

7th EDITION

Using & Understanding **MATHEMATICS**

A Quantitative Reasoning Approach

Jeffrey Bennett

University of Colorado at Boulder

William Briggs

University of Colorado at Denver



330 Hudson Street, NY NY 10013

CONTENTS

Preface	x
Acknowledgments	xvii
Prologue: Literacy for the Modern World	P-1

PART ONE LOGIC AND PROBLEM SOLVING

1 THINKING CRITICALLY 2

-  **ACTIVITY** Bursting Bubble 4
- 1A** Living in the Media Age 5
In Your World: Fact Checking on the Web 11
- 1B** Propositions and Truth Values 14
- 1C** Sets and Venn Diagrams 25
Brief Review: Sets of Numbers 29
- 1D** Analyzing Arguments 40
Mathematical Insight: Deductive Proof of the Pythagorean Theorem 49
- 1E** Critical Thinking in Everyday Life 54
In Your World: Beware of “Up to” Deals 60

2 APPROACHES TO PROBLEM SOLVING 68

-  **ACTIVITY** Global Melting 70
- 2A** Understand, Solve, and Explain 71
Brief Review: Common Fractions 74
Brief Review: Decimal Fractions 80
Using Technology: Currency Exchange Rates 82
In Your World: Changing Money in Foreign Countries 84
- 2B** Extending Unit Analysis 88
In Your World: Gems and Gold Jewelry 90
Brief Review: Powers of 10 92
Using Technology: Metric Conversions 95
In Your World: Save Money and Save the Earth 99
- 2C** Problem-Solving Hints 107
Mathematical Insight: Zeno’s Paradox 110

PART TWO QUANTITATIVE INFORMATION IN EVERYDAY LIFE

3 NUMBERS IN THE REAL WORLD 120

-  **ACTIVITY** Big Numbers 122
- 3A** Uses and Abuses of Percentages 122
Brief Review: Percentages 123
Brief Review: What Is a Ratio? 129
- 3B** Putting Numbers in Perspective 139
Brief Review: Working with Scientific Notation 140
Using Technology: Scientific Notation 143
- 3C** Dealing with Uncertainty 155
Brief Review: Rounding 157
Using Technology: Rounding in Excel 162

- 3D** **Index Numbers: The CPI and Beyond** 166
Using Technology: The Inflation Calculator 171
In Your World: The Chained CPI and the Federal Budget 173
- 3E** **How Numbers Can Deceive: Polygraphs, Mammograms, and More** 178

4

MANAGING MONEY

190

-  **ACTIVITY Student Loans** 192
- 4A** **Taking Control of Your Finances** 192
- 4B** **The Power of Compounding** 206
Brief Review: Powers and Roots 207
Using Technology: Powers 208
Using Technology: The Compound Interest Formula 211
Using Technology: The Compound Interest Formula for Interest Paid More Than Once a Year 215
Using Technology: APY in Excel 216
Using Technology: Powers of e 218
Brief Review: Four Basic Rules of Algebra 218
In Your World: Effects of Low Interest Rates 220
- 4C** **Savings Plans and Investments** 225
Mathematical Insight: Derivation of the Savings Plan Formula 227
Using Technology: The Savings Plan Formula 230
Using Technology: Fractional Powers (Roots) 232
In Your World: Building a Portfolio 237
- 4D** **Loan Payments, Credit Cards, and Mortgages** 244
Using Technology: The Loan Payment Formula (Installment Loans) 247
Mathematical Insight: Derivation of the Loan Payment Formula 248
Using Technology: Principal and Interest Portions of Loan Payments 249
In Your World: Avoiding Credit Card Trouble 251
In Your World: Choosing or Refinancing a Loan 255
- 4E** **Income Taxes** 262
- 4F** **Understanding the Federal Budget** 275

