Tom Carson

Prealgebra

FOURTH EDITION

Math Study System at a Glance

To the Student

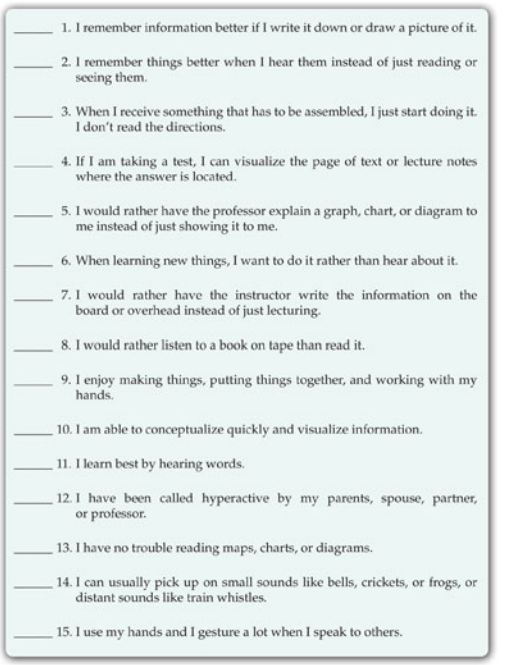
Learning Styles Inventory

The Study System

Learning Strategies

Your Learning Style

To discover what kind of learner you are, complete the Learning Styles Inventory on page xiv (or in MyMathLab). Then, in the textbook, watch for the Learning Strategy boxes and the accompanying icons that provide ideas for maximizing your own learning style.



_____ 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.

_____ 5. I would rather have the professor explain a graph, chart, or diagram to me instead of just showing it to me.

_____ 6. When learning new things, I want to do it rather than hear about it.

_____ 7. I would rather have the instructor write the information on the board or overhead instead of just lecturing.

_____ 8. I would rather listen to a book on tape than read it.

_____ 9. I enjoy making things, putting things together, and working with my hands.

_____ 10. I am able to conceptualize quickly and visualize information.

_____ 11. I learn best by hearing words.

_____ 12. I have been called hyperactive by my parents, spouse, partner, or professor.

_____ 13. I have no trouble reading maps, charts, or diagrams.

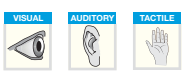
_____ 14. I can usually pick up on small sounds like bells, crickets, or frogs, or distant sounds like train whistles.

_____ 15. I use my hands and I gesture a lot when I speak to others.

Your Learning Strategies

Learning Strategy

Developing a good study system and understanding how you best learn is essential to academic success. Make sure you familiarize yourself with the study system outlined in the To the Student section at the beginning of the text. Also take a moment to complete the Learning Styles Inventory found at the end of that section to discover your personal learning style. In these Learning Strategy boxes, we offer tips and suggestions on how to connect the study system and your learning style to help you be successful in the course.



Learning Strategy

In the To the Student section, we suggest that when taking notes, you use a red pen for definitions and a blue pen for rules and procedures. Notice that we have used those colors in the design of the text to connect with your notes.

Definition **Additive inverses:** Two numbers whose sum in zero.

Examples of additive inverses:

15 and −15	**because 15 + (−15) = 0**
−9 and 9	**because −9 + 9 = 0**
0 and 0	**because 0 + 0 = 0**

Notice that 0 is its own additive inverse and that for numbers other than 0, the additive inverses have the same absolute value but *opposite* signs.

Rules

The sum of two additive inverses is zero.

The additive inverse of 0 is 0.

The additive inverse of a nonzero number has the same absolute value but opposite sign.

The Math Study System

The Carson Math Study System is designed to help you succeed in your math course. You will discover your own learning style, and you will use study strategies that match the way you learn best. You will also learn how to organize your course materials, manage your time efficiently, and study and review effectively.

Your Math Notebook

Notes

(see pages xvi–xvii)

Section # 9/20

We can simplify an expression by combining like terms.

p. 37 def. Like terms: constant terms or variable terms that have the same variable(s) raised to the same powers.

Ex 1) 2x and 3x are like terms.

Ex 2) 5x and 7y are not like terms.

Homework

(see pages xvii–xix)

Section # Homework 9/21

#1 – 15 odd

1. $5^2 + 3 \cdot 4 - 7$
   $= 25 + 3 \cdot 4 - 7$
   $= 25 + 12 - 7$
   $= 37 - 7$
   $= 30$

Quizzes/Tests

(see page xxi)

Chapter # Quiz 10/10

For 1-4, simplify.

1. $|-8|$ $= 8$ ✓
2. $|9|$ $= 9$ ✓
3. $-15 + 5$ $= -10$ ✓
4. $-8 + -6$ $= -14$ ✓

4/4 = 100% Nice work!

Study Materials

(see pages xix–xx)

Chapter # Study Sheets 9/10

To graph a number on a number line, draw a dot on the mark for the number. ex) Graph −2,

The absolute value of a positive number is positive. ex) $|7| = 7$

The absolute value of a negative number is positive. ex) $|-12| = 12$

Fourth Edition

Prealgebra

Tom Carson

PEARSON

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Contents

Preface

Prealgebra, Fourth Edition, provides a fresh approach for the student who needs a brush-up in arithmetic and basic algebra concepts and for those who are encountering algebra for the first time. Written in a relaxed, nonthreatening style, this text 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* a mathematical process works the way it does, instead of just *how* to follow the process.

Problems pulled from science, engineering, accounting, health fields, the arts, and everyday life link mathematics to the real world. The link to real-world problem solving is further developed through the Project Portfolio Workbook (see page ix for a complete description of the online *Project Portfolio Workbook*).

Part of the freshness of *Prealgebra*'s approach is the sequencing of ideas. For example, students learn the basics of polynomials early in this text to give them a patient introduction and ample practice of this fundamental algebra topic.

In addition, a complete study system with a Learning Styles Inventory and learning strategies integrated throughout the text provides further guidance for students (see pages xvi–xxi).

Upon completing the material in this text, a student should be able to proceed successfully to an introductory algebra course or a survey of math course. This text is designed to be versatile enough for use in a standard lecture format, a hybrid course, a self-paced lab, and even an independent-study format. A strong ancillary package provides a wealth of supplemental resources for both instructors and students (see pages ix–xi for complete descriptions).

What's New in This Edition?

In addition to revised explanations and a new design, the following changes were made to create the fourth edition.

Features

The **Math Study System** has been expanded with sample student notes, homework, and study materials to guide students in developing their own math notebooks to complement their personal learning styles. In addition, learning strategies written by students and recent college graduates have been added throughout the text, providing helpful tips from successful students. These can be identified by the student's name at the end of the strategy.

Chapter Openers now provide a brief topical overview of the chapter. In the instructor's edition, each opener also now includes teaching suggestions for the chapter.

Each section now begins with **Warm-up** Exercises that review previously learned material helpful to understanding the concepts in the section.

Section Exercises are now grouped by objective, to make it easier for students to connect examples with related exercises. In addition, Prep Exercises help students focus on the terminology, rules, and processes corresponding to the exercises that immediately follow.

Chapter Summary and Review The Chapter Summary is now interactive with Review Exercises integrated within the summary to encourage active learning and review. For each key topic, the student is prompted to complete the corresponding definitions, rules, and procedures. A key example is provided for reference. Review exercises complete each section of summarized material, so the student can apply the skills and concepts for immediate reinforcement.

Updates

- Fresh data: Real-data examples and exercises have been revised with more current data as needed to keep the applications relevant and contemporary.
- New examples and exercises: Many new examples and over 650 new exercises have been added throughout the text.

Content Changes

To improve readability, lengthy explanations were simplified and, where possible, visuals were added to show rather than say.

- The problem-solving outline is used in the more complicated application examples as needed.
- Discussion boxes have been turned into discussion suggestions to the instructor that now appear only in the annotated instructor's edition. This reduces some distractions to the student while still giving the instructor ideas for enriching class discussion.

In addition, the following specific content changes have been made to improve student comprehension and retention of material:

Chapter 1

In Section 1.1, number lines are now taught before inequalities and rounding. Also, expanded notation is now shown with words instead of multiplication to strengthen the connection with place value names.

Square roots and the order of operations agreement were moved to Chapter 2, improving the pacing of Chapter 1.

Mean, median, and mode are now introduced in Section 1.5 and revisited throughout the text.

