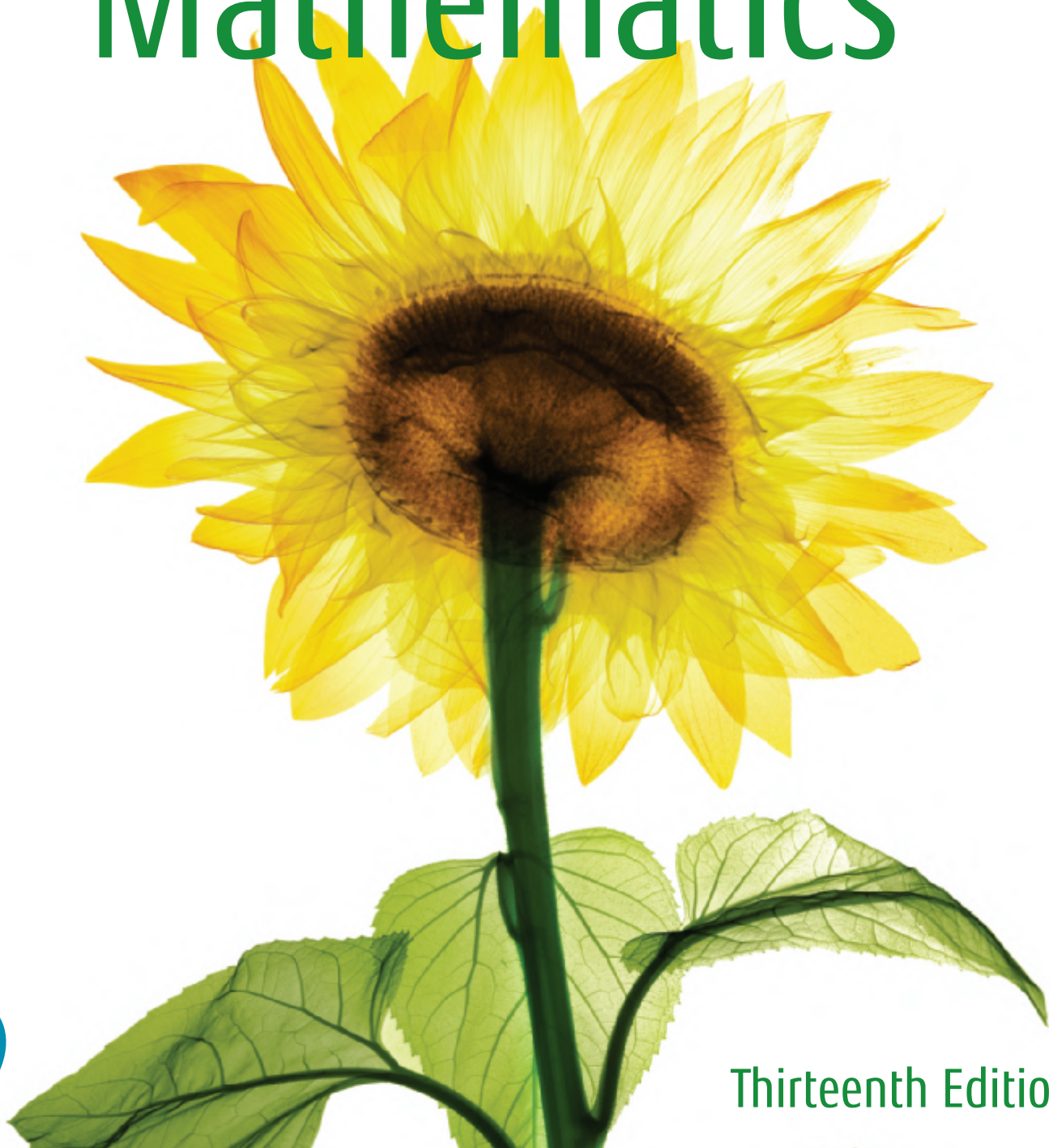


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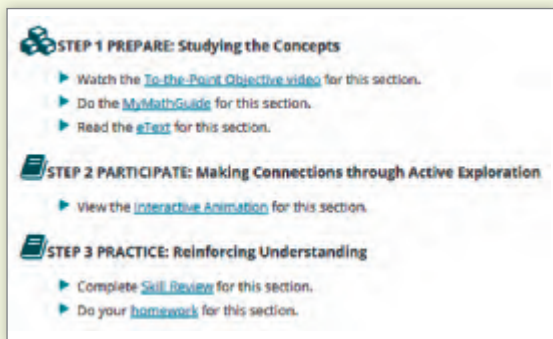


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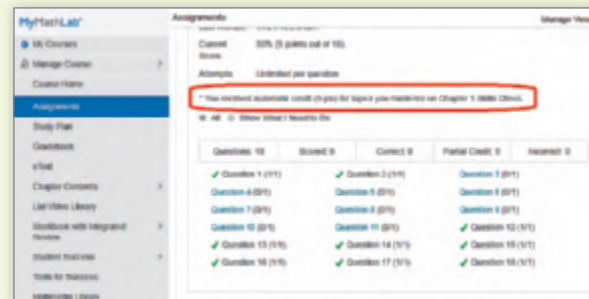
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EDITION

13

Basic College Mathematics

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Contents

Index of Activities	vi
Index of Animations	vii
Preface	ix
Index of Applications	xv

1 WHOLE NUMBERS

1

1.1	Standard Notation	2
1.2	Addition	9
1.3	Subtraction	14
1.4	Multiplication	19
1.5	Division	26
Mid-Chapter Review		35
1.6	Rounding and Estimating; Order	37
1.7	Solving Equations	48
1.8	Applications and Problem Solving	54
Translating for Success		62
1.9	Exponential Notation and Order of Operations	70
Summary and Review		78
Test		83

2 FRACTION NOTATION: MULTIPLICATION AND DIVISION

85

2.1	Factorizations	86
2.2	Divisibility	93
2.3	Fractions and Fraction Notation	99
2.4	Multiplication and Applications	109
2.5	Simplifying	115
Mid-Chapter Review		122

2.6	Multiplying, Simplifying, and Applications	124
2.7	Division and Applications	130

Translating for Success		134
Summary and Review		138
Test		143

3 FRACTION NOTATION AND MIXED NUMERALS

145

3.1	Least Common Multiples	146
3.2	Addition and Applications	153
3.3	Subtraction, Order, and Applications	160

Translating for Success		164
--------------------------------	--	------------

3.4	Mixed Numerals	168
-----	----------------	-----

Mid-Chapter Review		174
---------------------------	--	------------

3.5	Addition and Subtraction Using Mixed Numerals; Applications	176
3.6	Multiplication and Division Using Mixed Numerals; Applications	186

Translating for Success		190
--------------------------------	--	------------

3.7	Order of Operations, Complex Fractions, and Estimation	196
-----	--	-----

Summary and Review		203
---------------------------	--	------------

Test		209
-------------	--	------------

Cumulative Review		211
--------------------------	--	------------

4 DECIMAL NOTATION

213

4.1	Decimal Notation, Order, and Rounding	214
4.2	Addition and Subtraction	224

4.3	Multiplication	230
4.4	Division	238
Mid-Chapter Review		249
4.5	Converting from Fraction Notation to Decimal Notation	251
4.6	Estimating	260
4.7	Applications and Problem Solving	265

Translating for Success 270

Summary and Review 276

Test 281

Cumulative Review 283

5 RATIO AND PROPORTION 285

5.1	Introduction to Ratios	286
5.2	Rates and Unit Prices	293
5.3	Proportions	300

Mid-Chapter Review 307

5.4 Applications of Proportions 309

Translating for Success 314

5.5 Geometric Applications 320

Summary and Review 328

Test 333

Cumulative Review 335

6 PERCENT NOTATION 337

6.1	Percent Notation	338
6.2	Percent Notation and Fraction Notation	345
6.3	Solving Percent Problems Using Percent Equations	353
6.4	Solving Percent Problems Using Proportions	359

Mid-Chapter Review 365

6.5 Applications of Percent 367

Translating for Success 374

6.6 Sales Tax, Commission, and Discount 381

6.7 Simple Interest and Compound Interest; Credit Cards 390

Summary and Review 399

Test 405

Cumulative Review 407

7 DATA, GRAPHS, AND STATISTICS 409

7.1 Interpreting Data from Tables and Graphs 410

7.2 Interpreting and Drawing Bar Graphs and Line Graphs 420

7.3 Descriptive Statistics 429

Mid-Chapter Review 441

7.4 Frequency Distributions and Histograms 443

7.5 Probability 457

Translating for Success 461

Summary and Review 465

Test 471

Cumulative Review 475

8 MEASUREMENT 477

8.1 Linear Measures: American Units 478

8.2 Linear Measures: The Metric System 484

8.3 Converting Between American Units and Metric Units 491

Mid-Chapter Review 495

8.4 Weight and Mass; Medical Applications 497

8.5 Capacity; Medical Applications 505

8.6 Time and Temperature 511

8.7 Converting Units of Area 517

Translating for Success 519

Summary and Review 522

Test 527

Cumulative Review 529

9 GEOMETRY 531

9.1 Perimeter 532

9.2 Area 537

9.3 Circles 548

Mid-Chapter Review	557
9.4 Volume	559
9.5 Angles and Triangles	569
9.6 Square Roots and the Pythagorean Theorem	578

