



# INTRODUCTORY and INTERMEDIATE ALGEBRA

for College Students

*Robert Blitzer*





# INTRODUCTORY AND INTERMEDIATE ALGEBRA

FOR COLLEGE STUDENTS

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# Preface

*Introductory and Intermediate Algebra for College Students* provides comprehensive, in-depth coverage of the topics required in a course combining the study of introductory and intermediate algebra. The primary goals of the book are to help students acquire a solid foundation in introductory and intermediate algebra, without the repetition of topics in two separate texts, and to show how algebra can model and solve authentic real-world problems.

A source of frustration for me and my colleagues is that very few students read their textbook. When I ask students why they do not take full advantage of the text, their responses generally fall into two categories:

- “I cannot follow the explanations.”
- “The applications are not interesting.”

I thought about both of these objections in writing every page of this book.

**“I can’t follow the explanations.”** For many of my students, textbook explanations are too compressed. The chapters in *Introductory and Intermediate Algebra for College Students* have been written to make them extremely accessible. Every section contains a range of simple, intermediate, and challenging examples. Voice balloons allow for specific annotations in examples, further clarifying procedures and concepts.

**“The applications are not interesting.”** One of the things I enjoy most about teaching in a large urban community college is the diversity of who my students are and what interests them. Real-world data that celebrate this variety are used to bring relevance to examples, discussions, and applications. I selected all up-to-date real-world data to be interesting and intriguing to students. By connecting algebra to the whole spectrum of their interests, it is my intent to show students that their world is profoundly mathematical and, indeed, pi is in the sky.

## Key Pedagogical Features

*Introductory and Intermediate Algebra for College Students* is part of a series of four texts that include *Introductory Algebra for College Students*, Third Edition, *Intermediate Algebra for College Students*, Third Edition, and *Algebra for College Students*, Fourth Edition. The following features are found throughout the series.



- **Chapter-Opening and Section-Opening Scenarios.** Every chapter *and every section* opens with a compelling image that supports a scenario presenting a unique application of algebra in students' lives outside the classroom. Each scenario is revisited later in the chapter or section.
- **Section Objectives.** Learning objectives open every section. The objectives are stated in the margin at their point of use.
- **Detailed Illustrative Examples.** Each illustrative example is titled, making clear the purpose of the example. Examples are clearly written and provide students with detailed step-by-step solutions. No steps are omitted and each step is explained.
- **Check Point Examples.** Each worked example is followed by a similar matched problem for the student to work while reading the material. This actively involves the student in the learning process and gives students the opportunity to work with a concept as soon as they have learned it. Answers to all Check Points are given in the answer section.
- **Graphing.** Chapter 1 contains an introduction to graphing, a topic that is integrated throughout the book. Line, bar, circle, and rectangular coordinate graphs that use real data appear in nearly every section and exercise set. Many examples and exercises use graphs to explore relationships between data and to provide ways of visualizing a problem's solution.
- **Geometric Problem Solving.** Section 2.6 on problem solving in geometry teaches geometric concepts that are important to a student's understanding of algebra. There is frequent emphasis on problem solving in geometric situations, as well as on geometric models that allow students to visualize algebraic formulas.
- **Functions.** Functions are introduced in Chapter 8, with functions emphasized throughout the second half of the book.
- **Thorough, Yet Optional Technology.** Although the use of graphing utilities is optional, they are utilized in Using Technology boxes to enable students to visualize algebraic concepts. The use of graphing utilities is also reinforced in the technology exercises appearing in the exercise sets for those who want this option. With the book's early introduction to graphing, students can look at the calculator screens in the Using Technology boxes and gain an increased understanding of an example's solution even if they are not using a graphing utility in the course.
- **Enrichment Essays.** Enrichment essays provide historical, interdisciplinary, and otherwise interesting connections throughout the text.
- **Study Tips.** Study Tip boxes offer suggestions for problem solving, point out common student errors, and provide informal tips and suggestions. These invaluable hints appear in abundance throughout the book.
- **Discovery.** Discover for Yourself boxes, found throughout the text, encourage students to further explore algebraic concepts. These explorations are optional and their omission does not interfere with the continuity of the topic under consideration.
- **Exercise Sets.** An extensive collection of exercises is included in an exercise set at the end of each section. The text organizes exercises by level within six category types: Practice Exercises, Application Exercises, Writing in Mathematics, Technology Exercises, Critical Thinking Exercises, and



Review Exercises. This format makes it easy to create well-rounded homework assignments. Writing exercises offer students the opportunity to write about every objective covered in each section, as well as to discuss, interpret, and give opinions about data. Each review exercise contains the section number and example number of a similar worked-out example.