Chapter 2

Additive inverse is now taught in Section 2.2 after the addition of integers is introduced. This simplifies the topic and places it closer to Section 2.3, where it is used to write subtractions as equivalent additions.

Chapter 3

Section 3.1 now covers translating word phrases to mathematical expressions.

For clarity, combining like terms was moved from Section 3.3 to Section 3.2.

Chapter 6
Estimating was added to make decimal coverage consistent with fraction coverage.

Chapter 7
A more visual approach was used to explain how to translate application problems to a proportion to help students see the correct relationships between the numerators and denominators.

Chapter 8
Sections 8.2 and 8.3 were combined so that word-for-word translation to an equation and the proportion method are now taught side-by-side in one section. Teaching both methods for each example is a more efficient use of class time and makes it easier to discuss which method is best for the situation.

Chapter 9
Congruent triangles have been added to Section 9.1.

Hallmark Features

Real, relevant, and interesting applications Nearly every application problem is a real situation taken from science, engineering, health, finance, the arts, or everyday life. The real-world applications not only illustrate the uses of basic arithmetic and algebra concepts, but they also expose students to the wonders of the world in which we live. Often the problems follow up with open-ended discussion questions where there is no "correct" answer. These questions help students to think beyond just getting a numeric answer by encouraging them to apply mathematical results to solve problems (see pages 72, 234, and 547).

The how and the why This text explains 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 helps the students remember the concepts.

A Study System is presented in the To the Student section on pages xvi-xxii and is reinforced throughout the text. The system recommends using color codes for taking notes (red for definitions; blue for rules and procedures; and black for notes and examples) which are reinforced throughout the text. In addition, students are encouraged to use the Learning Styles Inventory (see p. xiv).

A Learning Styles Inventory is presented on page xiv to help students assess their particular style of learning and use it effectively in the course.

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 learning style (see pages 19, 282, 401, 536, and 605).

Connection boxes appear where appropriate in the text to help students see relationships between topics to develop a deeper understanding of the math (see pages 107, 377, and 603).

Problem-solving process On page 62 of Section 1.6, a problem-solving process is introduced:

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

This process is revisited throughout the text to reinforce the use of effective problem solving strategies (see pages 298, 439, and 513).

Student Supplements

Student's Solutions Manual

ISBN-13: 9780321782915
ISBN-10: 0321782917

Complete solutions to the odd-numbered section exercises and solutions to all of the section-level review exercises, chapter review exercises, practice tests, and cumulative review exercises.

MyWorkBook

ISBN-13: 9780321782939
ISBN-10: 0321782933

MyWorkBook can be packaged with the textbook or with the MyMathLab access kit and includes the following resources for each section of the text:

- Key vocabulary terms and vocabulary practice problems.
- Guided examples with stepped-out solutions and similar practice exercises, keyed to the text by learning objective.
- References to textbook examples and section lecture videos for additional help.
- Additional exercises with ample space for students to show their work, keyed to the text by learning objective.

Chapter Test Prep Videos

Chapter Tests can serve as practice tests to help students study. Watch instructors work through step-by-step solutions to all the Chapter Test exercises from the textbook. These videos are available on YouTube (search CarsonPrealgebra) and in MyMathLab.

Video Resources

- Series of lectures correlated directly to each section of the text.
- Video lectures include English captions.
- Ideal for distance learning or supplemental instruction.
- Available in MyMathlab.

Instructor Supplements

Annotated Instructor's Edition

ISBN-13: 9780321782854
ISBN-10: 0321782852

- Includes answers to all exercises, including puzzle problems, printed in blue near the corresponding problem.
- Useful instructor notes are printed in the margin.

Project Portfolio Workbook

- Activities and problems related to the theme of building a house are keyed to the relevant sections of the text. As they work through each project over the course of the semester, students apply the skills and concepts they've learned in a realistic and integrated context.
- Available in MyMathLab and from www.pearsonhighered.com/irc, this newly interactive feature is now assignable in MyMathLab.
- *Note to instructors*: The *Instructor's Resource Manual* includes tips and strategies for incorporating the project portfolio into your course.

Instructor's Solutions Manual (Download only)

ISBN-13: 9780321782861
ISBN-10: 0321782860

- Contains complete solutions to all even-numbered section exercises and puzzle problems.

Instructor's Resource Manual with Printable Test Forms (Download only)

ISBN-13: 9780321782922
ISBN-10: 0321782925

- A mini-lecture for each section of the text, organized by objective, includes key examples and teaching tips.
- Designed to help both new and adjunct faculty with course preparation and classroom management.
- Offers helpful teaching tips correlated to the sections of the text.
- Contains one diagnostic test per chapter; four free-response test forms per chapter, one of which contains higher-level questions; one multiple-choice test per chapter; one free-response midterm exam; two free-response final exams; and one multiple-choice final exam.

Additional Media Supplements

MyMathLab® Online Course (access code required)

MyMathLab delivers **proven results** in helping individual students succeed. It provides **engaging experiences** that personalize, stimulate, and measure learning for each student. And, it comes from a **trusted partner** with educational expertise and an eye on the future.

To learn more about how MyMathLab combines proven learning applications with powerful assessment, visit **www.mymathlab.com** or contact your Pearson representative.

MyMathLab Standard allows you to build your course your way, offering maximum flexibility and complete control over all aspects of assignment creation. Starting with a clean slate lets you choose the exact quantity and type of problems you want to include for your students. You can also select from pre-built assignments to give you a starting point.

Ready-to-Go MyMathLab comes with assignments pre-built and pre-assigned, reducing start-up time. You can always edit individual assignments as needed throughout the semester.

MyMathLab®Plus/MyStatLab™Plus

MyLabsPlus combines proven results and engaging experiences from MyMathLab® and MyStatLab™ with convenient management tools and a dedicated services team. Designed to support growing math and statistics programs, it includes additional features such as:

- **Batch Enrollment:** Your school can create the login name and password for every student and instructor, so everyone can be ready to start class on the first day. Automation of this process is also possible through integration with your school's Student Information System.
- **Login from your campus portal:** You and your students can link directly from your campus portal into your MyLabsPlus courses. A Pearson service team works with your institution to create a single sign-on experience for instructors and students.
- **Advanced Reporting:** MyLabsPlus's advanced reporting allows instructors to review and analyze students' strengths and weaknesses by tracking their performance on tests, assignments, and tutorials. Administrators can review grades and assignments across all courses on your MyLabsPlus campus for a broad overview of program performance.
- **24/7 Support:** Students and instructors receive 24/7 support, 365 days a year, by phone, email, or online chat.

MyLabsPlus is available to qualified adopters. For more information, visit our website at www.mylabsplus.com or contact your Pearson representative.

MathXL® Online Course (access code required)

MathXL® is the homework and assessment engine that runs MyMathLab. (MyMathLab is MathXL plus a learning management system.) With MathXL, instructors can:

- Create, edit, and assign online homework and tests using algorithmically generated exercises correlated at the objective level to the textbook.
- Create and assign their own online exercises and import TestGen tests for added flexibility.
- Maintain records of all student work tracked in MathXL's online gradebook.

With MathXL, students can:

- Take chapter tests in MathXL and receive personalized study plans and/or personalized homework assignments based on their test results.
- Use the study plan and/or the homework to link directly to tutorial exercises for the objectives they need to study.
- Access supplemental animations and video clips directly from selected exercises.

MathXL is available to qualified adopters. For more information, visit our website at www.mathxl.com, or contact your Pearson representative.

TestGen®

TestGen® (www.pearsoned.com/testgen) enables instructors to build, edit, print, and administer tests using a computerized bank of questions developed to cover all the objectives of the text. TestGen is algorithmically based, allowing instructors to create multiple but equivalent versions of the same question or test with the click of a button. Instructors can also modify test bank questions or add new questions. The software and test bank are available for download from Pearson Education's online catalog.

PowerPoint® Lecture Slides and Active Learning Questions

- PowerPoint Lecture Slides are written and designed specifically for this text, including figures and examples from the text.
- Active Learning Questions for use with classroom response systems include multiple choice questions to review lecture material.
- Both are available within MyMathLab® or from the Instructor Resource Center at www.pearsonhighered.com/irc.