Translating for Success 582

Summary and Review 586

Test 594

Cumulative Review 597

10

REAL NUMBERS

599

10.1 The Real Numbers	600
10.2 Addition of Real Numbers	608
10.3 Subtraction of Real Numbers	614

Mid-Chapter Review 620

10.4 Multiplication of Real Numbers 622

10.5 Division of Real Numbers and Order of Operations 626

Translating for Success 632

Summary and Review 636

Test 641

Cumulative Review 643

11

ALGEBRA: SOLVING EQUATIONS AND PROBLEMS

645

11.1 Introduction to Algebra	646
11.2 Solving Equations: The Addition Principle	655
11.3 Solving Equations: The Multiplication Principle	659

Mid-Chapter Review 664

11.4 Using the Principles Together 666

11.5 Clearing Fractions and Decimals 674

11.6 Applications and Problem Solving 680

Translating for Success 689

Summary and Review 695

Test 700

Cumulative Review 702

Answers A-1

Guided Solutions A-23

Glossary G-1

Index I-1

Index of Activities

Chapter	Title
Chapter 1	Album Sales
Chapter 2	Amphibians and Reptiles in the Southwest
Chapter 3	Pizza Party Planning
Chapter 4	Cellphone Subscriptions
Chapter 5	Sales, Coupons, and Unit Prices
Chapter 6	Discounts, Price Increases, and Commission
Chapter 7	App Stores
Chapter 8	Unit Conversion and Unit Price
Chapter 9	Garden Planning
Chapter 10	American Football
Chapter 11	Pets in the United States

Index of Animations

Section	Title
1.9b	Exponential Notation
2.4a	Multiplying Fractions
3.2a	Adding Fractions
4.1d	Rounding Decimal Notation
5.5a	Similar Triangles
6.5b	Percent Increase and Percent Decrease
7.4c	Histograms
8.2a	Converting Between Metric Units
9.4a	Volume of Rectangular Solids
10.1d	Order on the Number Line
11.3a	The Multiplication Principle

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Preface

Math doesn't change, but students' needs—and the way students learn—do.

With this in mind, *Basic College Mathematics*, 13th edition, continues the Bittinger tradition of objective-based, guided learning, while integrating many updates with the proven pedagogy. These updates are motivated by feedback that we received from students and instructors, as well as our own experience in the classroom. In this edition, our focus is on guided learning and retention: helping each student (and instructor) get the most out of all the available program resources—wherever and whenever they engage with the math.

We believe that student success in math hinges on four key areas: **Foundation**, **Engagement**, **Application**, and **Retention**. In the 13th edition, we have added key new program features (highlighted below, for quick reference) in each area to make it easier for each student to personalize his or her learning experience. In addition, you will recognize many proven features and presentations from the previous edition of the program.

FOUNDATION

Studying the Concepts

Students can learn the math concepts by reading the textbook or the eText, participating in class, watching the videos, working in the *MyMathGuide* workbook—or using whatever combination of these course resources works best for them.

In order to understand new math concepts, students must recall and use skills and concepts previously studied.

- **New!** **Skill Review**, in nearly every section of the text and the eText, reviews a previously presented skill at the objective level where it is key to learning the new material. This feature offers students two practice exercises with answers. In MyLab Math, new **Skill Review Videos**, created by the Bittinger author team, offer a concise, step-by-step solution for each Skill Review exercise.

Margin Exercises with Guided Solutions, with fill-in blanks at key steps in the problem-solving process, appear in nearly every text section and can be assigned in MyLab Math.

Basic College Mathematics Video Program, our comprehensive program of objective-based, interactive videos, can be used hand-in-hand with our *MyMathGuide* workbook. **Interactive Your Turn exercises** in the videos prompt students to solve problems and receive instant feedback. These videos can be accessed at the section, objective, and example levels.

MyMathGuide offers students a guided, hands-on learning experience. This objective-based workbook (available in print and in MyLab Math) includes vocabulary, skill, and concept review—as well as problem-solving practice with space for students to fill in the answers and stepped-out solutions to problems, to show (and keep) their work, and to

write notes. Students can use *MyMathGuide* while watching the videos, listening to the instructor’s lecture, or reading the text or the eText, in order to reinforce and self-assess their learning.

Studying for Success sections are checklists of study skills designed to ensure that students develop the skills they need to succeed in math, school, and life. They are available at the beginning of selected sections.

- **New! Expanded Statistics Content** Chapter 7, Data, Graphs, and Statistics, has been revised and expanded. Beginning with tables and graphs and continuing with discussions of one-variable statistics, frequency distributions, and probability, this chapter provides students with an introduction to foundational concepts of statistics. New to this edition is coverage of measures of spread, quartiles, frequency distributions and tables, stem-and-leaf plots, construction of histograms, tree diagrams, and probability. Students completing this chapter will be better equipped to understand and analyze the data and graphs they encounter, as well as to enter an introductory statistics course.
- **New!** Section 11.5, **Clearing Fractions and Decimals**, is new to the 13th edition. This added section allows students separate and extended practice with this important skill.

ENGAGEMENT

Making Connections through Active Exploration

Since understanding the big picture is key to student success, we offer many active learning opportunities for the practice, review, and reinforcement of important concepts and skills.

- **New! Chapter Opener Applications** with infographics use current data and applications to present the math in context. Each application is related to exercises in the text to help students model, visualize, learn, and retain the math.
- **New! Student Activities**, included with each chapter, have been developed as multistep, data-based activities for students to apply the math in the context of an authentic application. Student Activities are available in *MyMathGuide* and in MyLab Math.
- **New! Interactive Animations** can be manipulated by students in MyLab Math through guided and open-ended exploration to further solidify their understanding of important concepts.

Translating for Success offers extra practice with the important first step of the process for solving applied problems. This activity is available in the text and in MyLab Math.

Calculator Corner is an optional feature throughout the text that helps students use a calculator to perform calculations and to visualize concepts.

Learning Catalytics uses students’ mobile devices for an engagement, assessment, and classroom intelligence system that gives instructors real-time feedback on student learning.

APPLICATION

Reinforcing Understanding

As students explore the math, they have frequent opportunities to apply new concepts, practice, self-assess, and reinforce their understanding.

Margin Exercises, labeled “Do Exercise . . .,” give students frequent opportunities to apply concepts just discussed by solving problems that parallel text examples.

Exercise Sets in each section offer abundant opportunity for practice and review in the text and in MyLab Math. The Section Exercises are grouped by objective for ease of use, and each set includes the following special exercise types:

- **New! Check Your Understanding** with **Reading Check** and **Concept Check** exercises, at the beginning of each exercise set, gives students the opportunity to assess their grasp of the skills and concepts before moving on to the objective-based section exercises. In MyLab Math, many of these exercises use drag-and-drop functionality.
- **Skill Maintenance Exercises** offer a thorough review of the math in the preceding sections of the text.
- **Synthesis Exercises** help students develop critical-thinking skills by requiring them to use what they know in combination with content from the current and previous sections.

RETENTION

Carrying Success Forward

Because continual practice and review is so important to retention, we have integrated both throughout the program in the text and in MyLab Math.

- **New! Skill Builder Adaptive Practice**, available in MyLab Math, offers each student a personalized learning experience. When a student struggles with the assigned homework, Skill Builder exercises offer just-in-time additional adaptive practice. The adaptive engine tracks student performance and delivers to each individual questions that are appropriate for his or her level of understanding. When the system has determined that the student has a high probability of successfully completing the assigned exercise, it suggests that the student return to the assigned homework.

Mid-Chapter Review offers an opportunity for active review midway through each chapter. This review offers four types of practice problems:

Concept Reinforcement, Guided Solutions, Mixed Review, and Understanding Through Discussion and Writing

Summary and Review is a comprehensive learning and review section at the end of each chapter. Each of the five sections—**Vocabulary Reinforcement** (fill-in-the-blank), **Concept Reinforcement** (true/false), **Study Guide** (examples with stepped-out solutions paired with similar practice problems), **Review Exercises**, and **Understanding Through Discussion and Writing**—includes references to the section in which the material was covered to facilitate review.

Chapter Test offers students the opportunity for comprehensive review and reinforcement prior to taking their instructor’s exam. **Chapter Test Prep Videos** in MyLab Math show step-by-step solutions to the questions on the chapter test.

