbers*.

A number is **graphed** on a number line by shading the point on the number line that corresponds to the number. Some common sets of numbers and their graphs include:

Natural numbers: $\{1, 2, 3, \ldots\}$

Whole numbers: $\{0, 1, 2, 3, \ldots\}$

Integers: $\{\ldots, -3, -2, -1, 0, 1, 2, 3, \ldots\}$

Each listing of three dots, . . . , is called an **ellipsis** and means to continue in the same pattern.

A **set** is a collection of objects. The objects of a set are called its **members or elements.** When the elements of a set are listed, such as those displayed in the box above, the set is written in **roster** form.

Answer to Concept Check:
a number that is 0 or positive

A set can also be written in **set builder notation,** which describes the members of a set but does not list them. The following set is written in set builder notation.

$$\{x \mid x \text{ is a natural number less than } 3\}$$

The set of all x — such that — x is a natural number less than 3

> **Helpful Hint**
> Use { } or ∅ to write the empty set. {∅} is **not** the empty set because it has one element: ∅.

This same set written in roster form is $\{1, 2\}$.

A set that contains *no* elements is called the **empty set** (or **null set**), symbolized by { } or ∅. The set

$$\{x \mid x \text{ is a month with 32 days}\} \text{ is } \emptyset \text{ or } \{\ \}$$

because no month has 32 days. The set has no elements.

EXAMPLE 3 Write each set in roster form. (List the elements of each set.)

a. $\{x \mid x \text{ is a natural number greater than } 100\}$

b. $\{x \mid x \text{ is a whole number between 1 and } 6\}$

Solution

a. $\{101, 102, 103, \ldots\}$ **b.** $\{2, 3, 4, 5\}$ □

PRACTICE **3** Write each set in roster form. (List the elements of each set.)

a. $\{x \mid x \text{ is a whole number between 5 and } 10\}$

b. $\{x \mid x \text{ is a natural number greater than } 40\}$

The symbol $\in$ denotes that an element is in a particular set. The symbol $\in$ is read as "is an element of." For example, the true statement

$$3 \text{ is an element of } \{1, 2, 3, 4, 5\}$$

can be written in symbols as

$$3 \in \{1, 2, 3, 4, 5\}$$

The symbol $\notin$ is read as "is not an element of." In symbols, we write the true statement "p is not an element of $\{a, 5, g, j, q\}$" as

$$p \notin \{a, 5, g, j, q\}$$

EXAMPLE 4 Determine whether each statement is true or false.

a. $3 \in \{x \mid x \text{ is a natural number}\}$ **b.** $7 \notin \{1, 2, 3\}$

Solution

a. True, since 3 is a natural number and therefore an element of the set.

b. True, since 7 is not an element of the set $\{1, 2, 3\}$. □

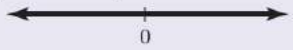
PRACTICE **4** Determine whether each statement is true or false.

a. $7 \in \{x \mid x \text{ is a natural number}\}$ **b.** $6 \notin \{1, 3, 5, 7\}$

We can use set builder notation to describe three other common sets of numbers.

Identifying Numbers

Real Numbers: $\{x \mid x \text{ corresponds to a point on the number line}\}$



Rational Numbers: $\left\{\frac{a}{b} \,\middle|\, a \text{ and } b \text{ are integers and } b \neq 0\right\}$

Irrational Numbers: $\{x \mid x \text{ is a real number and } x \text{ is not a rational number}\}$

Technology Note

A calculator can display only a finite number of digits and will not display the overbar symbol for repeating decimals. For example, if a calculator displays 10 digits, a repeating decimal is rounded to 10 digits to become an approximation.

Technology Note

Some graphing utilities have a fraction command that can change a decimal representation of a number to an equivalent fraction. Check to see whether your graphing utility has this capability.

Helpful Hint

Notice from the definition that all real numbers are either rational or irrational.

Every rational number can be written as a decimal that either repeats or terminates. For example,

Rational Numbers

$$\frac{1}{2} = 0.5 \qquad \frac{5}{4} = 1.25$$

$$\frac{2}{3} = 0.6666666\ldots = 0.\overline{6} \qquad \frac{1}{11} = 0.090909\ldots = 0.\overline{09}$$

An irrational number written as a decimal neither terminates nor repeats. For example, π and $\sqrt{2}$ are irrational numbers. Their decimal form neither terminates nor repeats. Decimal approximations of each are below:

Irrational Numbers

$$\pi \approx 3.141592\ldots \qquad \sqrt{2} \approx 1.414213\ldots$$

Notice that every integer is also a rational number since each integer can be written as the quotient of itself and 1:

$$3 = \frac{3}{1}, \quad 0 = \frac{0}{1}, \quad -8 = \frac{-8}{1}$$

Not every rational number, however, is an integer. The rational number $\frac{2}{3}$, for example, is not an integer. Some square roots are rational numbers and some are irrational numbers. For example, $\sqrt{2}$, $\sqrt{3}$, and $\sqrt{7}$ are irrational numbers while $\sqrt{25}$ is a rational number because $\sqrt{25} = 5 = \frac{5}{1}$. The set of rational numbers together with the set of irrational numbers make up the set of real numbers. To help you make the distinction between rational and irrational numbers, here are a few examples of each.

Rational Numbers			***Irrational Numbers***
Number		***Equivalent Quotient of Integers, $\frac{a}{b}$***	
$-\frac{2}{3}$	=	$\frac{-2}{3}$ or $\frac{2}{-3}$	$\sqrt{5}$
$\sqrt{36}$	=	$\frac{6}{1}$	$\frac{\sqrt{6}}{7}$
5	=	$\frac{5}{1}$	$-\sqrt{3}$
0	=	$\frac{0}{1}$	π
1.2	=	$\frac{12}{10}$	$\frac{2}{\sqrt{3}}$
$3\frac{7}{8}$	=	$\frac{31}{81}$	