- **Chapter Projects.** At the end of each chapter are collaborative activities that give students the opportunity to work cooperatively as they think and talk about mathematics. Many of these exercises should result in interesting group discussions.
- **Chapter Review Grids.** Each chapter contains a review chart that summarizes the definitions and concepts in every section of the chapter. Examples that illustrate these key concepts are also included in the chart. Like the summary grid, review exercises are organized by each section of the chapter.
- **End-of-Chapter Materials.** The review grids provide a focused summary and illustrative examples for each section in the chapter. A comprehensive collection of review exercises for each of the chapter's sections follows the review grid. This is followed by a chapter test. Beginning with Chapter 2, each chapter concludes with a comprehensive collection of cumulative review exercises.
- **A Review of Introductory Algebra.** Appendix A, entitled *Are You Prepared for Intermediate Algebra?*, provides students with a fast way to review introductory algebra topics before starting the intermediate algebra portion of the book.
- **Supplements Package.** This text is supported by a wealth of supplements designed for added effectiveness and efficiency. These items are described on pages xiii through xv.

## Supplements for the Instructor

### Printed Resources

#### *Annotated Instructor's Edition (0-13-032843-X)*

- Answers to exercises on the same text page or in Graphing Answer Section.
- Graphing Answer Section contains answers to exercises requiring graphical solutions.

#### *Instructor's Solutions Manual (0-13-034328-5)*

- Step-by-step solutions for every even-numbered section exercise.
- Step-by-step solutions for every (even and odd) Check Point exercise, Chapter Review exercise, Chapter Test and Cumulative Review exercise.

#### *Instructor's Resource Manual (0-13-034319-6)*

- Notes to the Instructor
- Eight Chapter Tests per chapter (5 free response, 3 multiple choice)
- Eight Final Exams ( 4 free response, 4 multiple choice)
- Twenty additional exercises per section for added test exercises or worksheets.
- Answers to all items



## Media Resources

### *TestGen-EQ with QuizMaster-EQ (CD-ROM for IBM and Macintosh 0-13-034324-2)*

- Algorithmically driven, text specific testing program.
- Networkable for administering tests and capturing grades on-line.
- Edit or add your own questions to create a nearly unlimited number of tests and worksheets.
- Use the new “Function Plotter” to create graphs.
- Tests can be easily exported to HTML so they can be posted to the Web.

### *Computerized Tutorial Software Course Management System*

#### MathPro Explorer 4.0

- Network version for IBM and Macintosh
- Enables instructors to create either customized or algorithmically generated practice quizzes from any section of a chapter.
- Includes an e-mail function for networked users, enabling instructors to send a message to a specific student or to an entire group.
- Network based reports and summaries for a class or student and for cumulative or selected scores are available.

#### MathPro 5

- Anytime. Anywhere.
- Online tutorial with enhanced class and student management features.
- Integration of TestGen-EQ allows for testing to operate within the tutorial environment.
- Course management tracking of both tutorial and testing activity.

### *Online Options for Distance Learning*

#### WebCT/Blackboard/CourseCompass

- Prentice Hall offers three different on-line interactivity and delivery options for a variety of distance learning needs. Instructors may access or adopt these in conjunction with this text.

## Supplements for the Student

### Printed Resources

#### *Student Solutions Manual (0-13-034327-7)*

- Step-by-step solutions for every odd-numbered section exercise.
- Step-by-step solutions for every (even and odd) Check Point exercise, Chapter Review exercise, Chapter Test and Cumulative Review exercise.

#### *How to Study Mathematics*

- Have your instructor contact the local Prentice Hall sales representative.

#### *Math on the Internet: A Student's Guide*

- Have your instructor contact the local Prentice Hall sales representative.



## Media Resources

### *Computerized Tutorial Software*

#### MathPro Explorer 4.0

- Keyed to each section of the text for text-specific tutorial exercises and instruction.
- Warm-up exercises and graded Practice Problems.
- Video clips show a problem being explained and worked out on the board.
- Algorithmically generated exercises. On-line help, glossary and summary of scores.

#### MathPro 5–Anytime. Anywhere.

- Enhanced, Internet-based version of Prentice Hall's popular tutorial software.