Cumulative Review follows each chapter beginning with Chapter 3. These revisit skills and concepts from all preceding chapters to help students retain previously presented material.

Resources for Success

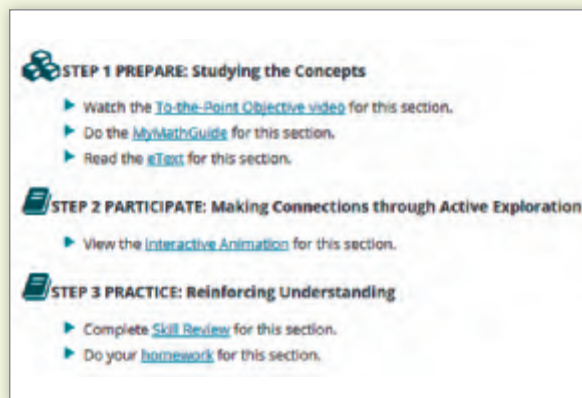
MyLab Math Online Course for Bittinger, Beecher, and Johnson, *Basic College Mathematics*, 13th Edition

(access code required)

MyLab™ Math is available to accompany Pearson's market-leading text offerings. To give students a consistent tone, voice, and teaching method, the pedagogical approach of the text is tightly integrated throughout the accompanying MyLab Math course, making learning the material as seamless as possible.

UPDATED! Learning Path

Structured, yet flexible, the updated learning path highlights author-created, faculty-vetted content—giving students what they need exactly when they need it. The learning path directs students to resources such as two new types of video: **Just-in-Time Review** (concise presentations of key topics from previous courses) and **Skill Review** (author-created exercises with step-by-step solutions that reinforce previously presented skills), both available in the Multimedia Library and assignable in MyLab Math.



STEP 1 PREPARE: Studying the Concepts

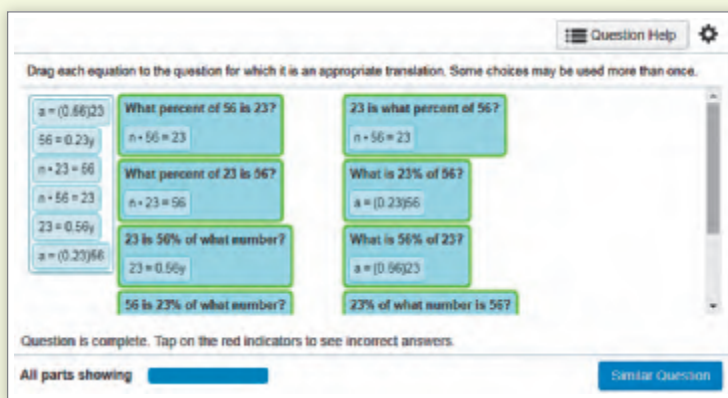
- ▶ Watch the [To-the-Point Objective video](#) for this section.
- ▶ Do the [MyMathGuides](#) for this section.
- ▶ Read the [eText](#) for this section.

STEP 2 PARTICIPATE: Making Connections through Active Exploration

- ▶ View the [Interactive Animation](#) for this section.

STEP 3 PRACTICE: Reinforcing Understanding

- ▶ Complete [Skill Review](#) for this section.
- ▶ Do your [homework](#) for this section.



Drag each equation to the question for which it is an appropriate translation. Some choices may be used more than once.

Question is complete. Tap on the red indicators to see incorrect answers.

All parts showing

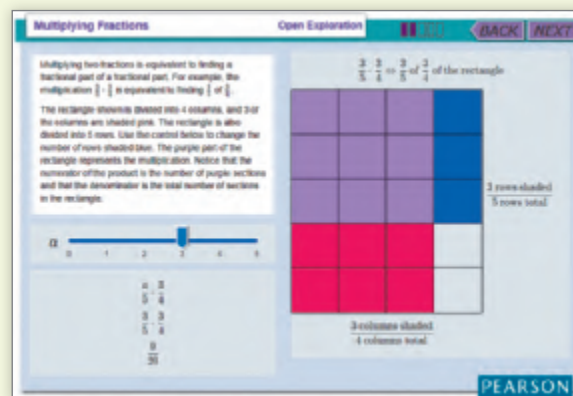
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Our goal in writing this textbook was to make mathematics accessible to every student. We want you to be successful in this course and in the mathematics courses you take in the future. Realizing that your time is both valuable and limited, and that you learn in a uniquely individual way, we employ a variety of pedagogical and visual approaches to help you learn in the best and most efficient way possible. We wish you a positive and successful learning experience.

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Judy Beecher
Barbara Johnson

Index of Applications

Agriculture

Acres planted, 270
Apple farm, 82, 144
Community garden, 159, 167
Confined feeding operations for chickens, 237
Corn production, 529
Cranberry bog, 112
Earth-moving equipment sales, 383–384
Farmland, 375
Fertilizer, 180, 292
Gardening, 192
Grain storage tank, 582
Grass seed, 192, 294, 318
Harvesting bushels of corn, 293
Harvesting walnut trees, 198–199
Honey production, 159
Hours spent farming, 643
Irrigation pipe, 190
Milk production, 159, 530
Planting corn, 164
Seed production, 530
Seeded area, 591
U.S. farmers producing peaches, 501
U.S. farmers producing pecans, 501

Astronomy

Circumference of Earth, 554
Diameter of Pluto, 703
Distance from the sun to Neptune, 8
Farthest distance of Mars from the sun, 493
Gravity of Mars, 405
Phases of the moon, 167
Planet orbits, 152
Planetary moons, 421
Planets, 417
Space shuttle orbits, 192, 336
Space travel, 254
Surface temperature on Mars, 616
Volume of a satellite, 567
Volume of Earth, 567

Automotive

Acceleration, 201
Car depreciation, 370, 376

Car sales, 644
Citations for truck drivers, 343
Driving costs, 248
Fuel economy, 448
Gallons of gasoline, 134, 314
Gas mileage, 59, 67, 98, 106, 137, 188, 193, 253–254, 258, 269, 270, 273, 279, 282, 293, 306, 315, 317, 329, 330, 333, 336, 430, 438, 468, 475, 529, 530, 556, 632
Interstate speed limits, 65
Licensed drivers, 271, 455
Motor vehicle production, 274
Odometer reading, 272
Parts for the auto industry, 343
Parts of a Toyota Camry, 99
Popular automobile colors, 349
Purchasing a new vehicle, 41
Speed limit, 493
Speeding ticket, 442, 638
Students owning a car, 475
Time a mechanic spends on a car, 530
Tread depth of a tire, 166

Biology

Animal species, 47
Bear population, 313
Beehives needed to pollinate apple trees, 82
Bees and honey, 510
Black bear cubs, 201
Bones in the hands and feet, 69
Deer population, 313
Elephant heart rate, 298
Endangered species, 415, 599, 630
Florida manatee mortalities, 599, 630
Flying speed of a red-tailed hawk, 209
Heart rates of mammals, 410–411
Heights of bearded irises, 425
Honeybees, 145, 163, 195
Insects, 475
Kangaroos, 494
Marine mammal strandings, 285, 288
Rescuing sea lions, 368–369
Rhino population, 418
Silicon in the Earth's crust, 290
Speed of a black racer snake, 297

Trout population, 318
Water in the human body, 346
Whale population, 318
Wingspan of the largest butterfly, 491

Business

Apple net income, 193
Book order, 209
Business days in a year, 143
Business trip expenses, 374
Candy company producing packages of gum, 58–59
Catering, 156
Change for a yard sale, 694
Cigarette exports, 510
Coffee production, 317
Conference expenses, 46
Copy-center account, 618
Defective valves, 476
Deli order, 190
Delivering orders, 106
Land sale, 374
Machine wrapping candy bars, 705
Mailing-list changes, 128
Membership sales, 383
Mining company, 82
Office supplies, 84
Owning a business, 476
Packaging, 81, 134, 164, 568
Pencil company, 152
Phone sales, 423
Price negotiations, 440
Producing tuxedos, 461
Publishing, 316
Quality control, 316, 331
Real estate developer, 111
Sales trip, 133, 137
Sales, 237, 284, 290, 330, 464
Selling a home without a realtor, 406
Shipping, 67
Shopping malls in the United States, 378
Sundae's Homemade Ice Cream & Coffee Co., 530
Video game industry, 476
Yard-sale profit, 66

Chemistry

Acid solution, 377
Alcohol solution, 377
Beakers of alcohol, 82
Boiling point and altitude, 516
Chemical reaction, 630, 642
Gold, 422, 556
Metallurgy, 316
Precious metals, 567
Tanzanite, 504
Temperature change in an experiment, 621
Weight of water, 192, 194, 222, 272, 526, 597

