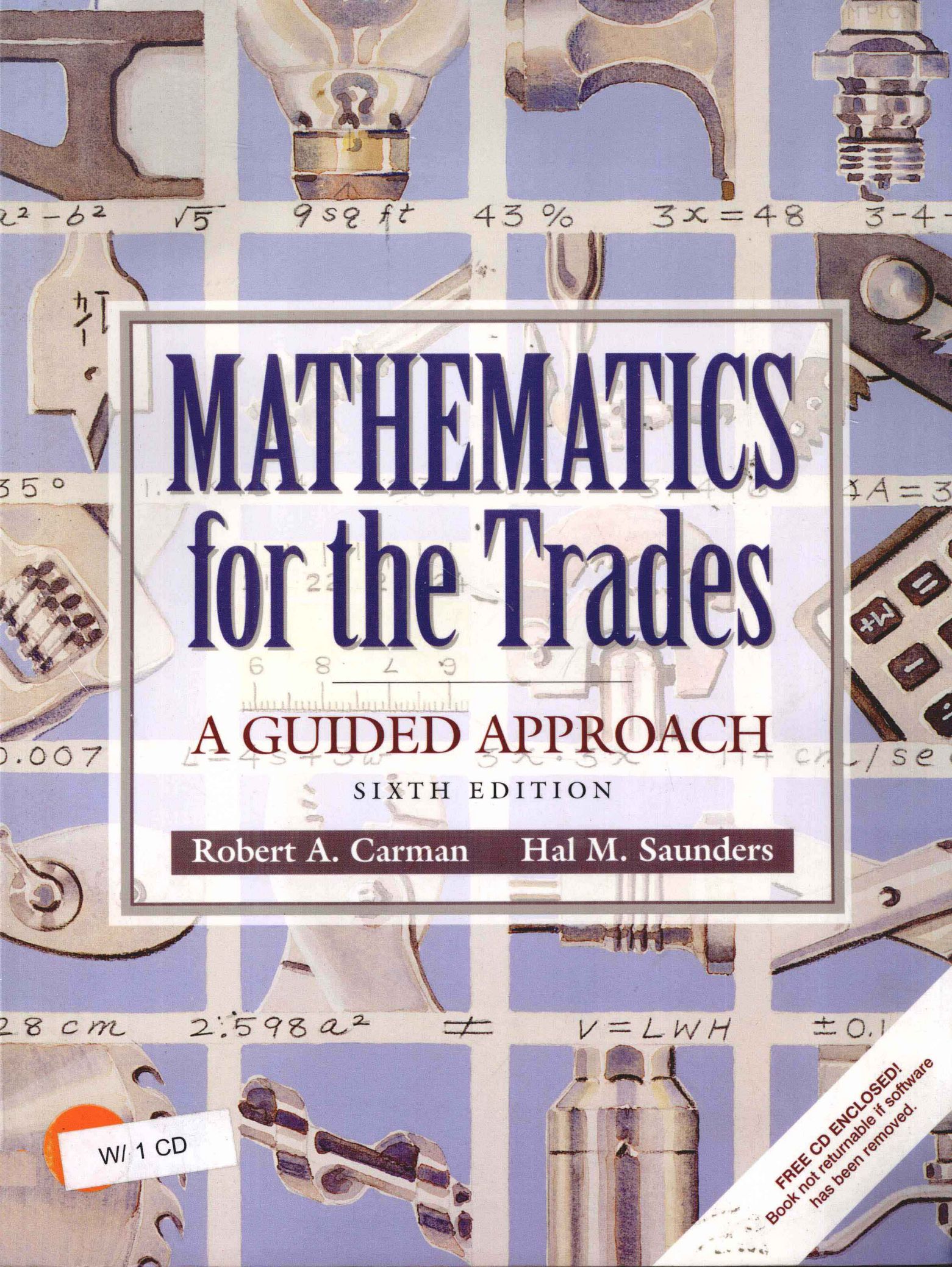

MATHEMATICS for the Trades

A GUIDED APPROACH

SIXTH EDITION

Robert A. Carman Hal M. Saunders

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SIXTH EDITION

Mathematics for the Trades

A GUIDED APPROACH

Robert A. Carman

Hal M. Saunders

Upper Saddle River, New Jersey
Columbus, Ohio

This book is dedicated to
Richie Berman
in admiration and in gratitude
for his many contributions
to mathematics education.