### *Lecture Videos*

- Keyed to each section of the text.

### *Digitized Lecture Videos on CD.*

- Have your instructor contact the local Prentice Hall sales representative.

### *Prentice Hall Tutoring Center*

- Provides one-on-one tutorial assistance by phone, e-mail, or fax.

### *Companion Website*

- Offers Warm-ups, Real World Activities and Chapter Quizzes.
- E-mail results to your instructor.
- Destination links provide additional opportunities to explore other related sites.

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Robert Blitzer





# To the Student

I've written this book so that you can learn about the power of algebra and how it relates directly to your life outside the classroom. All concepts are carefully explained, important definitions and procedures are set off in boxes, and worked-out examples that present solutions in a step-by-step manner appear in every section. Each example is followed by a similar matched problem, called a Check Point, for you to try so that you can actively participate in the learning process as you read the book. (Answers to all Check Points appear in the back of the book.) Study Tips offer hints and suggestions and often point out common errors to avoid. A great deal of attention has been given to applying algebra to your life to make your learning experience both interesting and relevant.

As you begin your studies, I would like to offer some specific suggestions for using this book and for being successful in this course:

**1. Attend all lectures.** No book is intended to be a substitute for valuable insights and interactions that occur in the classroom. In addition to arriving for lecture on time and being prepared, you will find it useful to read the section before it is covered in lecture. This will give you a clear idea of the new material that will be discussed.

**2. Read the book.** Read each section with pen (or pencil) in hand. Move through the illustrative examples with great care. These worked-out examples provide a model for doing exercises in the exercise sets. As you proceed through the reading, do not give up if you do not understand every single word. Things will become clearer as you read on and see how various procedures are applied to specific worked-out examples.

**3. Work problems every day and check your answers.** The way to learn mathematics is by doing mathematics, which means working the Check Points and assigned exercises in the exercise sets. The more exercises you work, the better you will understand the material.

**4. Prepare for chapter exams.** After completing a chapter, study the summary chart, work the exercises in the Chapter Review, and work the exercises in the Chapter Test. Answers to all these exercises are given in the back of the book.

**5. Use the supplements available with this book.** A solutions manual containing worked-out solutions to the book's odd-numbered exercises, all review exercises, and all Check Points, a dynamic web page, and video tapes created for every section of the book are among the supplements created to help you tap into the power of mathematics. Ask your instructor or bookstore what supplements are available and where you can find them.



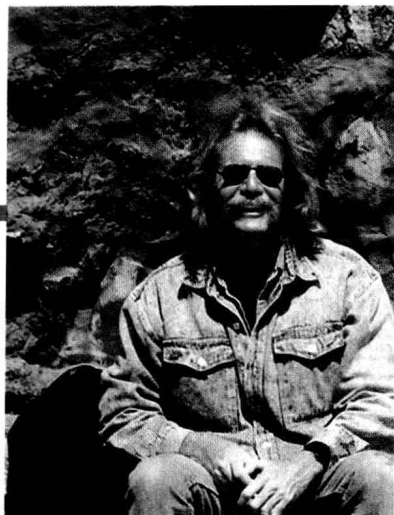
I wrote this book in Point Reyes National Seashore, 40 miles north of San Francisco. The park consists of 75,000 acres with miles of pristine surf-washed beaches, forested ridges, and bays bordered by white cliffs. It was my hope to convey the beauty and excitement of mathematics using nature's unspoiled beauty as a source of inspiration and creativity. Enjoy the pages that follow as you empower yourself with the algebra needed to succeed in college, your career, and in your life.

