INTRODUCTORY ALGEBRA
for College Students

Third Edition

Robert Blitzer

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INTRODUCTORY ALGEBRA FOR COLLEGE STUDENTS

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Preface

Introductory Algebra for College Students, Third Edition, provides comprehensive, in-depth coverage of the topics required in a one-term course in beginning or introductory algebra. The book is written for college students who have no previous experience in algebra and for those who need a review of basic algebraic concepts. The primary goals of the Third Edition are to help students acquire a solid foundation in the basic skills of algebra and to show how algebra can model and solve authentic real-world problems.

Writing the Third Edition

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 the Third Edition.

"I can't follow the explanations."   For many of my students, textbook explanations are too compressed. The chapters in the Third Edition have been extensively rewritten to make them more accessible. I have paid close attention to ensuring that the amount of detail and depth of coverage is appropriate for an introductory college algebra course. Every section has been rewritten to contain a better range of simple, intermediate, and challenging examples. Voice balloons allow for more specific annotations in examples, further clarifying procedures and concepts. A more open format gives the book a less crowded look than the Second Edition.

"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. Most data from the previous edition have been replaced to include data that extend as far up to the present as possible. I selected all updated 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.

New to the Third Edition

The Third Edition is a significant revision of the Second Edition, with increased emphasis on the relevance of algebra in everyday aspects of students' lives. In addition to the book's new open look, the expanded explanations, and the updated real-world data, you will find the following new features in the Third Edition.

Readability and Level. The chapters have been extensively rewritten to make them more accessible. The Third Edition pays close attention to ensuring that the amount of detail and depth of coverage is appropriate for a liberal arts college algebra course. Every section has been rewritten to contain a better range of simple, intermediate, and challenging examples. Voice balloons allow for more specific annotations in examples, further clarifying procedures and concepts for students.

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.

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. Answers to all Check Points are given in the answer section.

Updated Real-World Data. Real-world data is used to bring relevance to examples, discussions, and applications. Real-world data from the previous edition has been replaced to include data that extends as far up to the present as possible. Updated real-world data was selected on the basis of being interesting and intriguing to students.

Reorganized Exercise Sets. An extensive collection of exercises is included in an exercise set at the end of each section. The Third Edition organizes exercises by level within six category types: Practice Exercises, Application Exercises, Writing in Mathematics, Critical Thinking Exercises, Technology Exercises, and Review Exercises. This format makes it easy to create well-rounded homework assignments. Many new exercises have been added, with attention paid to making sure that the practice and application exercises are appropriate for the level and graded in difficulty.

Rewritten Exercise Sets. In order to update applications and take them to a new level, most application problems from the previous edition have been replaced with new exercises. At the same time, applications were carefully chosen to avoid readers becoming overwhelmed by an excessive number of options. Expanded 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 exercises now contains the section number and example number of a similar worked-out example.

Expanded Supplements Package. The Third Edition is supported by a wealth of supplements designed for added effectiveness and efficiency. These items are described on pages xii through xiv.

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 now organized by each section of the chapter.

Preserved and Expanded from the Second Edition. The features described below that helped make the Second Edition so popular continue in the Third Edition.

- **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.** Chapter 3 on problem solving contains a section that 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.

- **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.

- **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.

- **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.

- **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.

- **End-of-Chapter Materials.** The new 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.

Supplements for the Instructor

Printed Resources

Annotated Instructor's Edition (0-13-032841-3)

- 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 (0-13-034309-9)

- 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 (0-13-034300-5)

- 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 0-13-034305-6)

- 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.
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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 (0-13-034308-0)

- 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.
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- Keyed to each section of the text.

Digitized Lecture Videos on CD.

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

Prentice Hall Tutor 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.