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Preface

This book provides the practical mathematics skills needed in a wide variety of trade and technical areas, including electronics, auto mechanics, construction trades, air conditioning, machine technology, welding, drafting, and many other occupations. It is especially intended for students who have a poor math background and for adults who have been out of school for a time. Most of these students have had little success in mathematics, some openly fear it, and all need a direct, practical approach that emphasizes careful, complete explanations and actual on-the-job applications. This book is intended to provide practical help with real math, beginning at each student's own individual level of ability.

Features

Those who have difficulty with mathematics will find in this book several special features designed to make it most effective for them:

- Careful attention has been given to **readability.** Reading specialists have helped plan both the written text and the visual organization.
- A **diagnostic pretest** and performance **objectives** keyed to the text are included at the beginning of each unit. These clearly indicate the content of each unit and provide the student with a sense of direction.
- Each unit ends with a **problem set** covering the work of the unit.
- The **format** is clear and easy to follow. It respects the individual needs of each reader, providing immediate feedback at each step to ensure understanding and continued attention. The emphasis is on *explaining* concepts rather than simply *presenting* them. This is a practical presentation rather than a theoretical one.
- Special attention has been given to **on-the-job math skills,** using a wide variety of real problems and situations. Many problems parallel those that appear on professional and apprenticeship exams. The answers to all problems are given in the back of the book.
- A light, lively **conversational style** of writing and a pleasant, easy-to-understand visual approach are used. The use of humor is designed to appeal to students who have in the past found mathematics to be dry and uninteresting.

Six editions and almost two decades of experience with a wide variety of students indicate that this approach is successful—the book works and students learn, many of them experiencing success in mathematics for the first time.

Flexibility of use was a major criterion in the design of the book. Field testing and extensive experience with the first five editions indicate that the book can be used successfully in a variety of course formats. It can be used as a textbook in traditional lecture-oriented courses. It is very effective in situations where an instructor wishes to modify a traditional course by devoting a portion of class time to independent study. The book is especially useful in programs of individualized or self-paced instruction, whether in a learning lab situation, with tutors, with audio tapes, or in totally independent study.

Calculators

Calculators are a necessary tool for workers in trade and technical areas, and we have recognized this by using calculators extensively in the text, both in finding numerical solutions to problems, including specific keystroke sequences, and in determining the values of transcendental functions. We have taken care to first explain all concepts and problem solving without the use of the calculator and to estimate and check answers. Many realistic problems included in the exercise sets

involve large numbers, repeated calculations, and large quantities of information and are ideally suited to calculator use. They are representative of actual trades situations where a calculator is needed. Detailed instruction on the use of calculators is included in special sections at the end of appropriate chapters or is integrated into the text.

Supplements

An extensive package of supplementary materials is available for teachers and students using this textbook:

- A StudyWizard CD-ROM (packaged with this text) provides readers with extra practice problems.
- An Instructor's Solutions Manual containing completely worked out solutions to all exercises and providing step-by-step procedures to help students learn problem-solving skills.
- Transparency Masters for over 130 illustrations, charts, and other visual materials.
- A Test Item File of approximately 1000 problem-type, multiple-choice, and fill-in questions for a full range of testing.
- The Prentice Hall Test Manager, a state-of-the art system that provides, on CD-ROM, the test item file.
- A booklet, *How to Study Technical Math,* to illustrate methods and techniques for solving a wide range of problems in technical math.