*Regards,*

***Bob***

Robert Blitzer

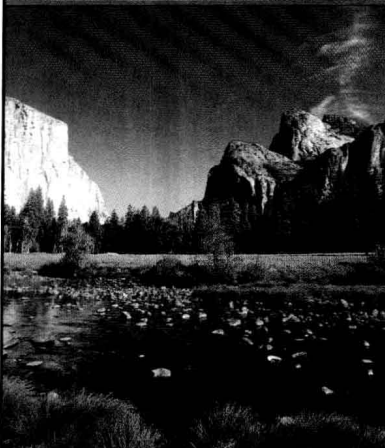




## About the Author

**Bob Blitzler** is a native of Manhattan and received a Bachelor of Arts degree with dual majors in mathematics and psychology (minor: English literature) from the City College of New York. His unusual combination of academic interests led him toward a Master of Arts in mathematics from the University of Miami and a doctorate in behavioral sciences from Nova University. Bob is most energized by teaching mathematics and has taught a variety of mathematics courses at Miami-Dade Community College for nearly 30 years. He has received numerous teaching awards, including Innovator of the Year from the League for Innovations in the Community College, and was among the first group of recipients at Miami-Dade Community College for an endowed chair based on excellence in the classroom. In addition to *Introductory and Intermediate Algebra for College Students*, Bob has written *Introductory Algebra for College Students*, *Intermediate Algebra for College Students*, *Algebra for College Students*, *Thinking Mathematically*, *College Algebra*, *Algebra and Trigonometry*, and *Precalculus*, all published by Prentice Hall.





*You are in Yosemite National Park in California, surrounded by evergreen forests, alpine meadows, and sheer walls of granite. The beauty of soaring cliffs, plunging waterfalls, gigantic trees, rugged canyons, mountains, and valleys is overwhelming. This is so different from where you live and attend college, a region in which grasslands predominate.*

**M**ost things in life depend on many variables. Temperature and precipitation are two variables that affect whether regions are forests, grasslands, or deserts. In this chapter, you will learn methods for modeling your world with inequalities. You will even see how inequalities are used to describe some of the most magnificent places in our nation's landscape.

## Chapter Openers

Every chapter opens with a photo and real-world "theme" application that is revisited later in the chapter.

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## Section Openers

Each section opens with a photo and application drawn from daily life to provide a real-life application of section topics.

### ► SECTION 9.1 Interval Notation and Business Applications Using Linear Inequalities

#### Objectives

- 1** Use interval notation.
- 2** Review how to solve linear inequalities.
- 3** Use linear inequalities to solve problems involving revenue, cost, and profit.



Driving through your neighborhood, you see kids selling lemonade. Would it surprise you to know that this activity can be analyzed using linear inequalities? By doing so, you will view profit and loss in the business world in a new way. In this section, we use linear inequalities to solve problems and model business ventures.

- 1** Use interval notation.

#### Interval Notation

Recall from Chapter 2 that any inequality in the form  $ax + b \leq c$  is called a **linear inequality in one variable**. The symbol between  $ax + b$  and  $c$  can be  $<$ ,  $>$ ,  $\leq$ , or  $\geq$ .

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### A Strategy for Solving Word Problems Using Equations

Problem solving is an important part of algebra. The problems in this book are presented in English. We must translate from the ordinary language of English into the language of algebraic equations. To translate, however, we must understand the English prose and be familiar with the forms of algebraic language. Here are some general steps we will follow in solving word problems.

#### Strategy for Solving Word Problems

**Step 1** Read the problem carefully. Attempt to state the problem in your own words and state what the problem is looking for. Let  $x$  (or any variable) represent one of the quantities in the problem.

**Step 2** If necessary, write expressions for any other unknown quantities in the problem in terms of  $x$ .

**Step 3** Write an equation in  $x$  that describes the verbal conditions of the problem.

**Step 4** Solve the equation and answer the problem's question.

**Step 5** Check the solution in the original wording of the problem, not in the equation obtained from the words.

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### Emphasis on Problem Solving

The text has been organized to emphasize problem solving.

Section 2.5 is "An Introduction to Problem Solving," and Chapter 4, "Systems of Linear Equations," fully explores problem-solving strategies.

For example,

$$(T - S)(2000) = T(2000) - S(2000) = \$10,500 - \$3400 = \$7100.$$

In 2000, the difference between total tax and state and local tax was \$7100. This is the per capita federal tax.

Figure 8.9 illustrates that information involving differences of functions often appears in graphs seen in newspapers and magazines. Like numbers and algebraic expressions, two functions can be added, subtracted, multiplied, or divided as long as there are numbers common to the domains of both functions. The common domain for functions  $T$  and  $S$  in Figure 8.9 is