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So many people have helped me in so many ways that I could write another book in saying thank you. Though the words of thanks to follow may be few, no amount of space can contain the genuine gratitude that I feel toward each and every person that gave of themselves to make this work the best that it can be.

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Tom Carson

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. What a great question! But why focus on math alone? What about English, history, psychology, or science? Does anyone really use *every* topic of *every* course in the curriculum? Most jobs do not require that we write essays on Shakespeare, discuss the difference between various psychological theories, or analyze the cell structure of a frog's liver. So what's the point? The issue comes down to recognizing that general education courses are not job training. The purpose of those courses is to stretch and exercise the mind so that the educated person can better communicate, analyze situations, and solve problems, which are all valuable skills in life and any job.

Professional athletes offer a good analogy. A professional athlete usually has an exercise routine apart from their sport designed to build and improve their body. They may seek a trainer to design exercises intended to improve strength, stamina, or balance and then push them in ways they would not normally push themselves. That trainer may have absolutely no experience with their client's sport, but can still be quite effective in designing an exercise program because the trainer is focused on building basic skills useful for any athlete in any sport. Education is similar: it is exercise for the mind. A teacher's job is like that of a physical trainer. A teacher develops exercises intended to improve communication skills, critical-thinking skills, and problem-solving skills. Different courses are like different types of fitness equipment. Some courses may focus more on communication through writing papers, discussion, and debate. Other courses, such as mathematics, focus more on critical thinking and problem solving.

Another similarity is that physical exercise must be challenging for your body to improve. Similarly, mental exercise must be challenging for the mind to improve. Expect course assignments to challenge you and push you mentally in ways you wouldn't push yourself. That's the best way to grow. So as you think about the courses you are taking and the assignments in those courses, remember the bigger picture of what you are developing: your mind. When you are writing papers, responding to questions, analyzing data, and solving problems, you are developing skills important to life and any career out there.

What Do I Need to Do to Succeed?

☑ **Adequate Time** To succeed, you must have adequate time and be willing to use that time to perform whatever is necessary. To determine if you have adequate time, use the following guide.

Step 1. Calculate your work hours per week.
Step 2. Calculate the number of hours in class each week.
Step 3. Calculate the number of hours required for study by doubling the number of hours you spend in class.
Step 4. Add the number of hours from steps 1–3 together.

Adequate time: If the total number of hours is below 60, then you have adequate time.

Inadequate time: If the total number of hours is 60 or more, then you do not have adequate time. You may be able to hang in there for a while, but eventually, you will find yourself overwhelmed and unable to fulfill all of your obligations. Remember, the above calculations do not consider other likely elements of life such as commuting, family, recreation, and so on. The wise thing to do is cut back on work hours or drop some courses.

Assuming you have adequate time available, choosing to use that time to perform whatever is necessary depends on your attitude, commitment, and self-discipline.

☑ **Positive Attitude** We do not always get to choose our circumstances, but we do get to choose our reaction and behavior. A positive attitude is choosing to be cheerful, hopeful, and encouraging no matter the situation. A benefit of a positive attitude is that it tends to encourage people around you. As a result, they

are more likely to want to help you achieve your goal. A negative attitude, on the other hand, tends to discourage people around you. As a result, they are less likely to want to help you. The best way to maintain a positive attitude is to keep life in perspective, recognizing that difficulties and setbacks are temporary.

☑ **Commitment** Commitment means binding yourself to a course of action. Remember, expect difficulties and setbacks, but don't give up. That's why a positive attitude is important, it helps you stay committed in the face of difficulty.

☑ **Self-Discipline** Self-discipline is choosing to do what needs to be done—even when you don't feel like it. In pursuing a goal, it is normal to get distracted or tired. It is at those times that your positive attitude and commitment to the goal help you discipline yourself to stay on task.

Thomas Edison, inventor of the lightbulb, provides an excellent example of all of these principles. Edison tried over 2000 different combinations of materials for the filament before he found a successful combination. When asked about all his failed attempts, Edison replied, "I didn't fail once, I invented the lightbulb. It was just a 2000-step process." He also said, "Our greatest weakness lies in giving up. The most certain way to succeed is always to try just one more time." In those two quotes, we see a person who obviously had time to try 2000 experiments, had a positive attitude about the setbacks, never gave up, and had the self-discipline to keep working.

Behaviors of Strong Students and Weak Students

The four requirements for success can be translated into behaviors. The following table compares the typical behaviors of strong students with the typical behaviors of weak students.

Strong Students . . .	Weak Students . . .
• are relaxed, patient, and work carefully.	• are rushed, impatient, and hurry through work.
• almost always arrive on time and leave the classroom only in an emergency.	• often arrive late and often leave class to "take a break."
• sit as close to the front as possible.	• sit as far away from the front as possible.
• pay attention to instruction.	• ignore instruction, chit-chat, draw, fidget, etc.
• use courteous and respectful language, encourage others, make positive comments, are cheerful and friendly.	• use disrespectful language, discourage others, make negative comments, are grumpy and unfriendly. Examples of unacceptable language include: "I hate this stuff!" (or even worse!) "Are we doing anything important today?" "Can we leave early?"
• ask appropriate questions and answer instructor's questions during class.	• avoid asking questions and rarely answer instructor's questions in class.
• take lots of notes, have organized notebooks, seek out and use study strategies	• take few notes, have disorganized notebooks, do not use study strategies
• begin assignments promptly and manage time wisely, and almost always complete assignments on time.	• procrastinate, manage time poorly, and often complete assignments late.
• label assignments properly and show all work neatly.	• show little or no work and write sloppily.
• read and work ahead.	• rarely read or work ahead.
• contact instructors outside of class for help, and use additional resources such as study guides, solutions manuals, computer aids, videos, and tutorial services.	• avoid contacting instructors outside of class, and rarely use additional resources available.

Assuming you have the prerequisites for success and understand the behaviors of a good student, our next step is to develop two major tools for success:

1. **Learning Style:** complete the Learning Styles Inventory to determine how you tend to learn.
2. **The Study System:** this system describes a way to organize your notebook, take notes, and create study tools to complement your learning style. We've seen students transform their mathematics grades from D's and F's to A's and B's by using the Study System that follows.

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.

_____ 5. I would rather have the professor explain a graph, chart, or diagram to me instead of just showing it to me.

_____ 6. When learning new things, I want to do it rather than hear about it.

_____ 7. I would rather have the instructor write the information on the board or overhead instead of just lecturing.

_____ 8. I would rather listen to a book on tape than read it.

_____ 9. I enjoy making things, putting things together, and working with my hands.

_____ 10. I am able to conceptualize quickly and visualize information.

_____ 11. I learn best by hearing words.

_____ 12. I have been called hyperactive by my parents, spouse, partner, or professor.

_____ 13. I have no trouble reading maps, charts, or diagrams.

_____ 14. I can usually pick up on small sounds like bells, crickets, or frogs, or distant sounds like train whistles.

_____ 15. I use my hands and I gesture a lot when I speak to others.

Write your score for each statement beside the appropriate statement number below. Then add the scores in each column to get a total score for that column.

1. _____	2. _____	3. _____
4. _____	5. _____	6. _____
7. _____	8. _____	9. _____
10. _____	11. _____	12. _____
13. _____	14. _____	15. _____
Total: _____	_____	_____
Visual	**Auditory**	**Tactile**

The largest total of the three columns indicates your dominant learning style.

Visual learners learn best by seeing. If this is your dominant learning style, then you should focus on learning strategies that involve seeing. The color coding in the study system (see page xvii-xviii) will be especially important. The same color coding is used in the text. Draw lots of diagrams, arrows, and pictures in your notes to help you see what is happening. Reading your notes, study sheets, and text repeatedly will be an important strategy.

Auditory learners learn best by hearing. If this is your dominant learning style, then you should use learning strategies that involve hearing. After getting permission from your instructor, bring a tape recorder to class to record the discussion. When you study your notes, play back the tape. Also, when you learn rules, say the rule over and over. As you work problems, say the rule before you do the problem. You may also find the videotapes to be beneficial because you can hear explanations of problems taken from the text.

Tactile (also known as kinesthetic) learners learn best by touching or doing. If this is your dominant learning style, you should use learning strategies that involve doing. Doing lots of practice problems will be important. Make use of the Your Turn exercises in the text. These are designed to give you an opportunity to do problems that are similar to the examples as soon as a topic is discussed. Writing out your study sheets and doing your practice tests repeatedly will be important strategies for you.