Construction

Addition to a medical clinic, 326
Addition to an athletic facility, 323
Apartment builder, 82
Board cutting, 692, 701
Brick-mason expense, 62
Building a ziggurat, 194
Building permits, 380
Carpenter drilling holes, 64
Carpentry, 158, 185, 207, 210
Carpeting, 212, 546
Ceramic tile, 112
Concrete mix, 159
Construction plans, 312
Cost of sports stadiums, 466
Crown molding, 534
Cutting rope, 164
Determining paint needs, 310, 332, 705
Drain pipe, 632
Fencing, 264, 534, 536, 556
“Flipping” houses, 619
Floor tiling, 114
Flooring, 189
Greenhouse dimensions, 171
Hancock Building dimensions, 694
Hanging a door, 336
Height of a ladder, 581, 582
Height of a wall, 325
Height of buildings, 490, 492, 528
Height of the Gateway Arch, 490
Height of Hoover Dam, 486
Height of the Washington Monument, 490
Height of towers, 4, 63, 334, 493, 494, 519
Highest bridges, 454
Houses with two-car garages, 355
Installing a rain gutter, 536
Installing a swimming-pool walk, 554
Insulation, 378
Interior design, 185
Kitchen remodeling, 703
Largest building in the world, 234
Leaning Tower of Pisa, 291

Length of a bolt, 185
Length of a wire, 596
Length of braces, 585
Lucas Oil Stadium, 11, 542
Millau viaduct, 493
Miniature air conditioning unit, 327
Nail length, 179
Norman window, 592
Painting, 23, 164, 183, 185, 190, 316, 317, 546
Palazzo hotel and casino, 521
Pipe cutting, 692
Pitch of a screw, 127, 137, 144
Plumber, 182
Pond edging, 553
Rafters of a house, 321–322, 593
Repaving a road, 142
Roof of a turret, 567
Skylight, 323
Stone bench, 184
Stone walkways, 171
Subflooring, 156
Thickness of a board and glue, 158, 207, 259
Tiles used for a sidewalk, 192
Two-by-four, 379, 692
Waterproofing a deck, 316
Widening a driveway, 178–179
Window code, 265
Window dimensions, 184, 326
Wire cutting, 211, 689, 705

Consumer

Amount spent on food, 701
Apartment rent, 632
Better buy, 558
Beverage consumption, 192, 237, 339, 420–421, 452, 634
Buying gasoline for a motor home, 77
Buying gift cards, 195
Buying video games, 69
Car rental, 692
Cell phone bill, 632
Consumer transactions, 338
Cost of gasoline, 270, 271, 510, 598
Cost with a coupon, 284
Cost, 263, 267, 268, 271, 275, 279, 282, 284, 319, 329, 374, 401, 408, 534, 536, 698, 703, 705
Coupon on a dinner bill, 380
Cruise cost, 582
Delivery truck rental, 684–685
Discount, 384, 385, 389, 403, 404, 405, 406
Electric bill, 314
Energy use, 340
Estimating cost, 260, 261, 263, 264
First-class postage, 469
Food consumption per day, 272

Gasoline usage, 519
Grocery spending, 63
Health club membership fee, 282
Highest auction price, 216
Hourly rate for repair charges, 62
Housing expenditure, 376
Online price, 314
Parking rates, 66
Paying for health care, 405
Personal consumption expenditures, 419
Planning a vacation, 45
Price of hotel rooms, 401
Prices, 404, 504, 692, 693, 699
Purchasing, 62, 66, 81, 134, 158, 261, 263, 266–267, 311
Rent, 701
Rice consumption, 221
Sale prices, 378, 385, 403, 404, 405, 679
Spending on groceries, 373
Spending on pets, 233
Spending on restaurant meals, 372–373
Taxi fares, 693
Tipping, 377, 380, 694
Total cost, 57, 261, 282
Transportation costs, 99
Transportation expenditure, 376
Travel expenses, 374
Unit price, 294, 295, 298, 299, 308, 329, 330, 331, 332, 333, 336, 408, 475, 598, 703
U.S. timberland, 510
Van rental, 692
Vegetable consumption, 470
Wasting water, 510
What Americans eat, 213

Domestic

Bake sale, 172
Baking, 158, 284
Bed sheets, 58
Bolt of fabric, 598
Cutco cutlery, 185
Cutting ribbon, 408
Fabric strips, 475
Flower vase, 140
Knitting a scarf, 134, 683–684
Mural painting, 192
Painting a decorative border, 207
Peat moss needed for rose bushes, 125
Planting flowers, 182
Quilt design, 172
Recipes, 112, 128, 142, 159, 193, 207, 211, 259, 336, 364, 475, 644
Ribbon needed to make a bow, 114, 536
Sewing, 136, 142, 183, 207
Upholstery fabric, 183

Economics

Assessed value of a house, 128
China's national debt, 237
Cost of living index, 426
Currency exchange, 221, 318, 331
Dow Jones Industrial Average, 273, 370–372, 378
Exports, 85, 128, 258
Facebook stock, 427
FICO scores, 117
Gold prices, 422
Home listing price, 691
Housing costs, 65
Imports, 237, 258
IRS driving allowance, 267–268
IRS processing income tax refunds, 233
McDonald's stock, 264
Meals tax, 403, 504
Median home prices, 439
Property taxes, 275
Real-estate values, 319
Sales tax, 381, 382, 386, 387, 401, 403, 405, 461, 536, 582, 598, 632, 689, 699
Selling price of houses, 429–430
Stock market changes, 642
Stock prices, 221, 374, 601, 618, 621, 634, 639, 693, 705
Tax freedom day, 291
Taxes, 705
Tax-exempt organization, 699
Tax-refund fraud, 379
Trade balance, 66
U.S. national debt, 237

Education

ACT scores, 446
Art departments sharing clay, 364
Associate's degrees, 142
Bachelor's degrees, 425
Books in libraries, 279
Class size, 317, 447
College acceptance, 123
College costs, 468
College enrollment, 62, 451, 455, 691
College profile, 129
College students living in dorms, 144
College tuition, 41, 164, 270, 451, 455
Course grade, 431, 432
Culinary arts department, 158
Dean's list, 644
Distance from college, 164
Enrollment in Japanese classes, 190
Exam scores, 432, 461
Foreign students, 402, 419
Full-time students working, 474
Grade point average, 431–432, 439, 468, 473
Grading, 316, 432, 439

Graduation rates, 343
Highest educational level completed, 344
Instructors at a community college, 69
Level of education and median income, 142
Master's degrees, 142
Online homework, 470
Postsecondary education, 47
Public school revenue, 446
Reading assignment, 56, 164
Research paper, 166
SAT score, 374
School fundraiser, 46
School purchasing Chromebooks, 266–267
Science knowledge scores for eighth graders, 453
Senior students, 504
Sociology assignment, 444, 449
Student ages, 705
Student debt, 453
Student-to-faculty ratio, 319
Study groups, 210
Study skills class, 452
Study time and test grades, 315
Substitute teaching, 128
Test questions, 121, 519
Test scores, 76, 375, 376, 403, 444, 447, 448, 473, 598, 688, 692, 694, 707

Engineering

Bicycle design, 323
Bridge length, 519
Channel Tunnel, 494
Coaxial cable, 137
Distance across a river, 325
Electrical wiring, 270
Electricity generation, 414
Energy consumption, 476
First stage detached from the rocket, 601
Gas pipeline, 566
Guy wire, 581
Height of a pole, 585, 593
Height of a tree, 324
Height of the Statue of Liberty, 692
Illuminated bridge, 481
Measuring the height of a hill, 325
Surveying, 585
Suspension bridge, 519

Environment

Arctic ice, 379, 597
Average rainfall, 454
Average temperature, 454
Deepest point in oceans, 642
Elevation, 601, 618, 619, 632, 642
Extreme climate, 606
Great Lakes, 568

Heat index, 416
Highest mountains, 453, 456
Hurricanes, 472
Length of a lake, 325
Length of canals, 266
Length of the Congo River, 4
Length of the Nile and Amazon Rivers, 699
Longest rivers, 64
Low points on continents, 619
Mississippi River, 375, 601
Mountain peaks in Colorado, 248
Municipal solid waste, 63
Number of trees on the planet, 233
Rainfall, 159, 287
Record snowfall, 287, 308
Snow melting to water, 317
Temperatures, 193, 512, 513, 516, 601, 606, 616, 618, 634, 644
Tornadoes, 469
Trash production, 331
Waste generated, 471
Water level, 461, 601
Wind speeds, 286
Windy cities, 258