$$\{1900, 1901, 1902, 1903, \dots, 2000\}.$$

page 533

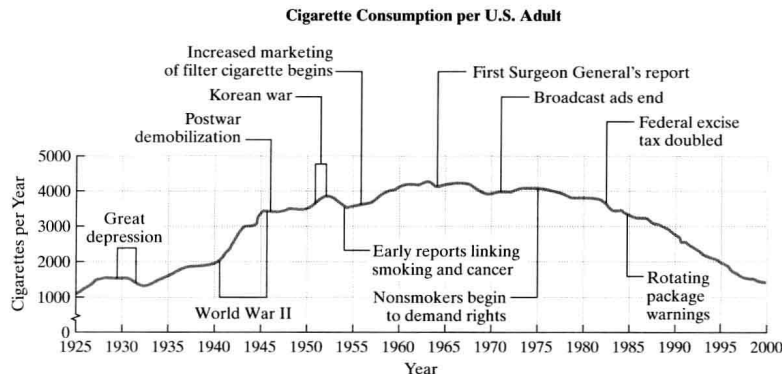
### Voice Balloons

*Voice Balloons* call out key problem-solving tips and observations to clarify the problem-solving process.

### Relevant Applications

Over 90% of the applications and many of the examples have been written to incorporate current, real-world data drawn from familiar sources, such as the Statistical Abstract published by the U.S. Census Bureau.

The graph shows cigarette consumption per U.S. adult from 1925 through 2000. The data from 1960 through 2000 can be modeled by the formula  $y = -3.1x^2 + 51.4x + 4024.5$ , where  $x$  represents years after 1960 and  $y$  represents cigarette consumption per U.S. adult. Use the formula to solve Exercises 93–94.



Source: U.S. Department of Health and Human Services

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## Critical Thinking Exercises

A wide array of exercises help students check concept mastery.



## Critical Thinking Exercises

69. Which one of the following statements is true?
- The equation  $3(x + 4) = 3(4 + x)$  has precisely one solution.
  - The equation  $2y + 5 = 0$  is equivalent to  $2y = 5$ .
  - If  $2 - 3y = 11$  and the solution to the equation is substituted into  $y^2 + 2y - 3$ , a number results that is neither positive nor negative.

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## Writing in Mathematics

- How do you determine whether an ordered pair is a solution of an equation in two variables,  $x$  and  $y$ ?
- Explain how to find ordered pairs that are solutions of an equation in two variables,  $x$  and  $y$ .

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## Writing in Mathematics Exercises

This text provides numerous exercises that ask students to explain concepts in their own words—providing reinforcement and encouraging acquisition of a mathematical vocabulary.

## Discover for Yourself

Obtain a second point in Example 4 by writing the slope as follows:

$$-\frac{2}{5} \text{ can be expressed as } \frac{-2}{5} \text{ or } \frac{2}{-5}. \quad m = \frac{2}{-5} = \frac{\text{Rise}}{\text{Run}}.$$

Obtain a second point in Figure 3.27 by moving *up* 2 units and to the *left* 5 units, starting at  $(0, 0)$ . What do you observe once you graph the line?

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## Discover for Yourself Boxes

Discover for Yourself boxes encourage students to actively participate in the learning process as they read the book.

## Study Tip

Try to avoid the following common errors that can occur when simplifying exponential expressions.

Correct	Incorrect	Description of Error
$\frac{2^{20}}{2^4} = 2^{20-4} = 2^{16}$	$\frac{2^{20}}{2^4} = 2^5$	Exponents should be subtracted, not divided.
$-8^0 = -1$	$-8^0 = 1$	Only 8 is raised to the 0 power.
$\left(\frac{x}{5}\right)^2 = \frac{x^2}{5^2} = \frac{x^2}{25}$	$\left(\frac{x}{5}\right)^2 = \frac{x^2}{5}$	The numerator and denominator must both be squared.

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## Study Tips

Study Tips make mathematical content more accessible to the student.



## Check Points

Each example is followed by an exercise that provides for a more interactive text and gives students the opportunity to work with a concept as soon as they have learned it.

### EXAMPLE 6 An Application of Subtraction Using the Word “Difference”

The bar graph in Figure 1.17 shows that in 1995, Social Security had an annual cash surplus of \$233 billion. By 2020, this amount is expected to be a negative number—a deficit of \$244 billion. What is the difference between the 1995 surplus and the projected 2020 deficit?

#### Solution

$$\begin{array}{ccccccc} \text{The difference} & & \text{is} & & \text{the 1995} & & \text{minus} & & \text{the 2020} \\ & & & & \text{surplus} & & & & \text{deficit.} \\ & & = & & 233 & & - & & (-244) \\ & & = & & 233 + 244 & = & 477 \end{array}$$

The difference between the 1995 surplus and the projected 2020 deficit is \$477 billion. ■

✓ **CHECK POINT 6** The peak of Mount Everest is 8848 meters above sea level. The Marianas Trench, on the floor of the Pacific Ocean, is 10,915 meters below sea level. What is the difference in elevation between the peak of Mount Everest and the Marianas Trench?