Note that the study system developed in this text is for all learners. Your learning style will help you decide what aspects and strategies in the study system to focus on, but being predominantly an auditory learner does not mean that you shouldn't read the textbook, do lots of practice problems, or use the color-coding system in your notes. Auditory learners can benefit from seeing and doing, and tactile learners can benefit from seeing and hearing. In other words, do not use your dominant learning style as a reason for not doing things that are beneficial to the learning process. Also, remember that the Learning Strategy boxes presented throughout the text provide tips to help you use your personal learning style to your advantage.

The Math Study System

Organize the notebook into four parts using dividers as shown:

Notes (see pages xvi-xvii)

Homework (see pages xvii-xix)

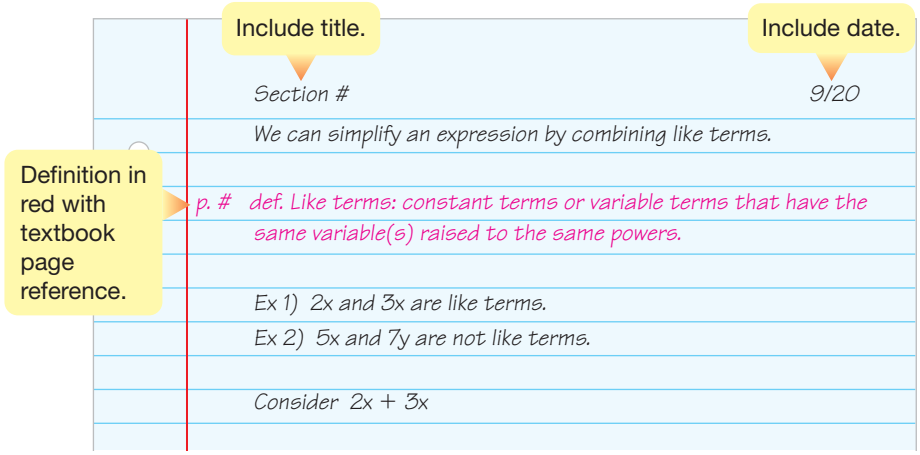
Study Materials
Study sheets (see page xix)
Practice tests (see page xx)
Game plans (see page xx)

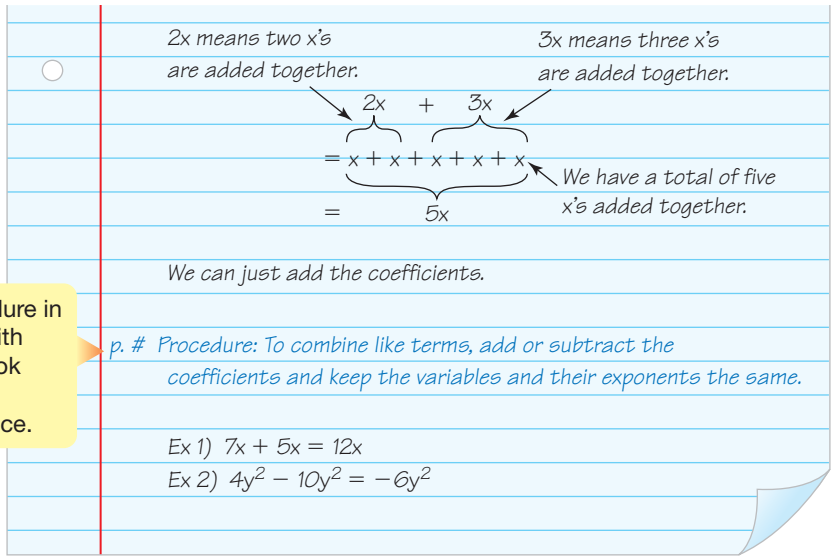
Quizzes/Tests (see page xxi)

Notes

- Use a color code: **red** for definitions, **blue** for rules or procedures, and **pencil** for all examples and other notes.
- Begin notes for each class on a new page (front and back for that day is okay). Include a topic title or section number and the date on each page.
- Try to write your instructor's spoken explanations along with the things he or she writes on the board.
- Mark examples your instructor emphasizes in some way to give them a higher priority. These problems often appear on quizzes and tests.
- Write warnings your instructor discusses about a particular situation.
- Include common errors that your instructor illustrates, but mark them clearly as errors so that you do not mistake them for correct.
- To speed note taking, eliminate unnecessary words like "the" and use codes for common words like + for "and" and ∴ for "therefore." Also, instead of writing complete definitions, rules, or procedures, write the first few words and place the page reference from the text so that you can copy from the text later.

Sample Notes with Color Code





Homework

This section of the notebook contains all homework. Use the following guidelines whether your assignments are from the textbook, a handout, or a computer program like MyMathLab or MathXL.

- Use pencil so that mistakes can be erased (scratching through mistakes is messy and should be avoided).
- Label according to your instructor's requirements. Usually, at least include your name, the date, and assignment title. It is also wise to write the assigned problems at the top as they were given. For example, if your instructor writes "Section 1.5 #1–15 odd," write it that way at the top. Labeling each assignment with this much detail shows that you take the assignment seriously and leaves no doubt about what you interpreted the assignment to be.
- For each problem you solve, write the problem number and show all solution steps neatly.

Why do I need to show work and write all the steps? Isn't the right answer all that's needed?

- Mathematics is not just about getting correct answers. You really learn mathematics when you organize your thoughts and present those thoughts clearly using mathematical language.
- You can arrive at correct answers with incorrect thinking. Showing your work allows your instructor to verify you are using correct procedures to arrive at your answers.
- Having a labeled, well-organized, and neat hard copy is a good study tool for exams.

What if I submit my answers in MyMathLab or MathXL? Do I still need to show work?

Think of MyMathlab or MathXL as a personal tutor who provides the exercises, offers guided assistance, and checks your answers before you submit the assignment. For the same reasons as those listed above, you should still create a neatly written hardcopy of your solutions, even if your instructor does not check the work. Following are some additional reasons to show your work when submitting answers in MyMathlab or MathXL.

- If you have difficulties that are unresolved by the program, you can show your instructor. Without the written work, your instructor cannot see your thinking.
- If you have a correct answer but have difficulty entering that correct answer, you have record of it and can show your instructor. If correct, your instructor can override the score.

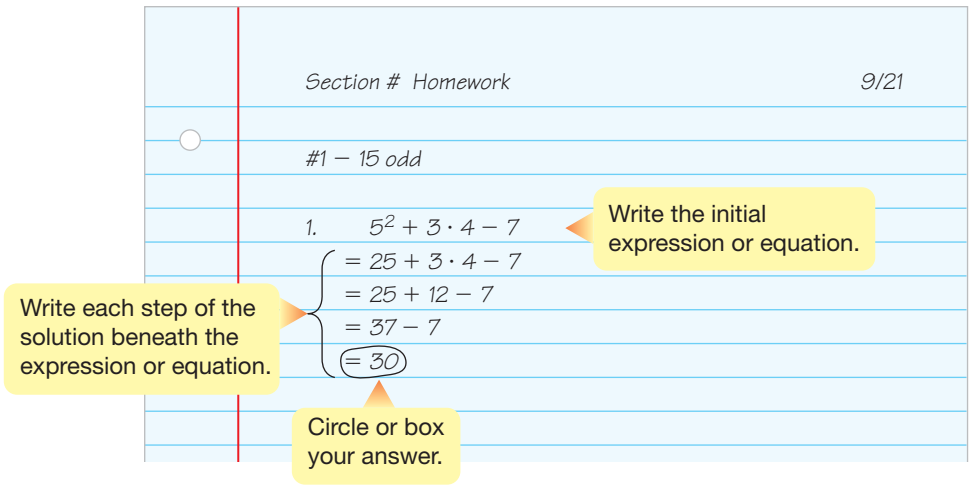
Sample Homework: Simplifying Expressions or Solving Equations

Suppose you are given the following exercise:

For Exercises 1–30 simplify.