Sixth Edition

In response to suggestions from many instructors who have used earlier versions of the text, this sixth edition includes a number of substantial revisions and improvements:

- All problem sets and examples have been revised and brought up to date. A significant number of new applied problems have been added to the exercise sets, and additional worked examples have been added where needed throughout the text.
- A new, easy-to-follow format allows the student to go from information and explanation to worked examples, guided practice, and finally to exercises with immediate feedback.
- Chapter 5, *Measurement,* has been revised extensively to clarify the explanation of rounding, precision, accuracy, and significant digits. The material on unit conversion has been reorganized so that it is easier for students to follow.
- Chapter 4, *Ratio, Proportion, and Percent,* has been expanded to include more applications of ratio and proportion, and new explanation on the use of the calculator.
- All calculator examples and problems now assume the use of a standard scientific calculator with a ten-digit display.
- Instruction on solid geometric figures has been expanded.
- Explanations in the many step-by-step examples have been improved and their readability has been enhanced.

Acknowledgments

It is a pleasure to acknowledge the help of many people who have contributed to the development of this book. 'Lyn Carman spent countless hours interviewing trades workers, union leaders, apprentices, teachers, and training program directors so that their experience could be used in developing realistic problems, an effective format, and appropriate content. Her contributions were invaluable to us.

The staff of Prentice Hall provided outstanding assistance at every step of the development and production of this sixth edition. We are especially grateful to editors Steve Helba and Michelle Churma of Prentice Hall for their guidance and assistance and to Holly Henjum of Clarinda Publication Services for coordinating this edition through the production process.

We are indebted to the following teachers who read preliminary versions of the text and offered many helpful suggestions:

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This book has benefited greatly from their excellence as teachers.

Finally, through every step of the seemingly endless sequence of researching, interviewing, testing, writing, and rewriting that makes a textbook, we have benefited from the patience, understanding, and concern of our wives, 'Lyn and Chris. They have made it a better book and a more pleasant experience than we would have otherwise had.

Robert A. Carman
Hal M. Saunders

Santa Barbara, California

How to Use This Book

In this book you will find many questions, not only at the end of each chapter or section, but on every page. This textbook is designed for those who need to learn the practical math used in the trades, and who want it explained carefully and completely at each step. The questions and explanations are designed so that you can:

- Start either at the beginning or where you need to start.
- Work on only what you need to know.
- Move as fast or as slowly as you wish.
- Receive the guidance and explanation you need.
- Skip material you already understand.
- Do as many practice problems as you need.
- Test yourself often to measure your progress.

In other words, if you find mathematics difficult and you want to be guided carefully through it, this book is designed for you.

This is no ordinary book. It is not designed for browsing or casual reading. You *work* your way through it. You will be led carefully, step by step, through a worked example. After this example, you will be challenged to work through a similar problem. In the solution to these *YOUR TURN* problems, you will be guided through the explanation. Finally, you will be given a problem or a brief set of problems to check your understanding of the concepts. Answers or detailed solutions provide immediate feedback. Learning helps or hints provide additional insight.

Because we know that every person is different and has different needs, each major section of the book starts with a preview that will help you to determine the topics on which you need to work.

Most students hesitate to ask questions that nag at their understanding. They are fearful that "dumb questions" will humiliate them and reveal their lack of understanding. To relieve you of worry over dumb questions, we will ask and answer them for you. Thousands of students have taught us that "dumb questions" can produce smart students.

This textbook has been designed for students who not only will read it but will be working to achieve understanding and acquire skills.

Be alert for the following learning devices as you use this textbook.

Reference Head Within each section of a chapter when new vocabulary is introduced or when new topics are presented, **reference headings** appear in the left margin as shown here. These signals show where the new information appears. Reference heads will be useful to you when you need to locate a word, phrase, equation, or topic, or when you need to review.

Note ▶ Every experienced teacher knows that certain mathematical concepts and procedures will present special difficulties for students. To help you with these, special notes are included in the text. A large triangle (▶) and a warning word appear in the left margin to indicate the start of the comment, and another triangle (◀)

shows when it is completed. The word **NOTE**, as used at the start of this paragraph, calls your attention to conclusions or consequences that might be overlooked. The word **CAREFUL** warns you about common mistakes many students make, and the phrase **LEARNING HELP** offers an alternative explanation or helpful hint. ◀

An important feature of this textbook is the use of many worked examples and detailed problem solutions. Each example in the text is introduced with a heading like this:

EXAMPLE

In these examples we will demonstrate in detail, step by step, how to solve a typical problem using the material being studied.