Acknowledgments

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Robert Blitzer
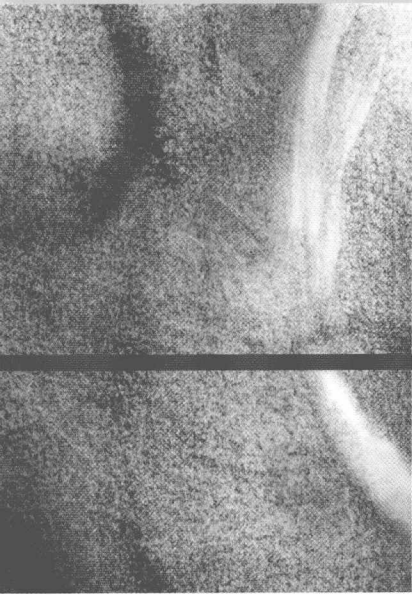
To the Student

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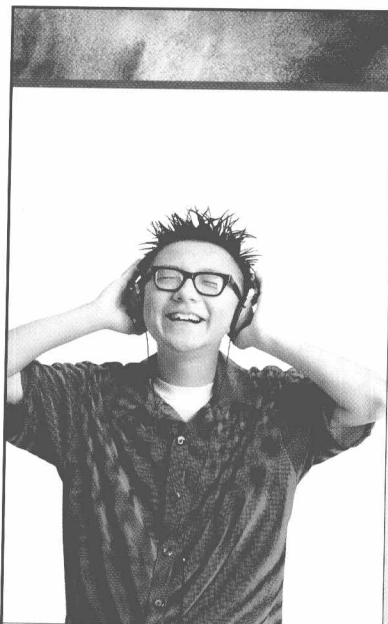
4. Prepare for chapter exams. After completing a chapter, study the summary chart, work the exercises in the Chapter Review, and work the exercises in the Chapter Test. Answers to all these exercises are given in the back of the book.

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.
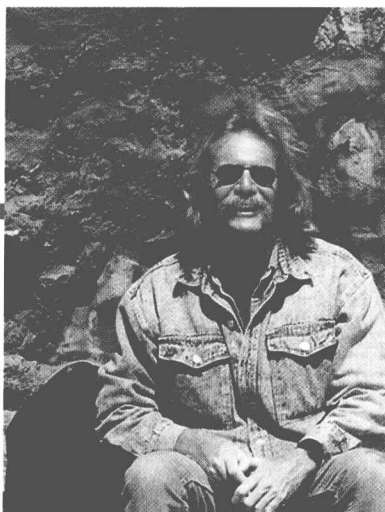
About the Author

Bob Blitzer 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 for an endowed chair based on excellence in the classroom. In addition to *Introductory Algebra for College Students*, Bob has written *Intermediate Algebra for College Students, Introductory and Intermediate Algebra for College Students, Algebra for College Students*, *Thinking Mathematically*, *College Algebra*, *Algebra and Trigonometry*, and *Precalculus*, all published by Prentice Hall.

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

page 101

*I*n 1999, prescription drug spending in the United States was $125 billion. The bitter cost of better pills can be modeled by a formula that predicts spending will exceed $250 billion by 2008. Formulas can be used to explain what is happening in the present and to make predictions about what might occur in the future. In this chapter, you will learn to use formulas in new ways that will help you to recognize patterns, logic, and order in a world that can appear chaotic to the untrained eye.

Listening to the radio on the way to work, you hear candidates in the upcoming election discussing the problem of the rising cost of prescription drugs. With millions of baby boomers pushing 60 and new drugs coming on the market, our nation's drug tab is headed for the stratosphere.
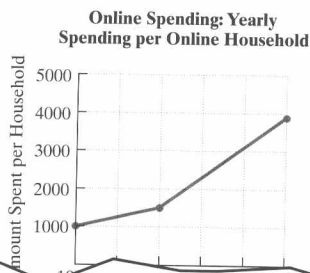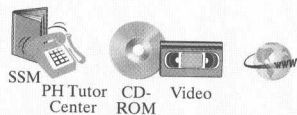
New Section Openers

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

▶ **SECTION 4.3** *Slope*

Objectives

1 Compute a line's slope.

2 Use slope to show that lines are parallel.

3 Calculate rate of change in applied situations.

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Online Spending: Yearly Spending per Online Household

Amount Spent per Household

5000
4000
3000
2000
1000

Good news: Projections indicate that in the next decades we'll live longer and move somewhere warmer where we'll shop online and chat on our tiny video cell phones. Figure 4.17 shows projected online shopping per U.S. online household through 2004. The graph is composed of two line segments. The segment on the right is steeper than the one on the left. This shows that online shopping is expected to increase more per year in 2001–2004 than in 1999–2001.

Data often fall on or near a line. In this section, we will study the idea of a line's steepness from a mathematical perspective.

The Slope of a Line

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.