1. $5^2 + 3 \cdot 4 - 7$

Your homework should look something like the following:



Sample Homework: Solving Application Problems

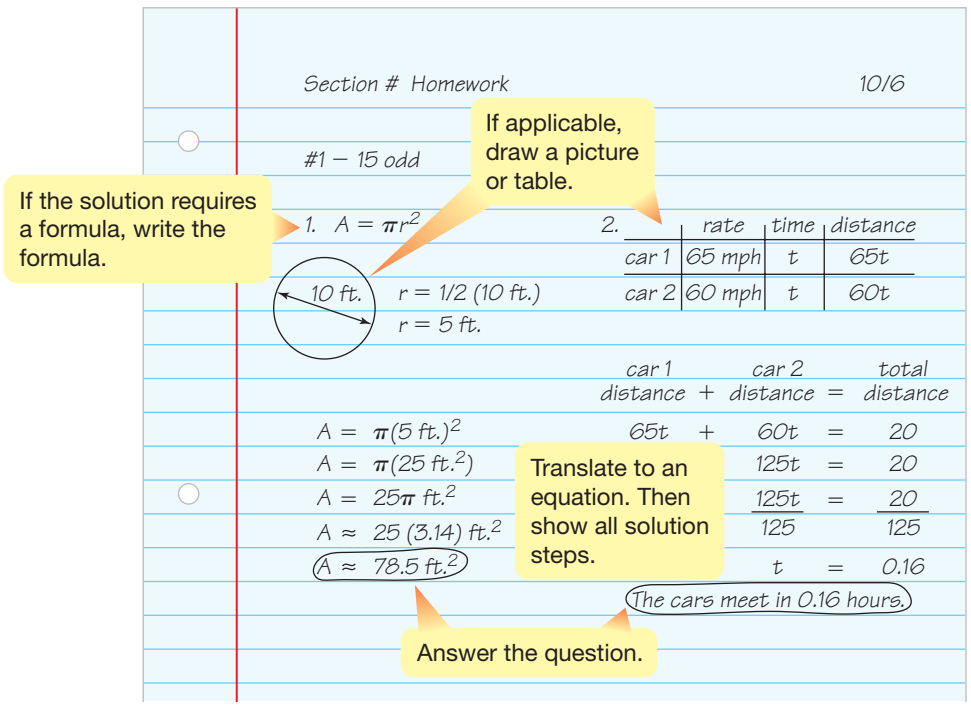
Example: Suppose you are given the following two problems.

For Exercises 1 and 2, solve.

1. Find the area of a circle with a diameter of 10 feet.

2. Two cars are traveling toward each other on the same highway. One car is traveling 65 miles per hour and the other is traveling at 60 miles per hour. If the two cars are 20 miles apart, how long will it be until they meet?

Your homework should look something like the following:



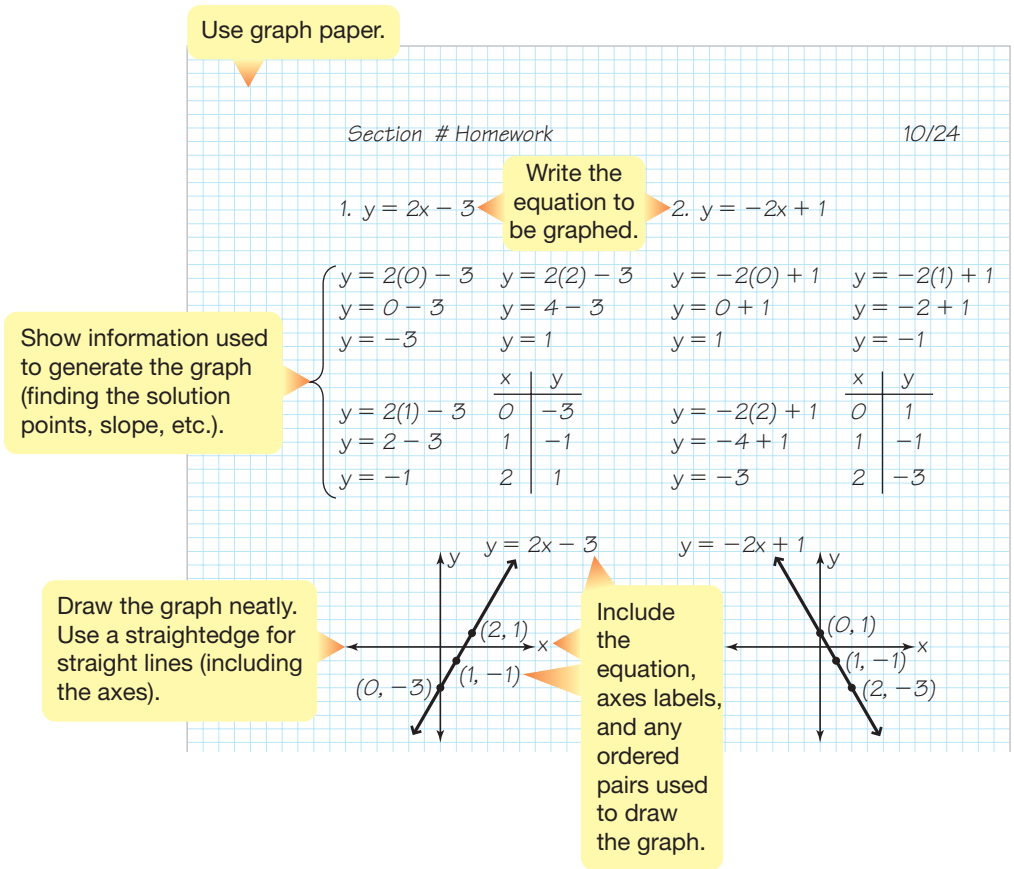
Sample Homework: Graphing

Example: Suppose you are given the following two problems.

For Exercises 1 and 2, graph the equation.

1. $y = 2x - 3$ **2.** $y = -2x + 2$

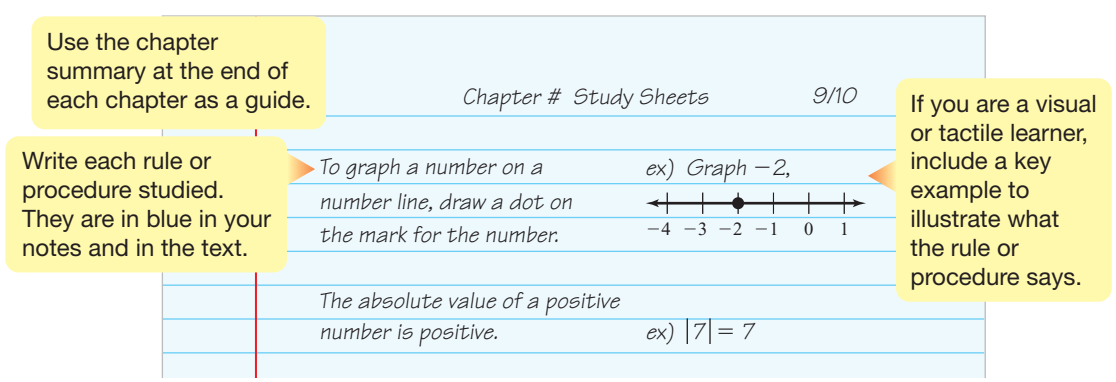
Your homework should look something like the following:

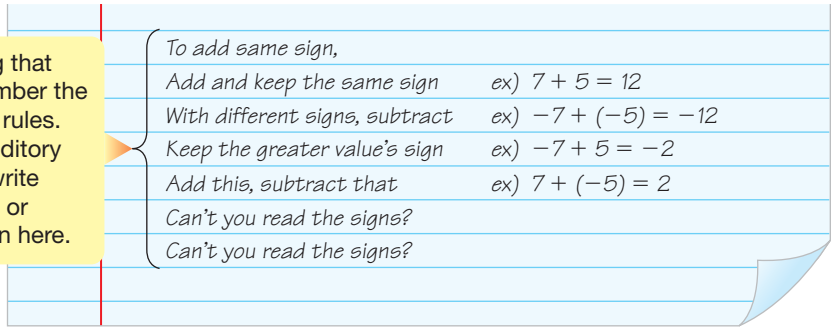


Study Materials

This section of the notebook contains three types of study materials for each chapter.

Study Material 1: The Study Sheet A study sheet contains *every* rule or procedure in the current chapter.