YOUR TURN

After working an example, you will be invited to work on a similar problem. To identify this second step look for the *YOUR TURN* heading.

SOLUTION

After solving a *YOUR TURN* problem, you will be guided through a solution to check your work.

PROBLEMS

Finally, when you are ready to test your understanding, a short problem set is given and followed by answers or detailed solutions.

A **check icon** appears in a problem solution to remind you to check your work.

Color, boxed comments, and other graphical aids are used to highlight the important or tricky aspects of a solution, if needed.

The calculator is an important tool for the modern trades worker or technician, and we assume in this textbook that once you have learned the basic operations of arithmetic you will use a calculator. Problems in the exercise sets or examples in the text that involve the use of a scientific calculator are preceded by the calculator symbol shown here.

Solutions often include a display of the proper calculator key sequences. For example, the calculation

$$\frac{85.7 + (12.9)^2}{71.6}$$

would be shown as

85.7 (+) **12.9** (x^2) (=) (÷) **71.6** (=) → 3.5210894385

Exercises 0-1 Sample Problem Set

At the conclusion of each section of each chapter, you will find a set of problems covering the work of that section. These will include a number of routine or drill problems as well as applications or word problems. Each applied problem begins with an indication of the trades area from which it has been taken. Many of these applications have been obtained from trades workers in these areas.

Problem Set 0 Each chapter ends with a set of problems reviewing all of the material covered in the chapter.

> Important rules, definitions, equations, or helpful hints are often placed in a box like this so that they will be easy to find.

If your approach to learning mathematics is to skim the text lightly on the way to puzzling through a homework assignment, you will have difficulty with this or any other textbook. If you are motivated to study mathematics so that you understand it and can use it correctly, this textbook is designed for you.

According to an old Spanish proverb, the world is an ocean and he who cannot swim will sink to the bottom. A study published by the U.S. Office of Education revealed that two-thirds of the skilled and semiskilled job opportunities in today's labor market are available only to those who have an understanding of the basic principles of arithmetic, algebra, and geometry. If the modern world of work is an ocean, the skill needed to keep afloat or even swim to the top is clearly mathematics. It is the purpose of this book to help you learn these basic skills.

Now, turn to page 1 and let's begin.

R. A. C.
H. M. S.

Contents

	Preface	viii
	How to Use This Book	xii
CHAPTER 1	**Arithmetic of Whole Numbers**	
	PREVIEW 1	1
1-1	Working with Whole Numbers	3
	Expanded Form	4
	Addition of Whole Numbers	6
	Rounding Whole Numbers	7
	Estimating	9
1-2	Subtraction of Whole Numbers	16
1-3	Multiplication of Whole Numbers	24
	Multiplying by Zero and One	25
	Multiplying by Larger Numbers	26
	Two-Digit Multiplications	29
1-4	Division of Whole Numbers	33
	Factors	38
	Primes	39
	Prime Factors	39
1-5	Order of Operations	43
	PROBLEM SET 1	47
	Using a Calculator, I: Whole-Number Calculations	49
CHAPTER 2	**Fractions**	
	PREVIEW 2	55
2-1	Working with Fractions	57
	Numerator	58
	Denominator	58
	Proper Fraction	59
	Improper Fraction	59
	Mixed Numbers	60
	Equivalent Fractions	62
	Writing in Lowest Terms	63
	Comparing Fractions	66
2-2	Multiplication of Fractions	68
2-3	Division of Fractions	73
	Reciprocal	74
2-4	Addition and Subtraction of Fractions	79
	Addition	79
	Like Fractions	80
	Unlike Fractions	81
	Least Common Denominator	81
	Subtraction	87
	Using a Calculator, II: Fractions	91
	PROBLEM SET 2	93
CHAPTER 3	**Decimal Numbers**	
	PREVIEW 3	97
3-1	Addition and Subtraction of Decimals	99

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Place Value of Decimal Numbers 99
Expanded Form 101
Decimal Digits 102
Addition 103
Subtraction 106
3-2 Multiplication and Division of Decimal Numbers 110
Multiplication 111
Division 114
Rounding Decimal Numbers 119
Rounding During Division 121
Averages 121
3-3 Decimal Fractions 125
Repeating Decimals 128
Terminating Decimals 129
Decimal-Fraction Equivalents 130
PROBLEM SET 3 **135**
Using a Calculator, III: Decimals 139