Finance

Account balance, 69, 268–269, 270, 279, 284, 634, 644
Billionaires, 476
Borrowing money, 404
Budgets, 82, 129, 530
Change received, 272
Checking account balance, 62, 81, 134, 195, 269, 274, 275, 619, 620
Compound interest, 391, 392, 393, 397, 402, 404, 405, 406, 408, 530, 547, 598
Credit cards, 266, 377, 379, 393–395, 398, 404, 406, 619, 693
Deposit and withdrawal, 606
Disposable income, 416
Effective yield, 398
Equal shares of money, 211
Expense needs, 306
Home improvement loan, 68
Inheritance, 270, 582
Interest rates, 340, 473
Loan interest, 693
Loan payments, 62, 68, 84, 273, 427
Lottery winnings, 164, 271
Median income, 193
Mortgage payments, 46, 378
Non-cash payments, 273
Overdraft fees, 268–269, 379
Safety deposit box, 560
Savings increase, 378
Savings interest, 693
Savings investment, 705

Simple interest, 390, 391, 396, 402, 404,
405, 521, 536, 598, 632, 688, 705
Total assets, 639
Travel funds, 270
Tuition loan, 128, 284

Food

Bagged salad greens, 333
Berry salad, 156
Boxes of candy, 134
Brussel sprouts, 439
Candy bar, 99
Candy in giveaway bags, 63
Case of soda, 619
Cereal, 134, 136, 314, 317, 351,
417–418, 504
Cheese, 167, 306
Chocolate desserts, 424
Chocolate fudge bars, 190
Coffee drinks, 287
Cookies, 694
Crème de Menthe Thins, 134
Doughnuts, 26
Egg costs, 332
Favorite ice cream, 403
Flounder fillet, 229
Fudge, 306
Game snacks, 270
Gourmet sandwiches, 684
Grapes, 498
Ham servings, 333
Hamburgers, 297, 497
Hostess Ding Dongs®, 84
Ice-cream roll-up cake, 101
Iced brownies, 158
Iced tea, 144
Icing on cinnamon rolls, 167
Lean boneless ham, 267
Mangoes, 439
Maple syrup, 315
Margherita pizza, 166
Marshmallow peeps, 80
Oatmeal comparisons, 466
Organic russet potatoes, 294
Peanut products, 476
Pears, 703
Pizza, 114, 195
Popcorn, 167
Pork servings, 582
Powdered milk, 598
Serving of cheesecake, 159
Servings of fish, 194, 229, 306
Soda cans, 619
Strawberry punch, 159
Strip of taffy, 144
Sugar, 136
Swiss cheese, 195
Taco filling preferences, 121, 349

Thanksgiving dinner, 331
Tossed salad, 114
Truffles, 125
Turkey servings, 207, 316, 332
Wasting food, 377
Weight of cheese, 183
Weight of eggs, 434, 504
Weight of turkey, 183

Geometry

Angles of a triangle, 686–687, 689, 693,
699, 701
Area of a border, 545
Area of a circular region, 552, 553, 554
Area of a field, 545
Area of a kite, 542
Area of a lawn, 545
Area of a rectangular region, 23, 25,
57–58, 63, 67, 82, 84, 112, 114, 192, 273,
284, 541, 542, 545, 590, 591, 592, 644
Area of a sidewalk, 545, 554
Area of a square region, 25, 137, 552
Area of lots, 272, 314
Building area, 547
Circumference of a circle, 549, 553, 554
Diameter of a circle, 553, 554
Dimensions of a rectangular region,
184, 270, 291, 685–686, 692, 699, 701
Lengths of a carpet runner, 698
Office space area, 25
Open cardboard container, 84
Perimeter of a rectangular region, 11,
13, 67, 82, 84, 184, 273, 314, 534, 536,
582, 590, 686, 689
Perimeter of a square region, 13, 137, 536
Radius of a circle, 554
Triangular sail, 547
Volume of a circular cone, 567, 582
Volume of a cube, 567, 568
Volume of a cylinder, 566, 567, 582, 644
Volume of a medicine capsule, 563
Volume of a propane gas tank, 563
Volume of a rectangular solid, 560, 567
Volume of a sphere, 562, 566, 567, 568, 582
Volume of a submarine, 567
Width of a rectangular region, 289,
291, 308, 312, 322, 323, 689

Government

Budget for military defense, 354
Committee in the United States
Senate, 141
Federal taxes spending, 350
Library of Congress, 279
Presidential assassinations in office, 369
Presidential libraries, 494
Spending on health care, 234
Women in Congress, 341

Health/Medicine

Birth weights of triplets, 199
Blood alcohol level, 340
Blood types, 344
Body temperature, 271, 275
Brushing teeth, 136
Caffeine, 65, 158
Calcium supplement, 330
Calories, 84, 274, 287, 309, 314, 317, 334,
418, 691
Daily vitamin requirements, 351
Desirable body weights, 471
Doses of an antibiotic, 132–133
Fatal medical errors, 407
Heart disease, 476
Heights, 62, 183, 306, 314, 439
High blood pressure, 344
Human heart rate, 298
Impulses in nerve fibers, 297
Length of pregnancy, 439
Life expectancy, 216, 282
Medical dosage, 159, 500, 503, 504, 506,
507, 509, 510, 525, 526, 528
Medicine capsule, 563
Milk alternatives, 691
Multivitamin-mineral supplements, 405
Nutrition, 417–418
Organ transplants in the United States,
337, 375
Overweight Americans, 316
Patients a doctor sees in a week, 679
Physical therapists, 408
Physician specialties, 403
Prevalence of diabetes, 316
Recommended dosage, 310, 316
Rehabilitation program, 167
Sitting vs. exercising, 338
Sodium consumption, 279
Waist-to-hip ratio, 311–312
Walking laps at a health club, 210
Water output by sweating, 403
Weight loss, 60–61, 68, 274, 378, 530
Weight of a human brain, 556

Labor

Careers in medicine, 291
Commission, 383–384, 387, 388, 389,
402, 403, 404, 405, 406, 476, 530, 536,
556, 679, 698, 705
Construction pay, 274
Earnings, 142, 638
Employment growth, 297
Firefighting, 597
Government payroll, 3
Hourly wage, 279, 294
Job opportunities, 406
Labor force age 65 and older, 359
Late to work, 704

Level of education and median income, 142
Microsoft interview, 167
New jobs, 68
Nurse practitioners, 379
Pay rate, 195, 329
Police officers, 107
Raises, 404
Salaries, 319, 375, 404, 408, 433, 439, 442, 468, 679, 699, 705
Sick leave, 341
Sports salaries, 7
Summer work, 274
Take-home pay, 273
Unemployment rates, 454
U.S. armed forces, 377
Vacation days, 190
Women in the workforce, 376

Miscellaneous

Aalsmeer Flower Auction, 521
Actual time in a day, 515
Baby names, 451
Beverage choices, 452
Bird feeders, 306
Book circulation, 472
Book size, 184
Bookshelves in an office, 69
Bubble wrap, 164
Bucket holding water, 136
Candy colors, 464
Choosing a day or month at random, 464, 467
Cord of wood, 560
Do Not Call Registry, 7, 441
Dog height, 183
Dog ownership, 190
Drawing a cube out of a bag, 474
Drawing a marble from a bag, 457, 458, 460, 462, 463
Drawing mini chocolate bars out of a bag, 474
Extensions cords, 136
Fashion design, 183
First language, 346
Flipping a coin, 254, 457, 458, 463, 464, 474
Flywheel revolutions, 330
Gallon of paint, 222
Gasoline can or tank capacity, 114, 134, 137, 140
Goliath's height, 483
Grass in a yard, 273
Guessing the number of marbles in a jar, 334
Guitar design, 183
Gypsy-moth tape, 553
Hair donation, 180
Height of a billboard, 332

Height of a flagpole, 321, 324
History of Times Square Ball, 531, 566
Hours in a week, 65
Index cards, 11
Interpreters and translators, 529
Koi pond, 189
Landline phones, 343
Landscaping, 125, 137, 476
Lawn mowing, 374
Lawn watering, 298, 330
Lefties, 317
Length of rope, 598
Lincoln-head pennies, 81
Locker numbers, 689
Longest tunnels, 192
Machine stamping out washers, 336
Magic tricks, 190
Mailing labels, 66
Medals of Honor, 691
Mine rescue, 630
Minutes in a day or more, 65, 98
Mosquito netting, 541
National parks, 73–74, 291
Noah's Ark, 483
Package tape, 314
Packages in a carton, 284
Paper measures, 66
Pieces of mail, 634
Puppies and kittens, 106
Pyramid of Cheops, 585
“Rock, Paper, Scissors” game, 457, 458, 464
Rolling a die, 457, 459, 463, 464, 474
Selecting a card, 460, 462, 463, 469, 470
Selecting an audience member, 460
Shadow length, 324
Spinning a spinner, 459, 461, 463, 469
Spreadsheet entries, 64
Staplers, 84
Stringing lights around the roof of a gazebo, 536
Tank capacity, 272
Tattoos, 342
Temperature in enclosed vehicle, 423
Thermos bottle capacity, 164
Thickness of money, 492
Tiananmen Square, 137
Time length, 515
Time loss on a watch, 333
Volume of mail, 372
Water depth, 185
Winterizing a swimming pool, 183
Wire to make a spring, 133