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## CHAPTER 8 GROUP PROJECTS

1. Consult an almanac, newspaper, magazine, or the Internet to find data displayed in the style of Figure 8.9 on page 532 or in Exercises 53–56 in Exercise Set 8.2 on page 539. Using the two graphs that group members find most interesting, introduce two or more functions that are related to the graphs. Then write and solve a problem involving function addition and function subtraction for each selected graph.
2. Group members should consult an almanac, newspaper, magazine, or the Internet and return to the group with data that have a variable that is first decreasing and then increasing over time, or vice versa. The group should select the two most interesting data sets. For each set selected:
  - a. Identify three data points and use the function  $y = ax^2 + bx + c$  to model the data. Let  $x$  represent the number of years after the first year in the data set.
  - b. Use the quadratic function to make a prediction about what might occur in the future.
3. The group should write three original word problems that can be solved using a system of linear equations in three variables. Each problem should be on a different topic. The group should turn in the three problems and their algebraic solutions.
4. Turn on your computer and read your e-mail or write a paper. When you need to do research, use the Internet to browse through art museums and photography exhibits. When you need a break, load a flight simulator program and fly through a photorealistic computer world. As different as these experiences may be, they all share one thing—you're looking at images based on matrices. Matrices have applications in numerous fields, including the new technology of digital photography in which pictures are represented by numbers rather than film. Members of the group should research

## Chapter Projects and Group Activities

Extended applications conclude each chapter. Some activities feature related Websites for student research and exploration.

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## Review Exercises

In Exercises 75–76, insert either  $<$  or  $>$  in the box between each pair of numbers to make a true statement.

75.  $-24 \square -20$  (Section 1.2, Example 6)

76.  $-\frac{1}{3} \square -\frac{1}{5}$  (Section 1.2, Example 6)

77. Simplify:  $-9 - 11 + 7 - (-3)$ . (Section 1.6, Example 3)

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## Review Exercises

Review Exercises in section exercise sets are cross-referenced back to an example in the text—giving students a pattern for problem solving.

## CHAPTER SUMMARY, REVIEW, AND TEST

### SUMMARY

#### DEFINITIONS AND CONCEPTS

#### EXAMPLES

#### Section 8.1 Introduction to Functions

A relation is any set of ordered pairs. The set of first components of the ordered pairs is the domain and the set of second components is the range. A function is a relation in which each member of the domain corresponds to exactly one member of the range. No two ordered pairs of a function can have the same first components and different second components.

The domain of the relation  $\{(1, 2), (3, 4), (3, 7)\}$  is  $\{1, 3\}$ . The range is  $\{2, 4, 7\}$ . The relation is not a function: 3, in the domain, corresponds to both 4 and 7 in the range.

If a function is defined as an equation, the notation  $f(x)$ , read “ $f$  of  $x$ ” or “ $f$  at  $x$ ,” describes the value of the function at the number, or input,  $x$ .

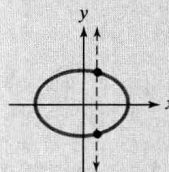
$$\begin{aligned}\text{If } f(x) &= 7x - 5, \text{ then} \\ f(a + 2) &= 7(a + 2) - 5 \\ &= 7a + 14 - 5 \\ &= 7a + 9.\end{aligned}$$

The graph of a function is the graph of its ordered pairs.

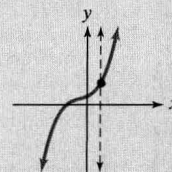
#### The Vertical Line Test for Functions

If any vertical line intersects a graph in more than one point, the graph does not define  $y$  as a function of  $x$ .

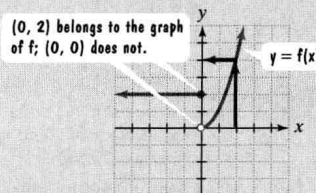
At the left or right of a function's graph, you will often find closed dots, open dots, or arrows. A closed dot shows the graph ends and the point belongs to the graph. An open dot shows the graph ends and the point does not belong to the graph. An arrow indicates the graph extends indefinitely.



Not the graph of a function



The graph of a function



To find  $f(2)$ , locate 2 on the  $x$ -axis. The graph shows  $f(2) = 4$ .

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