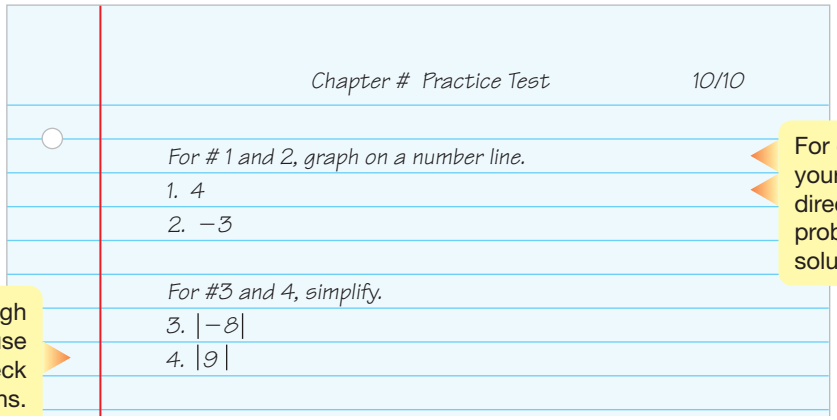




Include anything that helps you remember the procedures and rules. For example, auditory learners might write poems, rhymes, or jingles, as shown here.

Study Material 2: The Practice Test If your instructor gives you a practice test, proceed to the discussion of creating a game plan.

If your instructor does not give you a practice test, use your notes to create your own practice test out of the examples given in class. Include only the instructions and the problem, not the solutions. The following sample practice test was created from examples in the notes for Chapter 2 in a prealgebra course.

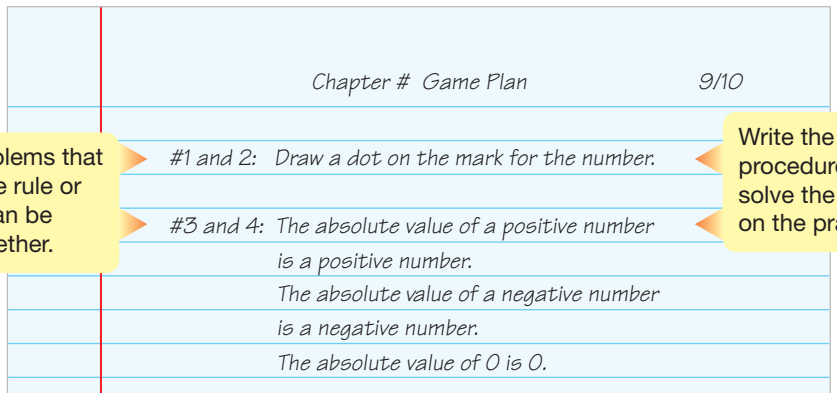


For each example in your notes, write the directions and the problem but not the solution.

After working through the practice test, use your notes to check your solutions.

Study Material 3: The Game Plan The game plan refines the study process further. It is your plan for the test based on the practice test. For each problem on your practice test, write the definition, rule, or procedure used to solve the problem.

The sample shown gives the rule or procedure used to solve each problem on the sample practice test on the previous page. The rules and procedures came from the sample study sheet.



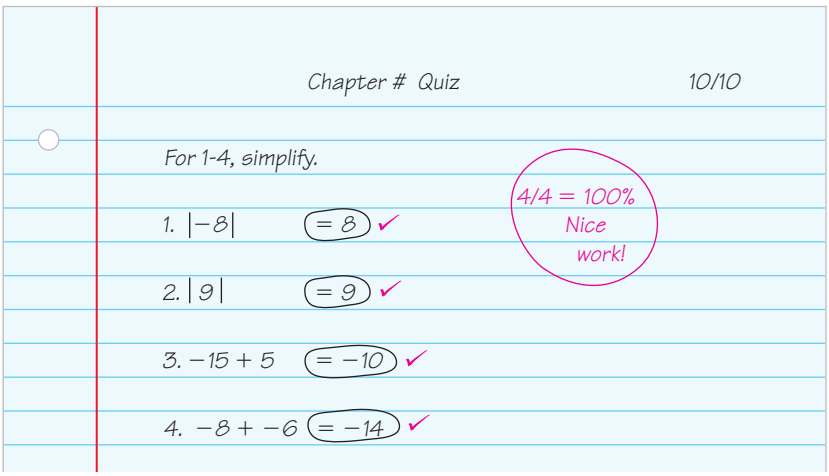
Multiple problems that use the same rule or procedure can be grouped together.

Write the rule or procedure used to solve the problems on the practice test.

Quizzes/Tests

Archive all returned quizzes and tests in this section of the notebook.

- Midterm and final exams questions are often taken from the quizzes and tests, so they make excellent study tools for those cumulative exams.
- Keeping all graded quizzes and tests offers a backup system in the unlikely event your instructor should lose any of your scores.
- If a dispute arises about a particular score, you have the graded test to show your instructor.



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CHAPTER

1

Whole Numbers

Chapter Overview

To be successful in studying mathematics, we must build a solid foundation. Chapter 1 is the foundation of this course. In it, we explore:

- Arithmetic with whole numbers.
- Key geometry concepts: perimeter, area, and volume.
- Key statistical concepts: mean, median, and mode.

The skills developed here will be used in every chapter; so talk with your instructor if you have difficulty in this chapter.

1.1 Introduction to Numbers, Notation, and Rounding

Objectives

1. Name the digit in a specified place.
2. Write whole numbers in standard and expanded form.
3. Write the word name for a whole number.
4. Graph a whole number on a number line.
5. Use $<$, $>$, or $=$ to write a true statement.
6. Round numbers.
7. Interpret bar graphs and line graphs.

Warm-up Refer to the *To the Student Section* on p. xx.

1. What are the four sections of the notebook?
2. What is the color code for notes?
3. Complete the Learning Style Inventory. What is your learning style?

Learning Strategy

Every day after class, read over your notes and the related parts in the chapter. By looking at the information while it's still fresh in your mind, it will be easy to remember.

—Sarah S.

Numbers form the foundation of mathematics. To write numbers, we use ten *numerals*, or *digits*: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. Because our numeral system has ten numerals, it is a *base-10* system. To write numbers beyond 9, we use combinations of numerals in a place-value system, which we will explore in a moment.

Of Interest

Numerals have been written many different ways throughout history. Our modern numerals are derived from Hindu-Arabic forms. Numerals from various cultures are shown in the margin.

Numbers are classified into groups called **sets.** In this chapter, we focus on the set of **whole numbers,** which contains 0 and all of the counting numbers: 1, 2, 3, and so on. The counting numbers make up the set of **natural numbers.** Because every natural number is in the set of whole numbers, we say that the set of natural numbers is a **subset** of the set of whole numbers.

Definitions **Set:** A group of elements.

Subset: A set within a set.

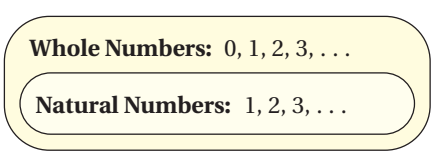
Natural numbers: The natural numbers are 1, 2, 3, . . .

Note The three periods are an *ellipsis*, indicating that the numbers continue forever. ◀

Whole numbers: The whole numbers are 0, 1, 2, 3, . . .

The following figure shows the set of natural numbers contained within the set of whole numbers.

Note 0 is the only whole number that is not a natural number. ▶



Objective 1 Name the digit in a specified place.

Figure 1-1 shows how the place values are arranged.

Answers to Warm-up

1. notes, homework, study materials, graded work
2. red = definitions; blue = rules/procedures; pencil = all other notes
3. Answers may vary.

Figure 1-1 Place Values

Place Values														
Trillions period			Billions period			Millions period			Thousands period			Ones period		
◄··· Hundred trillions	Ten trillions	Trillions	Hundred billions	Ten billions	Billions	Hundred millions	Ten millions	Millions	Hundred thousands	Ten thousands	Thousands	Hundreds	Tens	Ones

The dashed arrow to the left of the table indicates that the place values continue to the left indefinitely. Notice that the place values are arranged in groups of three, called *periods*. Numbers written using the place-value system are said to be in *standard form*. When writing numbers in standard form, we separate the periods with commas, as in 3,243,972.

Example 1 What digit is in the thousands place in 209,812?

Answer: 9

Explanation: The digit in the thousands place is the fourth digit from the right.

► Do Your Turn 1

Objective 2 Write whole numbers in standard and expanded form.

Another way to write numbers is in *expanded form*, which shows a number's meaning using its digits and place values. For example, 430 is the sum of 4 hundreds, 3 tens, and 0 ones.