Physics

Speed of light, 69, 297
Speed of sound, 297
Wheel revolutions, 275

Social Sciences

Accessing Facebook, 483
Banquet attendance, 46
Camp sponsorships, 632
Charity donations, 461, 632, 705
Charity work, 334
Emergency food pantry fund, 211
Foreign adoptions, 405
Fraternity or sorority membership, 689
Heifer International, 3–4
Homelessness, 469
Humane Society pie sale, 207
Languages, 99, 284, 346
Volunteering, 158
Wigs for Kids, 180
World undernourishment, 1

Sports/Entertainment

Amusement park visitors, 645
Average number of career hits, 74
Babe Ruth, 294
Baseball, 13, 25, 102, 319, 379, 449, 584
Basketball courts, 67, 686
Batting averages, 121, 257, 405, 430
Biking posture, 569
Billiard table, 536
Boston Marathon, 272
Bowling, 562
Broadway musicals, 297
Broadway shows, 2, 6
Champion women's gymnastics teams, 443
Collecting baseball memorabilia, 389
College band, 62
Concert tickets, 14
Cross-country skiing, 211
Crossword puzzle, 64, 66
Daytona International Speedway, 491
Diver's position, 634
Earned run average, 319
Everybody Loves Raymond episodes, 66
Field hockey, 291
500 Festival Mini-Marathon, 691
Fly fishing, 185
Football, 112, 491
Free throws, 308
Golf, 306, 341, 568
Grand slam tennis tournaments, 450
Guitarist, 159
Hank Aaron, 440
Height of basketball players, 493
Hiking, 159, 201
The Hobbit: An Unexpected Journey, 315
Hockey, 13, 25, 327
Home runs, 319
Ice-skating rink, 123
Indianapolis 500, 193, 221, 249
Jogging, 175

Lacrosse field, 341, 685–686
Los Angeles Lakers points per game, 454
Major League World Series, 443
Marathon training, 461
Media usage, 287
Men's 4 × 100 meter medley relay team, 214
Men's long-jump world records, 179
Men's soccer: high school to pro, 114
Mountain climbing, 167
Movie opening revenues, 272
Movie theater tickets, 440, 701
Movies released, 331, 440
Museum attendance, 408, 438
NASCAR racing, 7
National park visitation, 640
NBA, 288, 408
Olympic marathon, 491
Olympic trampoline, 82
100-meter dash, 491
Photography Club, 128, 476
Playing games, 175
Points scored in a basketball game, 431, 454
Pole vault pit, 273
Pool tables, 23, 84
Purchasing tickets to a food festival, 310–311
Radio and television stations, 6, 483
Raffle tickets, 190
Roller coasters, 28, 413, 519, 687–688
Roller-rink floor, 554
Running, 207, 208, 216, 683
Seinfeld episodes, 66
Set of weights, 378
Soccer, 319, 336
Softball diamond, 584
Sports equipment, 106
State parks in the United States, 5
Strikeouts per home run, 294, 306
Summer Olympics, 4–5, 64
Super Bowl TV viewership, 634
Swimming, 164, 166
Television game show winners, 644
Tennis court, 590, 593
Tickets to a campus theater production, 329
Top movie in theater revenue, 249
Touchdown passes, 442
Training regimens, 188
Trampoline, 554
Triathlon, 159
Vertical leaps, 201
Walkathon, 211
Walking distance, 210, 374, 408, 598, 644, 705
Walking rate, 334
Weight of wrestlers, 248

Women's basketball: high school to pro, 114
Women's dunks, 210
World running records, 494, 526, 528
Yardage gained or lost, 601, 640

Statistics/Demographics

Americans eating chocolate, 278
Area of Colorado, 4, 77
Area of Lake Ontario, 692
Area of oceans, 8, 237
Area of Russia, 278
Areas of the New England states, 258
Birth rate, 221
Boundaries between countries, 64
Centenarians, 379
Change in population, 374
City population, 47, 193, 205
Colonial population, 65
Countries in Africa, 102
Dimensions of Wyoming, 698
Foreign-born population, 99, 338
Growth in digital play, 344
Island population, 689
Largest states, 84
Lawyers per capita, 331
Living veterans, 377
Longevity beyond age 65, 428
Median age, 215
Most populous countries in the world, 7
Percentage of kids believing they are too fat, 456
Percentage of people living in Asia, 405
Population decrease, 408
Population density, 244, 296, 411–412
Population, 380, 504, 519, 634, 642, 705
Residents age 14 or younger, 343
Smoking cigarettes, 351
State populations, 192, 205
States east of the Mississippi River, 107
States north of Nashville, Tennessee, 107
Survey on favorite milkshake flavor, 355
Survey results, 444–446, 450
Tallest mountain in the world, 619
Urban population, 338
U.S. population by age, 351, 421, 529
World population, 5, 274, 281, 338, 375

Technology

Apps, 634
Digital downloads, 464
HDTV screen, 289
Internet usage and Smartphone ownership, 468

iRobot Roomba, 214
Pixels, 64
Robocalls, 233–234
Scanning blueprints, 282
Scanning posters, 279
Video games, 55
Websites, 3
Word processing, 194

Transportation

Airplane seating configuration, 68
Airplane's distance, 585
Airport control tower, 691
Bicycle paths, 133
Bicycling, 134, 190, 317
Buses needed for a field trip, 34
Busiest airport, 7
Busiest U.S. ports, 254
Car travel, 336
Carry-on luggage, 560
City driving, 296
Commuting time, 426
Cruise vacations, 384
Cycling in Vietnam, 682–683
Distance between cities, 329, 491, 493
Distance from a city, 183, 229
Driving distance, 519
Gotthard Base Tunnel, 492
Highway driving, 296
Highway routes, 272
Length of trip, 142, 705
Long airline flights, 137
Longest railway tunnels, 477
Map drawing, 67
Map scaling, 128, 318, 334, 408
Miles driven, 272, 317, 430, 530
Nonstop flight, 183
Pacific Coast Highway, 492
Panama Canal expansion, 343
Passports, 634
Pedestrian paths, 481
Predicting total distance, 309
Rail miles, 461
Rate (speed), 294, 297, 298
Segway® tour, 158
Spending on the interstate highway system, 233
State highway beautification project, 158
Submarine depth, 601
Summer vacation destination, 141
Sunken ships, 606
Traffic congestion delays, 409, 438
Train travel, 331
Transportation to work, 367–368
Travel distance, 56, 63, 133, 142, 179, 188, 333
Vacation miles, 461

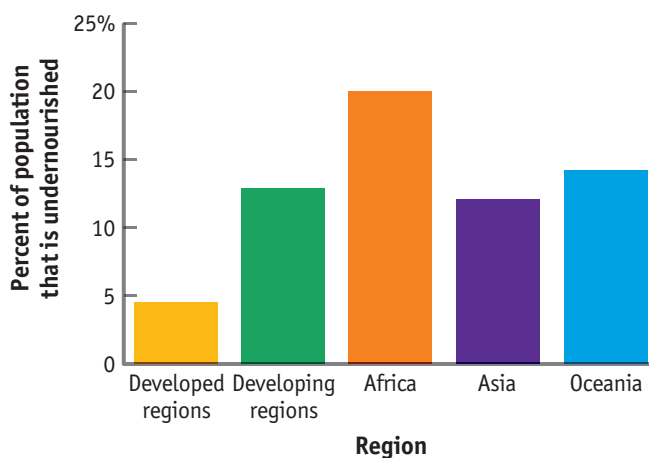


Whole Numbers

Many people around the world lack access to clean water or to sufficient food. Approximately 663 million people, or 9% of the world's population, drink water that is not clean.

Hunger is a reality for even more people: 10% of the world's population lacks sufficient nourishment. As the graph indicates, some regions of the world are more affected by undernourishment than others.

World Undernourishment



DATA: worldhunger.org

DATA: charitywater.org; actionagainsthunger.org; stopthehunger.com

In Example 8 and Margin Exercise 9 of Section 1.1, we will examine the numbers of families helped by one charity that seeks to alleviate hunger.

- 1.1 Standard Notation
- 1.2 Addition
- 1.3 Subtraction
- 1.4 Multiplication
- 1.5 Division

Mid-Chapter Review

- 1.6 Rounding and Estimating; Order
- 1.7 Solving Equations
- 1.8 Applications and Problem Solving

Translating for Success

- 1.9 Exponential Notation and Order of Operations

Summary and Review Test

STUDYING FOR SUCCESS *Getting Off to a Good Start*

- Your syllabus for this course is extremely important. Read it carefully, noting required texts and materials.
- If there is an online component for your course, register for it as soon as possible.
- At the front of the text, you will find a Student Organizer card. This pullout card will help you keep track of important dates and useful contact information.