Adding and Subtracting Variable Terms On Both Sides of an Equation

In some equations, variable terms appear on both sides. Here is an example:

$$4x = 7 + 3x.$$

A variable term, 4x, is on the left side.   A variable term, 3x, is on the right side.

Revised and Relevant Applications

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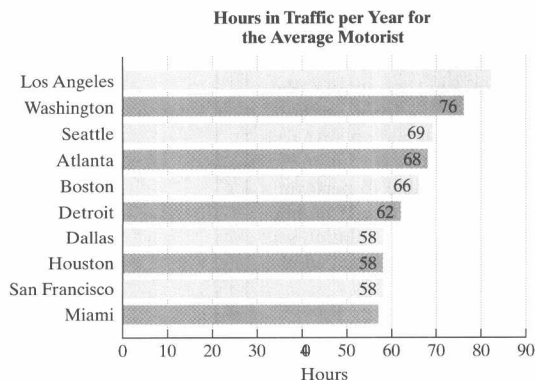
Emphasis on Problem Solving

The text has been reorganized to emphasize problem solving. Section 2.5 is now "An Introduction to Problem Solving," and Chapter 3, "Problem Solving," fully explores problem-solving strategies.

Voice Balloons

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

37. Each year, Americans in 68 urban areas waste almost 7 billion gallons of fuel sitting in traffic. The bar graph shows the number of hours in traffic per year for the average motorist in ten cities. The average motorist in Los Angeles spends 32 hours less than twice that of the average motorist in Miami stuck in traffic each year. In the two cities combined, 139 hours are spent by the average motorist per year in traffic. How many hours are wasted in traffic by the average motorist in Los Angeles and Miami?

Hours in Traffic per Year for the Average Motorist

City	Hours
Los Angeles	
Washington	76
Seattle	69
Atlanta	68
Boston	66
Detroit	62
Dallas	58
Houston	58
San Francisco	58
Miami	

Source: Texas Transportation Institute

A wider array of exercises help students check concept mastery.

62. Which one of the following is true?
  a. The graph of $y = 3x + 1$ looks exactly like the graph of $y = 2x$, but shifted up 1 unit.
  b. The graph of any equation in the form $y = mx + b$ passes through the point $(0, b)$.
  c. The ordered pair $(3, 4)$ satisfies the equation
  $$2y - 3x = -6.$$
  d. If $(2, 5)$ satisfies an equation, then $(5, 2)$ also satisfies the equation.

Writing in Mathematics

75. Explain what it means to solve for a variable in a formula.

76. What is a percent?

77. Describe how to express a decimal number as a percent and give an example.

78. Describe how to express a percent as a decimal number and give an example.

79. What does the percent formula, $A = PB$, describe? Give an example of how the formula is used.

80. Describe one way in which you use percents in your daily life.

Writing in Mathematics Exercises

The new editions provide even more exercises that ask students to explain concepts in their own words—providing reinforcement and encouraging acquisition of a mathematical vocabulary.

Discover for Yourself Boxes

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

Discover for Yourself

As a partial check, select one number from the solution set for the inequality in Example 5. Substitute that number into the original inequality. Perform the resulting computations. You should obtain a true statement.

Is it possible to perform a partial check using a number that is not in the solution set? What should happen in this case? Try doing this.

Study Tip

You can solve
$$7x + 15 \geq 13x + 51$$
by isolating x on the right side. Subtract $7x$ from both sides:
$$7x + 15 - 7x$$
$$\geq 13x + 51 - 7x$$
$$15 \geq 6x + 51.$$
Now subtract 51 from both sides:
$$15 - 51 \geq 6x + 51 - 51$$
$$-36 \geq 6x.$$
Finally, divide both sides by 6:
$$\frac{-36}{6} \geq \frac{6x}{6}$$
$$-6 \geq x.$$
This last inequality means the same thing as
$$x \leq -6.$$

Study Tips

Study Tips make mathematical content more accessible to the student.

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 8   An Application: Vocabulary and Age

There is a relationship between a child's vocabulary, V, and the child's age, A, in months. This relationship can be modeled by the formula

$$V + 900 = 60A.$$

Use the formula to find the vocabulary of a child at the age of 30 months.