4	3	0
hundreds	tens	ones

4 hundreds + 3 tens + 0 ones

◄ **Note** Adding 0 does not affect a sum; so we do not have to write 0 ones and can write 4 hundreds + 3 tens.

Procedure

To write a number in expanded form, write each digit followed by its place-value name and a plus sign until you reach the last place, which is not followed by a plus sign.

Example 2 Write the number in expanded form.

a. 57,483

Answer: 5 ten thousands + 7 thousands + 4 hundreds + 8 tens + 3 ones

b. 4,705,208

Answer: 4 millions + 7 hundred thousands + 5 thousands + 2 hundreds + 8 ones

► Do Your Turn 2

Connection The place-value table is like the money tray in a cash register. Writing a digit in a particular place is like putting that many bills in the designated tray of the register. For example, writing a 7 in the hundreds place is like putting seven $100 bills in the hundreds tray of the register, which is worth a total of $700.

Note The comma is optional in a four-digit number. For example, we can write 4,538 or 4538.

► Your Turn 1

a. What digit is in the hundred thousands place in 62,407,981?

b. What digit is in the ten millions place in 417,290,006?

► Your Turn 2

Write the number in expanded form.

a. 82,469

b. 7,082,049

c. 410,159,200

Answers to Your Turn 1

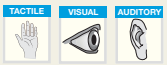
a. 4 **b.** 1

Answers to Your Turn 2

a. 8 ten thousands + 2 thousands + 4 hundreds + 6 tens + 9 ones

b. 7 millions + 8 ten thousands + 2 thousands + 4 tens + 9 ones

c. 4 hundred millions + 1 ten million + 1 hundred thousand + 5 ten thousands + 9 thousands + 2 hundreds



Learning Strategy

If you are using the note-taking system from the *To the Student* section of this text, remember to use a red pen for definitions and a blue pen for procedures and rules.

▶ Your Turn 3

Write the number in standard form.

a. 2 hundred thousands + 3 ten thousands + 1 thousand + 5 hundreds + 9 tens + 8 ones

b. 9 hundred millions + 1 ten thousand + 4 thousands + 7 hundreds

▶ Your Turn 4

Write the word name.

a. 49,777 (2009 median family income; *Source:* U.S. Bureau of the Census)

b. 14,256,000,000,000 (2009 Gross Domestic Product; *Source:* U.S. Bureau of the Census)

c. 847,716 (Diameter of the sun in miles)

Answers to Your Turn 3

a. 231,598
b. 900,014,700

Answers to Your Turn 4

a. forty-nine thousand, seven hundred seventy-seven
b. fourteen trillion, two hundred fifty-six billion
c. eight hundred forty-seven thousand, seven hundred sixteen

Let's convert from expanded form to standard form.

Procedure

To convert a number from expanded form to standard form, write each digit in the place indicated by the corresponding place value. If the expanded form is missing a place value, write a 0 for that place value in the standard form.

Example 3 Write the number in standard form.

a. 6 ten thousands + 9 thousands + 2 hundreds + 5 tens + 3 ones

Answer: 69,253

b. 9 millions + 2 ten thousands + 7 hundreds + 9 tens + 3 ones

Answer: 9,020,793

◀ **Note** There are no hundred thousands and no thousands in the expanded form. So we write 0s in those places in the standard form.

◀ Do Your Turn 3

Objective 3 Write the word name for a whole number.

The word name for a number is the way we say the number.

Procedure

To write the word name for a whole number, work from left to right through the periods.

1. Write the word name of the number formed by the digits in the period.
2. Write the period name followed by a comma.
3. Repeat steps 1 and 2 for each period except the ones period. For the ones period, write only the word name formed by the digits. Do not follow the ones period with its name.

Warning Do not write the word *and* in the word name for a whole number. As we will see in Chapter 6, the word *and* takes the place of a decimal point.

Example 4 Write the word name.

a. 2160 (diameter of the moon in miles)

Answer: two thousand, one hundred sixty

Explanation:

Thousands Period			Ones Period		
		2	1	6	0
two thousand			one hundred sixty		

b. 92,958,349 (average distance from the earth to the sun in miles)

Answer: ninety-two million, nine hundred fifty-eight thousand, three hundred forty-nine

Explanation:

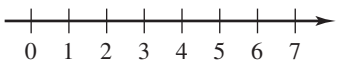
Millions period			Thousands period			Ones period		
	9	2	9	5	8	3	4	9
ninety-two million			nine hundred fifty-eight thousand			three hundred forty-nine		

Note All two-digit numbers from 21 to 99 whose names contain two words, such as forty-nine, fifty-eight, or ninety-two, require a hyphen between the two words.

◀ Do Your Turn 4

Objective 4 Graph a whole number on a number line.

We sometimes use a number line as a visual tool. On the following number line, we have marked the whole numbers through 7.



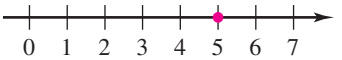
Note The arrow pointing to the right indicates that the numbers increase indefinitely. When we discuss integers in Chapter 2, we will see that the number line continues indefinitely to the left as well.

Procedure

To graph a whole number on a number line, draw a dot on the mark for that number.

Example 5 Graph 5 on a number line.

Solution:



Draw a dot on the mark for 5.

▶ Do Your Turn 5

▶ **Your Turn 5**

Graph the number on a number line.

a. 3 **b.** 6

Objective 5 Use $<$, $>$, or $=$ to write a true statement.

Now let's compare two numbers. A statement that contains an equal sign, such as $12 = 12$, is an **equation.** A statement that contains an inequality symbol, such as $6 < 10$, is an **inequality.**

Definitions **Equation:** A mathematical relationship that contains an equal sign $(=)$.

Inequality: A mathematical relationship that contains an inequality symbol $(<, >)$.

The inequality symbol $>$ means "greater than," whereas $<$ means "less than." Equations and inequalities can be true or false. The following table lists some equations and inequalities, shows how they are read, and whether they are true or false.

Statement	Translation to words	True or False
$12 = 12$	"twelve is equal to twelve"	True
$15 = 7$	"fifteen is equal to seven"	False
$6 < 10$	"six is less than ten"	True
$9 < 4$	"nine is less than four"	False
$11 > 8$	"eleven is greater than eight"	True
$0 > 5$	"zero is greater than five"	False

Procedure

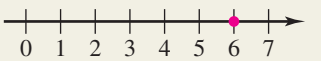
To use $<$, $>$, or $=$ to make an incomplete statement true:

- If the two numbers are the same, use $=$.
- If the two numbers are different, choose $<$ or $>$ so that the inequality symbol opens toward the greater of the two numbers.

Answers to Your Turn 5

a.

b.



Learning Strategy

If you are a visual learner, imagine $<$ and $>$ as mouths that open to eat the bigger meal.

Your Turn 6

Use $<$, $>$, or $=$ to write a true statement.

a. 15,907 ? 15,906

b. 1,291,304 ? 1,291,309

c. 64,108 ? 64,108

d. 24,300 ? 25,300

Example 6 Use $<$, $>$, or $=$ to write a true statement.

a. 208 ? 205

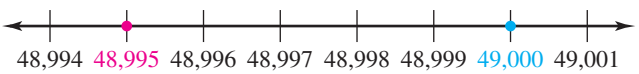
Answer: $208 > 205$

Explanation: On a number line, 208 is farther to the right than 205; so 208 is greater. We use the greater than symbol to open toward 208.

b. 48,995 ? 49,000

Answer: $48{,}995 < 49{,}000$

Explanation: On a number line, 49,000 is farther to the right than 48,995; so 49,000 is greater. We use the less than symbol to open toward 49,000.

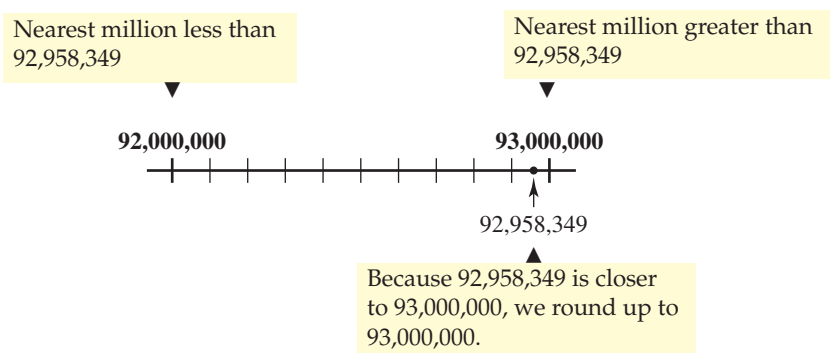


Do Your Turn 6

Objective 6 Round numbers.