1.1

OBJECTIVES

- a** Give the meaning of digits in standard notation.
- b** Convert from standard notation to expanded notation.
- c** Convert between standard notation and word names.

Standard Notation

We study mathematics in order to be able to solve problems. In this section, we study how numbers are named. We begin with the concept of place value.

a PLACE VALUE

Attendance at various types of Broadway performances in New York City for the 2016–2017 season is given in the following table.

TYPE OF PERFORMANCE	ATTENDANCE
Musicals	11,362,732
Plays	1,798,723
Specials	109,797

DATA: The Broadway League

A **digit** is a number 0, 1, 2, 3, 4, 5, 6, 7, 8, or 9 that names a place-value location. For large numbers, digits are separated by commas into groups of three, called **periods**. Each period has a name: *ones*, *thousands*, *millions*, *billions*, *trillions*, and so on. To understand the number of people attending Broadway musicals in the table above, we can use a **place-value chart**, as shown below.

PLACE-VALUE CHART																	
Trillions			Billions			Millions			Thousands			Ones					
						1		1	3	6	2	7	3	2			
Hundreds	Tens	Ones	Hundreds	Tens	Ones	Hundreds	Tens	Ones	Hundreds	Tens	Ones	Hundreds	Tens	Ones			
									11 millions			362 thousands			732 ones		

EXAMPLES In each of the following numbers, what does the digit 8 mean?

1. 27**8**,342 8 thousands
2. **8**72,342 8 hundred thousands
3. **28**,343,399,223 8 billions
4. **98**,413,099 8 millions
5. 63**28** 8 ones

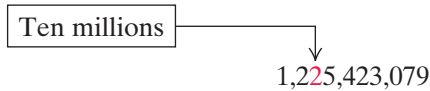
Do Exercises 1–6 (in the margin at right). ▶

What does the digit 2 mean in each number?

1. 526,555 2. 265,789
3. 42,789,654 4. 24,789,654
5. 8924 6. 5,643,201

EXAMPLE 6 Websites. In July 2017, the total number of active websites on the world wide web was 1,225,423,079. What digit names the number of ten millions?

Data: internetlivestats.com



The digit 2 is in the ten millions place, so 2 names the number of ten millions.

Do Exercise 7. ▶

7. Government Payroll. In 2015, the total payroll for all full-time federal employees in the United States was \$19,369,134,421. What digit names the number of ten billions?

Data: U.S. Census Bureau

b

CONVERTING FROM STANDARD NOTATION TO EXPANDED NOTATION

Heifer International is a charitable organization whose mission is to work with communities to end hunger and poverty and care for the earth by providing farm animals to impoverished families around the world. Consider the data in the following table.

GEOGRAPHICAL AREAS OF NEED	NUMBER OF FAMILIES ASSISTED DIRECTLY AND INDIRECTLY BY HEIFER INTERNATIONAL IN 2016
Africa	959,734
Americas	640,604
Asia, South Pacific	1,699,836
Central and Eastern Europe	254,427

DATA: *Heifer International 2016 Annual Report*



Answers

1. 2 ten thousands 2. 2 hundred thousands
3. 2 millions 4. 2 ten millions 5. 2 tens
6. 2 hundreds 7. 1

The number of families assisted in Africa was 959,734. This number is expressed in **standard notation**. We write **expanded notation** for 959,734 as follows:

$$959,734 = 9 \text{ hundred thousands} + 5 \text{ ten thousands} \\ + 9 \text{ thousands} + 7 \text{ hundreds} \\ + 3 \text{ tens} + 4 \text{ ones.}$$

EXAMPLE 7 Write expanded notation for 1776 ft, the height of One World Trade Center in New York City.

$$1776 = 1 \text{ thousand} + 7 \text{ hundreds} + 7 \text{ tens} + 6 \text{ ones}$$

EXAMPLE 8 Write expanded notation for 640,604, the number of families in the Americas assisted by Heifer International in 2016.

$$640,604 = 6 \text{ hundred thousands} + 4 \text{ ten thousands} \\ + 0 \text{ thousands} + 6 \text{ hundreds} + 0 \text{ tens} + 4 \text{ ones}$$

or






$$6 \text{ hundred thousands} + 4 \text{ ten thousands} + 6 \text{ hundreds} + 4 \text{ ones}$$

◀ **Do Exercises 8–11.**

C CONVERTING BETWEEN STANDARD NOTATION AND WORD NAMES

We often use **word names** for numbers. When we pronounce a number, we are speaking its word name. Russia won 56 medals in the 2016 Summer Olympics in Rio de Janeiro, Brazil. A word name for 56 is “fifty-six.” Word names for some two-digit numbers like 36, 51, and 72 use hyphens. Others, like that for 17, use only one word, “seventeen.”

2016 Summer Olympics Medal Count

COUNTRY	GOLD	SILVER	BRONZE	TOTAL
 United States of America	46	37	38	121
 Great Britain	27	23	17	67
 People's Republic of China	26	18	26	70
 Russia	19	18	19	56
 Germany	17	10	15	42

DATA: espn.com

Write expanded notation.

- 8.** 2718 mi, the length of the Congo River in Africa

$$2718 = 2 \text{ } + 7 \text{ } \\ + \text{ } \text{ ten} + \text{ } \text{ ones}$$

GS

- 9.** 254,427, the number of families in Central and Eastern Europe assisted by Heifer International in 2016
- 10.** 1670 ft, the height of the Taipei 101 Tower in Taiwan
- 11.** 104,094 square miles, the area of Colorado

Answers

- 8.** 2 thousands + 7 hundreds + 1 ten + 8 ones
9. 2 hundred thousands + 5 ten thousands + 4 thousands + 4 hundreds + 2 tens + 7 ones
10. 1 thousand + 6 hundreds + 7 tens + 0 ones, or 1 thousand + 6 hundreds + 7 tens
11. 1 hundred thousand + 0 ten thousands + 4 thousands + 0 hundreds + 9 tens + 4 ones, or 1 hundred thousand + 4 thousands + 9 tens + 4 ones

Guided Solution:

- 8.** thousands, hundreds, 1, 8

EXAMPLES Write a word name.

9. 46, the number of gold medals won by the United States

Forty-six

10. 15, the number of bronze medals won by Germany

Fifteen

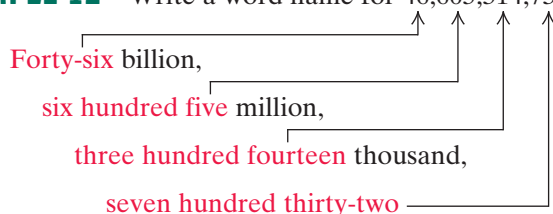
11. 121, the total number of medals won by the United States

One hundred twenty-one

Do Exercises 12–14. ▶

For word names for larger numbers, we begin at the left with the largest period. The number named in the period is followed by the name of the period; then a comma is written and the next number and period are named. Note that the name of the ones period is not included in the word name for a whole number.

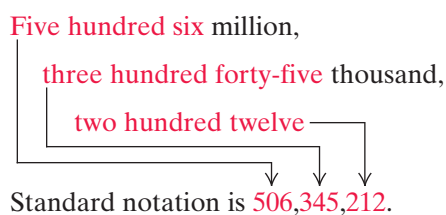
EXAMPLE 12 Write a word name for 46,605,314,732.



The word “and” *should not* appear in word names for whole numbers. Although we commonly hear such expressions as “two hundred *and* one,” the use of “and” is not, strictly speaking, correct in word names for whole numbers. For decimal notation, it is appropriate to use “and” for the decimal point. For example, 317.4 is read as “three hundred seventeen *and* four tenths.”

Do Exercises 15–18. ▶

EXAMPLE 13 Write standard notation.



Do Exercise 19. ▶

Write a word name. (Refer to the chart on the previous page.)

12. 67, the total number of medals won by Great Britain

13. 18, the number of silver medals won by the People’s Republic of China

14. 38, the number of bronze medals won by the United States

Write a word name.