CHAPTER 4 **Ratio, Proportion, and Percent**
PREVIEW 4 **141**
4-1 Ratio and Proportion 145
Ratio 145
Simple Equations 148
Proportions 149
Problem Solving Using Proportions 153
4-2 Introduction to Percent 157
Changing Decimal Numbers to Percents 159
Changing Fractions to Percents 160
Changing Percents to Decimal Numbers 162
Changing Percents to Fractions 163
4-3 Percent Problems 166
When P Is Unknown 166
When R Is Unknown 169
When B Is Unknown 170
4-4 Applications of Percent Calculations 174
Discount 174
Sales Tax 179
Interest 180
Commission 182
Efficiency 185
Tolerances 185
Percent Change 188
4-5 Applications of Ratio and Proportion 194
Scale Drawings 195
Similar Figures 197
Direct and Inverse Proportion 198
Gears and Pulleys 201
PROBLEM SET 4 **209**

CHAPTER 5 **Measurement**
PREVIEW 5 **215**
5-1 Working with Measurement Numbers 217
Units 217
Significant Digits 218
Precision and Accuracy 219
Addition and Subtraction of Measurement Numbers 221
Multiplication and Division of Measurement Numbers 223
Rounding Products and Quotients 226
Decimal Equivalents 227

5-2 English Units and Unit Conversion 231
Unity Fractions 233
Compound Units 237
Area 238
Volume 239
Speed 242
5-3 Metric Units 245
Length 245
Weight 249
Area 252
Volume 253
Speed 255
Temperature 256
5-4 Direct Measurements 262
Length Measurements 262
Micrometers 266
Vernier Micrometers 270
Vernier Calipers 272
Protractors 275
Meters 277
Gauge Blocks 279
PROBLEM SET 5 **285**

CHAPTER 6 **Pre-Algebra**
PREVIEW 6 **289**
6-1 Addition of Signed Numbers 291
The Meaning of Signed Numbers 291
Addition of Signed Numbers 293
Absolute Value 295
6-2 Subtraction of Signed Numbers 300
Opposites 300
Subtraction of Signed Numbers 300
6-3 Multiplication and Division of Signed Numbers 305
Multiplication of Signed Numbers 305
Rules for Multiplication 305
Division of Signed Numbers 306
6-4 Exponents and Square Roots 309
Exponents 309
Order of Operations with Exponents 312
Square Roots 313
PROBLEM SET 6 **319**

CHAPTER 7 **Basic Algebra**
PREVIEW 7 **323**
7-1 Algebraic Language and Formulas 327
Multiplication 327
Parentheses 328
Division 328
Algebraic Expressions 329
Evaluating Formulas 330
7-2 Adding and Subtracting Algebraic Expressions 338
Combining Like Terms 338
Expressions with Parentheses 340
7-3 Solving Simple Equations 345
Solution 345
Equivalent Equations 346
Solving Equations 347
7-4 Solving Equations Involving Two Operations 355
7-5 Solving More Equations and Formulas 363

Parentheses in Equations 363
Variable on Both Sides 367
Solving Formulas 372

7-6 Solving Word Problems 379
Translating English to Algebra 379
Translating Sentences to Equations 382
General Word Problems 384

7-7 Multiplying and Dividing Algebraic Expressions 389
Multiplying Simple Factors 389
Rule for Multiplication 390
Dividing Simple Factors 391
Negative Exponents 392

7-8 Scientific Notation 394
Definition of Scientific Notation 394
Converting to Scientific Notation 395
Converting from Scientific Notation to Decimal Form 396
Multiplying and Dividing in Scientific Notation 397

PROBLEM SET 7 **403**

CHAPTER 8 **Practical Plane Geometry**

PREVIEW 8 **409**

8-1 Angle Measurement 411
Labeling Angles 411
Measuring Angles 413
Classifying Angles 413
Drawing Angles 415
Angle Facts 416