PART THREE PROBABILITY AND STATISTICS

5

STATISTICAL REASONING

292

-  **ACTIVITY Cell Phones and Driving** 294
- 5A** **Fundamentals of Statistics** 294
Using Technology: Random Numbers 298
- 5B** **Should You Believe a Statistical Study?** 309
In Your World: The Gun Debate: Defensive Gun Use 314
- 5C** **Statistical Tables and Graphs** 319
Using Technology: Frequency Tables in Excel 321
Using Technology: Bar Graphs and Pie Charts in Excel 325
Using Technology: Line Charts in Excel 327
- 5D** **Graphics in the Media** 333
Using Technology: Graphs with Multiple Data Sets 337
- 5E** **Correlation and Causality** 354
Using Technology: Scatterplots in Excel 359

6 PUTTING STATISTICS TO WORK 370

-  **ACTIVITY** Are We Smarter Than Our Parents? 372
- 6A** Characterizing Data 373
Using Technology: Mean, Median, and Mode in Excel 376
- 6B** Measures of Variation 386
Using Technology: Standard Deviation in Excel 392
- 6C** The Normal Distribution 397
Using Technology: Standard Scores and Percentiles in Excel 405
- 6D** Statistical Inference 408
In Your World: Is Polling Reliable? 414

7 PROBABILITY: LIVING WITH THE ODDS 424


-  **ACTIVITY** Lotteries 426
- 7A** Fundamentals of Probability 426
Brief Review: The Multiplication Principle 431
- 7B** Combining Probabilities 441
- 7C** The Law of Large Numbers 453
- 7D** Assessing Risk 464
In Your World: Terrorism, Risk, and Human Psychology 465
- 7E** Counting and Probability 474
Using Technology: Factorials 476
Brief Review: Factorials 476
Using Technology: Permutations 477
Using Technology: Combinations 479

PART FOUR MODELING

8 EXPONENTIAL ASTONISHMENT 488

-  **ACTIVITY** Towers of Hanoi 490
- 8A** Growth: Linear vs. Exponential 491
- 8B** Doubling Time and Half-Life 499
Using Technology: Logarithms 505
Brief Review: Logarithms 506
- 8C** Real Population Growth 510
In Your World: Choosing Our Fate 517
- 8D** Logarithmic Scales: Earthquakes, Sounds, and Acids 520
In Your World: Ocean Acidification 526

9 MODELING OUR WORLD 532

-  **ACTIVITY** Climate Modeling 534
- 9A** Functions: The Building Blocks of Mathematical Models 536
Brief Review: The Coordinate Plane 539
- 9B** Linear Modeling 546
Using Technology: Graphing Functions 551
In Your World: Algebra's Baghdad Connection 554
- 9C** Exponential Modeling 560
Brief Review: Algebra with Logarithms 563
Mathematical Insight: Doubling Time and Half-Life Formulas 565
In Your World: Changing Rates of Change 570

10 MODELING WITH GEOMETRY 576 **ACTIVITY** Eyes in the Sky 578

- 10A** Fundamentals of Geometry 579
Mathematical Insight: Archimedes and Pi 583
In Your World: Plato, Geometry, and Atlantis 587
- 10B** Problem Solving with Geometry 593
- 10C** Fractal Geometry 608

PART FIVE FURTHER APPLICATIONS**11** MATHEMATICS AND THE ARTS 620 **ACTIVITY** Digital Music Files 622

- 11A** Mathematics and Music 623
In Your World: Music Just for You 627
- 11B** Perspective and Symmetry 630
- 11C** Proportion and the Golden Ratio 643

12 MATHEMATICS AND POLITICS 654 **ACTIVITY** Partisan Redistricting 656

- 12A** Voting: Does the Majority Always Rule? 657
In Your World: Counting Votes—Not as Easy as It Sounds 663
- 12B** Theory of Voting 675
In Your World: The Electoral College and the Presidency 680
- 12C** Apportionment: The House of Representatives and Beyond 686
- 12D** Dividing the Political Pie 701

Credits C-1

Answers to Quick Quizzes and Odd-Numbered Exercises A-1

Index I-1