Solution   In the formula, A represents the child's age, in months. We are interested in a 30-month-old child. Thus, we substitute 30 for A. Then we use the addition property of equality to find V, the number of words in the child's vocabulary.

$$V + 900 = 60A \qquad \text{This is the given formula.}$$
$$V + 900 = 60(30) \qquad \text{Substitute 30 for A.}$$
$$V + 900 = 1800 \qquad \text{Multiply: } 60(30) = 1800.$$
$$V + 900 - 900 = 1800 - 900 \qquad \text{Subtract 900 from both sides and solve for V.}$$
$$V = 900$$

At the age of 30 months, a child has a vocabulary of 900 words.   ∎

The points in the rectangular coordinate system in Figure 2.1 allow us to "see" the formula $V + 900 = 60A$. The x-coordinate of each point represents the child's age, in months. The y-coordinate represents the child's vocabulary. The points are rising steadily from left to right. This shows that a typical child's vocabulary is steadily increasing with age.

✔ **CHECK POINT 8**   Use the formula $V + 900 = 60A$ to find the vocabulary of a child at the age of 50 months.

CHAPTER 2 GROUP PROJECTS

1. One of the best ways to learn how to *solve* a word problem in algebra is to *design* word problems of your own. Creating a word problem makes you very aware of precisely how much information is needed to solve the problem. You must also focus on the best way to present information to a reader and on how much information to give. As you write your problem, you gain skills that will help you solve problems created by others.

   The group should design five different word problems that can be solved using an algebraic equation. All of the problems should be on different topics. For example, the group should not have more than one problem on finding a number. The group should turn in both the problems and their algebraic solutions.

2. Group members are to write a helpful list of items for a pamphlet called "A Student's Guide to Solving Linear Equations, Inequalities, and Word Problems." The pamphlet will be used primarily by students who sit, stare, and get nervous every time they are asked to solve an algebraic word problem. It will also be used by students who make errors such as these when solving equations and inequalities:

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

↻ **Review Exercises**

92. Find the absolute value: $|-13.4|$. (Section 1.2, Example 8)
93. Simplify: $7x - (3x - 5)$. (Section 1.7, Example 7)
94. Graph: $-2 \le x < 4$. (Section 2.6, Example 1)

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 4.1 Graphing Linear Equations

An ordered pair is a solution of an equation in two variables if replacing the variables by the coordinates of the ordered pair results in a true statement.

Is $(-1, 4)$ a solution of $2x + 5y = 18$?

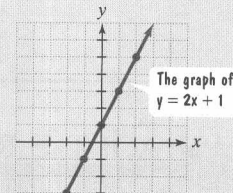$$2(-1) + 5 \cdot 4 \stackrel{?}{=} 18$$
$$-2 + 20 \stackrel{?}{=} 18$$
$$18 = 18, \text{ true}$$

Thus, $(-1, 4)$ is a solution.

One method for graphing an equation in two variables is point plotting. Find several ordered-pair solutions, plot them as points, and connect the points with a smooth curve or line.
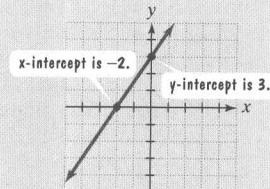
Graph: $y = 2x + 1$.

x	$y = 2x + 1$	(x, y)
-2	$y = 2(-2) + 1 = -3$	$(-2, -3)$
-1	$y = 2(-1) + 1 = -1$	$(-1, -1)$
0	$y = 2 \cdot 0 + 1 = 1$	$(0, 1)$
1	$y = 2 \cdot 1 + 1 = 3$	$(1, 3)$
2	$y = 2 \cdot 2 + 1 = 5$	$(2, 5)$

The graph of $y = 2x + 1$

Section 4.2 Graphing Linear Equations Using Intercepts

If a graph intersects the x-axis at $(a, 0)$, then a is the x-intercept.
If a graph intersects the y-axis at $(0, b)$, then b is the y-intercept.

x-intercept is -2.
y-intercept is 3.

An equation of the form $Ax + By = C$, where A, B, and C are integers, is called the standard form of the equation of a line. The

Graph using intercepts: $4x + 3y = 12$.
x-intercept: $4x = 12$
                   $x = 3$

Chapter Summaries

Chapter Summaries are organized by section and are featured at the end of every chapter to highlight important information and make it easy for students to study and master chapter content.

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