15. 204

16. 10,336, the number of state parks in the United States

Data: stateparks.org

- GS** 17. 1,879,204

One , eight
hundred thousand,
two hundred

18. 7,401,989,718, the world population in 2017

Data: U.S. Census Bureau

19. Write standard notation.

Two hundred thirteen million,
one hundred five thousand,
three hundred twenty-nine

Answers

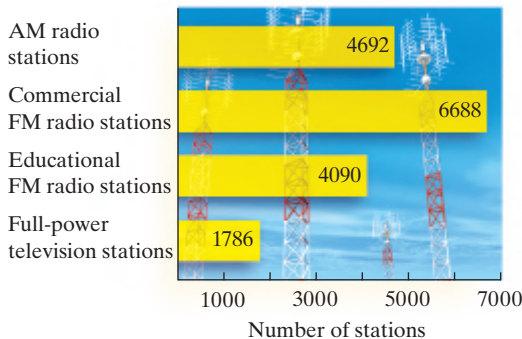
12. Sixty-seven 13. Eighteen
14. Thirty-eight 15. Two hundred four
16. Ten thousand, three hundred thirty-six
17. One million, eight hundred seventy-nine thousand, two hundred four
18. Seven billion, four hundred one million, nine hundred eighty-nine thousand, seven hundred eighteen
19. 213,105,329

Guided Solution:

17. Million, seventy-nine, four

**✓ Check Your Understanding****Reading Check** Complete each statement with the correct word from the following list.

digit expanded period standard

RC1. In 983, the _____ 9 represents 9 hundreds.**RC2.** In 615,702, the number 615 is in the thousands _____.**RC3.** The phrase “3 hundreds + 2 tens + 9 ones” is _____ notation for 329.**RC4.** The number 721 is written in _____ notation.**Concept Check** Write a word name.**CC1.** 5,000,000**CC2.** 42,000,000**CC3.** 3,000,000,000**CC4.** 18,000,000,000**CC5.** 7,000,000,000,000**CC6.** 40,000,000,000,000**a** What does the digit 5 mean in each number?**1.** 235,888**2.** 253,777**3.** 1,488,526**4.** 500,736**Broadway Shows.** In the 2016–2017 season, Broadway shows grossed \$1,449,321,564. What digit names the number of:**5.** thousands?**6.** millions?**7.** ten millions?**8.** hundred thousands?**b** Write expanded notation.**Radio and Television Stations.** The figure below shows the number of AM radio, FM radio, and full-power television stations in the United States. In Exercises 9–12, write expanded notation for the given number of stations.**Radio and Television Stations**

DATA: radiosurvivor.com; Federal Communications Commission

9. 4692 AM radio stations**10.** 6688 commercial FM radio stations**11.** 4090 educational FM radio stations**12.** 1786 full-power television stations

13. 93,986

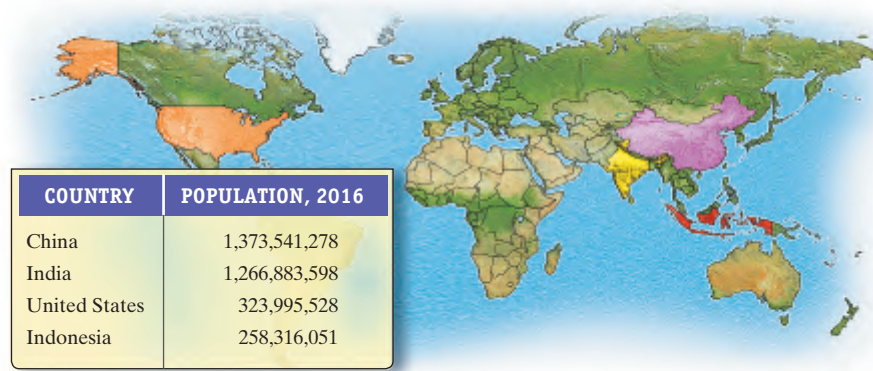
14. 38,453

15. 401,690

16. 135,080

Population. The table below shows the populations of four countries in 2016. In Exercises 17–20, write expanded notation for the given population.

Four Most Populous Countries in the World



DATA: *The CIA World Factbook*

17. 1,373,541,278 for China

18. 1,266,883,598 for India

19. 258,316,051 for Indonesia

20. 323,995,528 for the United States

C Write a word name.

21. 85

22. 48

23. 88,000

24. 45,987

25. 123,765

26. 111,013

27. 7,754,211,577

28. 43,550,651,808

29. **Airports.** In 2017, the world’s busiest airport, Hartsfield-Jackson Atlanta International Airport, scheduled 394,249 departures. Write a word name for 394,249.

Data: U.S. Bureau of Transportation Statistics

30. **NASCAR Racing.** The average attendance at a NASCAR race is 99,853. Write a word name for 99,853.

Data: statisticbrain.com

31. **Sports Salaries.** The average annual salary over the life of his contract for Major League Baseball player Clayton Kershaw is \$30,714,286. Write a word name for 30,714,286.

Data: *USA Today*

32. **Do Not Call Registry.** The number of active registrations in the National Do Not Call Registry in 2016 was 226,001,288. Write a word name for 226,001,288.

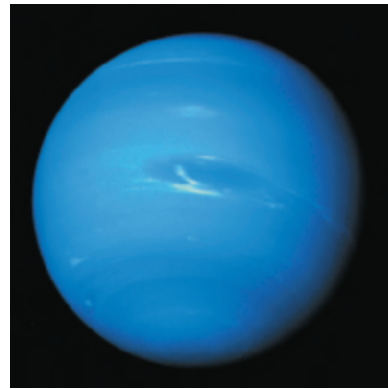
Data: Federal Trade Commission

Write each number in standard notation.

33. Six hundred thirty-two thousand, eight hundred ninety-six
34. Three hundred fifty-four thousand, seven hundred two
35. Fifty thousand, three hundred twenty-four
36. Seventeen thousand, one hundred twelve
37. Two million, two hundred thirty-three thousand, eight hundred twelve
38. Nineteen million, six hundred ten thousand, four hundred thirty-nine
39. Eight billion
40. Seven hundred million
41. Forty million
42. Twenty-six billion
43. Thirty million, one hundred three
44. Two hundred thousand, seventeen

Write standard notation for the number in each sentence.

45. **Pacific Ocean.** The area of the Pacific Ocean is sixty-four million, one hundred eighty-six thousand square miles.
46. The average distance from the sun to Neptune is two billion, seven hundred ninety-three million miles.



Synthesis

To the student and the instructor: The Synthesis exercises found at the end of every exercise set challenge students to combine concepts or skills studied in the section or in preceding parts of the text. Exercises marked with a  symbol are meant to be solved using a calculator.

47. How many whole numbers between 100 and 400 contain the digit 2 in their standard notation?
48.  What is the largest number that you can name on your calculator using standard notation? How many digits does that number have? How many periods?

Addition

1.2

OBJECTIVES

- a** Add whole numbers.
- b** Use addition in finding perimeter.

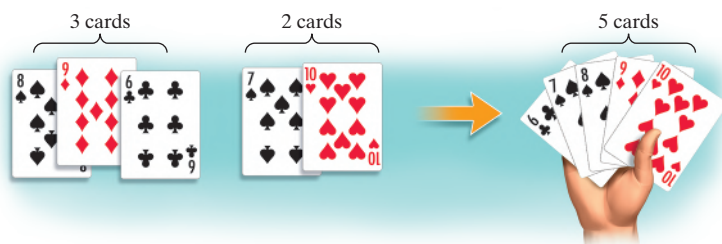
a ADDITION OF WHOLE NUMBERS

To answer questions such as “How many?”, “How much?”, and “How tall?”, we often use whole numbers. The set, or collection, of **whole numbers** is

0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, . . .

The set goes on indefinitely. There is no largest whole number, and the smallest whole number is 0. Each whole number can be named using various notations. The set 1, 2, 3, 4, 5, . . . , without 0, is called the set of **natural numbers**.

Addition of whole numbers corresponds to combining things together.



We say that the **sum** of 3 and 2 is 5. The numbers added are called **addends**. The addition that corresponds to the figure above is

$$\begin{array}{r} 3 + 2 = 5 \\ \downarrow \quad \downarrow \quad \downarrow \\ \text{Addend} \quad \text{Addend} \quad \text{Sum} \end{array}$$

To add whole numbers, we add the ones digits first, then the tens, then the hundreds, then the thousands, and so on.

EXAMPLE 1 Add: $878 + 995$.

Place values are lined up in columns.

$$\begin{array}{r} 8 \\ + 9 \\ \hline 3 \end{array}$$

Add ones. We get 13 ones, or 1 ten + 3 ones. Write 3 in the ones column and 1 above the tens. This is called *carrying*, or *regrouping*.

$$\begin{array}{r} 8 \\ + 9 \\ \hline 7 \end{array}$$

Add tens. We get 17 tens, so we have 10 tens + 7 tens. This is also 1 hundred + 7 tens. Write 7 in the tens column and 1 above the hundreds.

$$\begin{array}{r} 8 \\ + 9 \\ \hline 8 \end{array}$$

Add hundreds. We get 18 hundreds.

$$\begin{array}{r} 8 \\ + 9 \\ \hline 1 \end{array}$$

We show you these steps for explanation. You need write only this.

$$\begin{array}{r} 8 \\ + 9 \\ \hline 1 \end{array} \leftarrow \begin{array}{l} \text{Addends} \\ \text{Sum} \end{array}$$

SKILL REVIEW

Give the meaning of digits in standard notation. [1.1a]

In each of the following numbers, what does the digit 4 mean?

1. 8342
2. 14,976

Answers: 1. 4 tens
2. 4 thousands