8-2 Area and Perimeter of Polygons 423
Polygons 423
Perimeter 424
Quadrilaterals 425
Rectangles 427
Squares 430
Parallelograms 431
Trapezoids 434

8-3 Triangles, Hexagons, and Irregular Polygons 438
Types of Triangles 438
Pythagorean Theorem 440
Area of a Triangle 443
Hexagons 448
Irregular Polygons 452

8-4 Circles 458
Circumference 458
Parts of Circles 460
Area of a Circle 462
Rings 464

PROBLEM SET 8 **471**

CHAPTER 9 **Solid Figures**

PREVIEW 9 **477**

9-1 Prisms 479
Surface Area and Volume 481
Volume Conversion 483

9-2 Pyramids and Frustums of Pyramids 489
Pyramids 489
Frustum of a Pyramid 493

9-3 Cylinders and Spheres 497
Cylinders 497
Spheres 501

9-4	Cones and Frustums of Cones	505
	Cones	505
	Frustum of a Cone	508
	PROBLEM SET 9	**515**
CHAPTER 10	**Triangle Trigonometry**	
	PREVIEW 10	**519**
10-1	Angles and Triangles	523
	Angle Measurement	524
	Radian Measure	526
	Sectors	527
	Linear and Angular Speed	528
	Right Triangles	529
	Pythagorean Theorem	530
	Special Right Triangles	531
10-2	Trigonometric Ratios	537
	Sine Ratio	539
	Cosine Ratio	541
	Tangent Ratio	542
	Finding Values of Trigonometric Functions	544
	Angles in Degrees and Minutes	545
	Finding the Angle	545
10-3	Solving Right Triangles	547
10-4	Oblique Triangles (Optional)	555
	Oblique Triangles	555
	Law of Sines	556
	Law of Cosines	562
	PROBLEM SET 10	**569**
CHAPTER 11	**Advanced Algebra**	
	PREVIEW 11	**573**
11-1	Systems of Equations	575
	Solution by Substitution	577
	Dependent and Inconsistent Systems	580
	Solution by Elimination	582
	Multiplication with the Elimination Method	585
	Multiplying Both Equations	589
	Word Problems	591
11-2	Quadratic Equations	596
	Standard Form	597
	Solutions to Quadratic Equations	598
	Solving $x^2 - a = 0$	599
	Quadratic Formula	601
	Word Problems and Quadratic Equations	605
	PROBLEM SET 11	**611**
	Answers to Previews	**613**
	Answers	**616**
	Index	**651**
	Index of Applications	**656**

PREVIEW

Arithmetic of Whole Numbers

Objective	Sample Problems		For Help Go to Page
When you finish this unit you will be able to:			
1. Add and subtract whole numbers.	(a) $67 + 58$	_____	6
	(b) $7009 + 1598$	_____	
	(c) $82 - 45$	_____	16
	(d) $4035 - 1967$	_____	
	(e) $14 + 31 + 59 - 67 + 22 + 37 - 19$	_____	
2. Multiply and divide whole numbers	(a) 64×37	_____	24
	(b) 305×243	_____	
	(c) 908×705	_____	33
	(d) $2006 \div 6$	_____	
	(e) $7511 \div 37$	_____	
3. Do word problems with whole numbers.	**Machine Technology** A metal casting weighs 680 lb; 235 lb of metal is removed during shaping. What is its finished weight?	_____	

_____
Name

_____
Date

_____
Course/Section

4. Determine factors and prime factors.

(a) List all the factors of 12. _____ 38

(b) Write 12 as a product of its prime factors. _____ 39

5. Use the correct order of operations with addition, subtraction, multiplication, and division.

(a) $6 + 9 \times 3$ _____ 43

(b) $35 - 14 \div 7$ _____

(c) $56 \div 4 \times 2 + 9 - 4$ _____

(d) $(23 - 7) \times 24 \div (12 - 4)$ _____

(Answers to these preview problems are given in the Appendix. Don't peek.)

If you are certain that you can work *all* these problems correctly, turn to page 47 for a set of practice problems. If you cannot work one or more of the preview problems, turn to the page indicated to the right of the problem. For those who wish to master this material with the greatest success, turn to Section 1-1 and begin to work there.

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