In Example 4b, we saw that the average distance from the earth to the sun is 92,958,349 miles. Because numbers such as 92,958,349 are rather tedious to say and work with, we often round such numbers so they are easier to communicate.

When we round a number, we must identify a place value to round to; often the place value will be specified. For example, let's round 92,958,349 to the nearest million. First, we must determine whether 92,958,349 is closer to the exact million greater than 92,958,349, which is 93,000,000, or the exact million less than 92,958,349, which is 92,000,000. A number line can be helpful.



Warning Make sure you include all 0s after the rounded place. Instead of 93, write 93,000,000. Think about money. \$93 is very different from \$93,000,000.

Although we could use a number line every time we round, the digit in the place to the right of the place to be rounded can tell us whether to round up or down. If that digit is greater than 5, the number is closer to the greater number; so we round up. If that digit is less than 5, the number is closer to the lesser number; so we round down. If it is 5, we agree to round up. Our example suggests the following procedure.

Answers to Your Turn 6

a. $15{,}907 > 15{,}906$
b. $1{,}291{,}304 < 1{,}291{,}309$
c. $64{,}108 = 64{,}108$
d. $24{,}300 < 25{,}300$

Procedure

To round a number to a given place value:

1. Identify the digit in the given place value.
2. If the digit to the right of the given place value is 5 or greater, round up by increasing the digit in the given place value by 1. If the digit to the right of the given place value is 4 or less, round down by keeping the digit in the given place value the same.
3. Change all of the digits to the right of the rounded place value to zeros.

Example 7 Round 43,572,991 to the specified place.

a. hundred thousands

Solution: 43,572,991

Hundred thousands — The digit to the right of 5 is 7, which is greater than 5; so we round up.

Answer: 43,600,000

b. ten thousands

Solution: 43,572,991

Ten thousands — The digit to the right of 7 is 2, which is less than 4; so we round down.

Answer: 43,570,000

c. millions

Solution: 43,572,991

Millions — The digit to the right of 3 is 5; so we round up.

Answer: 44,000,000

d. hundreds

Solution: 43,572,991

Hundreds — The digit to the right of 9 is 9, which is greater than 5; so we round up.

Answer: 43,573,000

◀ **Note** When the 9 in the hundreds place is rounded up, it becomes 10. Because 10 hundreds is 1000, we must add 1 to the digit in the thousands place so that the 2 becomes a 3. This process of adding to the next place to the left is sometimes called *regrouping* or *carrying*.

▶ **Do Your Turn 7**

In the real world, we are seldom told what place to round to; so we round to a place that makes sense for the situation. Some questions to consider are as follows:

- How precise must the numbers be?
- How accurately can the amounts involved be measured?
- Are others depending on what we do?
- Are lives at stake?

For rough estimation purposes, we can round so that there is only one digit that is not 0. This means to round to the place value farthest to the left.

▶ **Your Turn 7**

Round 602,549,961 to the specified place.

a. ten thousands
b. tens
c. millions
d. thousands
e. hundreds

Answers to Your Turn 7

a. 602,550,000
b. 602,549,960
c. 603,000,000
d. 602,550,000
e. 602,550,000

▶ Your Turn 8

Round each number so that there is only one nonzero digit.

a. 27,502,341

b. 6,128,200

c. 453,219

Example 8 Round each number so that there is only one nonzero digit.

a. 36,568

Solution: 36,568

Farthest left

The digit to the right of 3 is 6, which is greater than 5; so we round up.

Answer: 40,000

b. 621,905

Solution: 621,905

Farthest left

The digit to the right of 6 is 2, which is less than 5; so we round down.

Answer: 600,000

Note Remember, when rounding down, the digit in the rounded place remains the same.

◀ Do Your Turn 8

Objective 7 Interpret bar graphs and line graphs.

Numbers are also common in graphs, such as bar graphs, which are usually used to compare amounts.

▶ Your Turn 9

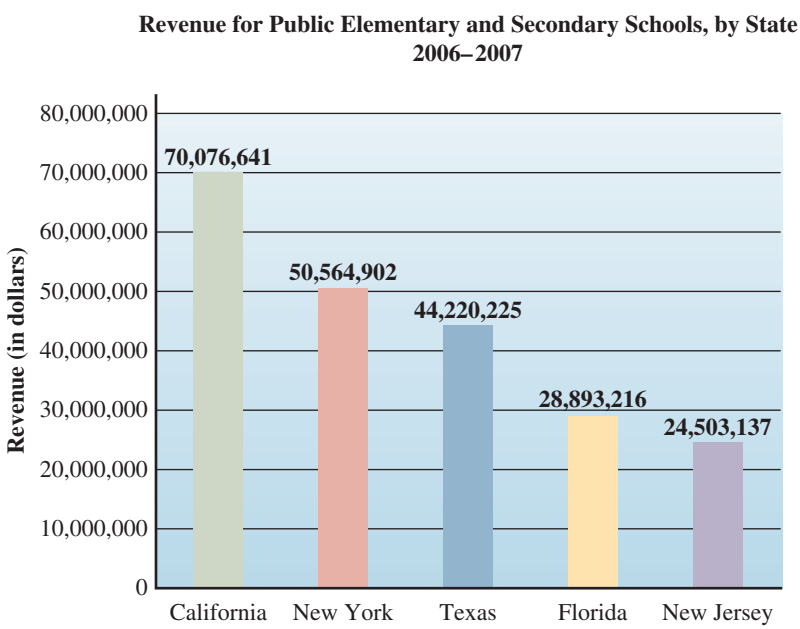
Use the graph in Example 9.

a. What revenue did New York generate?

b. Which state had the least revenue?

c. Round New York's revenue to the nearest hundred thousand.

Example 9 Use the following graph, which shows the five states with the highest revenues for public education in 2006–2007.



Answers to Your Turn 8

a. 30,000,000

b. 6,000,000

c. 500,000

Answers to Your Turn 9

a. $50,564,902

b. New Jersey

c. $50,600,000

a. What revenue did Florida generate?

Answer: $28,893,216

b. Which state had the greatest revenue?

Answer: California

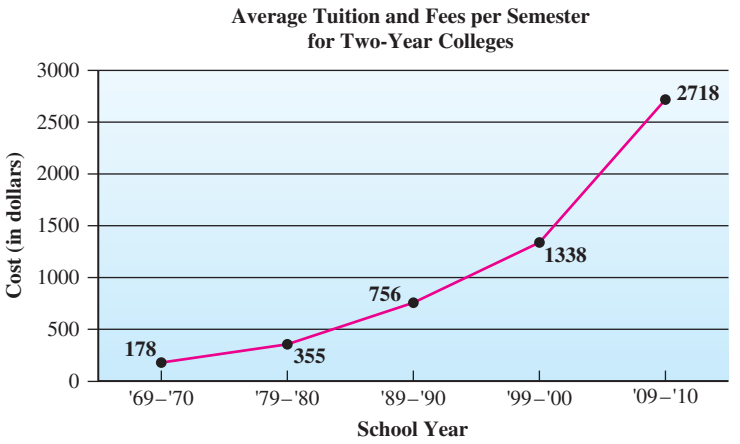
c. Round Texas' revenue to the nearest million.

Answer: $44,000,000

▶ Do Your Turn 9

We may also encounter line graphs, which are usually used to show how amounts have changed over time.

Example 10 Use the following graph, which shows average tuition and fees at two-year colleges.



a. What were the average tuition and fees per semester in '89–'90?

Answer: $756

b. Round the average tuition and fees per semester in '79–'80 to the nearest hundred.

Answer: $400

c. What general trend does the graph indicate?

Answer: The cost of tuition has increased over the years (nearly doubling every decade).

▶ Do Your Turn 10

▶ Your Turn 10

Use the graph in Example 10.

a. What were the average tuition and fees per semester in '99–'00?

b. Round the average tuition and fees per semester in '09–'10 so that there is only one nonzero digit.

Answers to Your Turn 10
a. $1338 **b.** $3000