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The fun and easy way[®] to understand
the basic concepts and problems of pre-algebra

Basic Math & Pre-Algebra FOR DUMMIES[®]



Mark Zegarelli
Math tutor and writer

A Reference for the Rest of Us![®]

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Comparing English and Metric Units

Converting measurements between the English and metric systems is a common everyday reason to know math. Chapter 15 gives you detailed information on the subject, but here's a brief overview:

Metric to English Conversions	Metric Units in Plain English
1 meter \approx 3.26 feet	A meter is about 3 feet (1 yard).
1 kilometer \approx 0.62 miles	A kilometer is about $\frac{1}{2}$ mile.
1 liter \approx 0.26 gallons	A liter is about 1 quart ($\frac{1}{4}$ gallon).
1 kilogram \approx 2.20 pounds	A kilo is about 2 pounds.
0 degrees C = 32 degrees F	0 degrees C is cold.
10 degrees C = 50 degrees F	10 degrees C is cool.
20 degrees C = 68 degrees F	20 degrees C is warm.
30 degrees C = 86 degrees F	30 degrees C is hot.

Order of Operations (Order of Precedence)

When arithmetic expressions get complex, use the *order of operations* (also called *order of precedence*) to simplify them. (See Chapter 5 for more details.)

Evaluate arithmetic expressions *from left to right* according to the following order of precedence:

1. Parentheses
2. Exponents
3. Multiplication and division
4. Addition and subtraction

Properties of Big Four Operations, Exponents, Roots, and Absolute Value

Math *operations* allow you to combine numbers and perform calculations. Here are some important properties of the Big Four operations (adding, subtracting, multiplying, and dividing), as well as three more advanced operations (exponents, square roots, and absolute value). See Chapter 4 for more information on this topic.

Addition and Subtraction are *inverse operations*. For example:

$$\begin{array}{lcl} 2 + 3 = 5 & \text{so} & 5 - 3 = 2 \\ 7 - 1 = 6 & \text{so} & 6 + 1 = 7 \end{array}$$

Multiplication and Division are *inverse operations*. For example:

$$\begin{array}{lcl} 3 \times 4 = 12 & \text{so} & 12 \div 4 = 3 \\ 10 \div 2 = 5 & \text{so} & 5 \times 2 = 10 \end{array}$$

Addition is *commutative*.

For example:

$$3 + 5 = 5 + 3$$

Addition is *associative*. For example:

$$(2 + 4) + 7 = 2 + (4 + 7)$$

Multiplication is *commutative*.

For example:

$$2 \times 7 = 7 \times 2$$

Multiplication is *associative*.

For example:

$$3 \times (4 \times 5) = (3 \times 4) \times 5$$

Multiplication is *distributive* over addition. For example:

$$5 \times (2 + 4) = (5 \times 2) + (5 \times 4)$$

Exponents (powers) are repeated multiplication. For example:

$$7^2 = 7 \cdot 7 = 49$$

$$2^5 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 32$$

Square roots (*radicals*) are the inverse of exponent 2. For example:

$$\sqrt{9} = 3 \text{ because } 3^2 = 9$$

$$\sqrt{16} = 4 \text{ because } 4^2 = 16$$

Absolute value always gives you a positive value. For example:

$$|7| = 7$$

$$|-13| = 13$$

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Converting between Fractions, Decimals, and Percents

The chapters in Part III cover fractions, decimals, and percents in great detail, but if you want a fast reference for common conversions among the three, be sure to keep the following table close by.

Fraction	Decimal	Percent	Fraction	Decimal	Percent
$\frac{1}{100}$	0.01	1%	$\frac{3}{5}$	0.6	60%
$\frac{1}{20}$	0.05	5%	$\frac{7}{10}$	0.7	70%
$\frac{1}{10}$	0.1	10%	$\frac{3}{4}$	0.75	75%
$\frac{1}{5}$	0.2	20%	$\frac{4}{5}$	0.8	80%
$\frac{1}{4}$	0.25	25%	$\frac{9}{10}$	0.9	90%
$\frac{3}{10}$	0.3	30%	1	1.0	100%
$\frac{2}{5}$	0.4	40%	2	2.0	200%
$\frac{1}{2}$	0.5	50%	10	10.0	1,000%

Common Geometric Formulas

Whether you're taking measurements for a home construction project or trying to determine whether the cake batter you intended for a round pan will also fit a square pan, geometric formulas are useful things to know. Read Chapter 16 for information on how to use these formulas, and then keep this list of basics on hand for when you need them.

Circle:

$$d = 2 \cdot r$$

$$C = 2 \cdot \pi \cdot r = \pi \cdot d$$

$$A = \pi \cdot r^2$$

Cube:

$$V = s^3$$

Box (Rectangular solid):

$$V = l \cdot w \cdot h$$

Parallelogram:

$$P = 2 \cdot (b + s)$$

$$A = b \cdot h$$

Prism and cylinder:

$$V = A_b \cdot h$$

Pyramid and cone:

$$V = \frac{A_b \cdot h}{3}$$

Pythagorean Theorem:

$$a^2 + b^2 = c^2$$

Rectangle:

$$P = 2 \cdot (l + w)$$

$$A = l \cdot w$$

Rhombus:

$$P = 4 \cdot s$$

$$A = s \cdot h$$

Square:

$$P = 4 \cdot s$$

$$A = s^2 \text{ or } A = s \cdot s$$

Trapezoid:

$$A = \frac{h \cdot (b_1 + b_2)}{2}$$

Triangle:

$$A = \frac{b \cdot h}{2}$$

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by Mark Zegarelli



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Mark Zegarelli is the author of *Logic For Dummies* (Wiley). He holds degrees in both English and math from Rutgers University. He has earned his living for many years writing vast quantities of logic puzzles, a hefty chunk of software documentation, and the occasional book or film review. Along the way, he's also paid a few bills doing housecleaning, decorative painting, and (for ten hours) retail sales. He likes writing best, though.

Mark lives mostly in Long Branch, New Jersey, and sporadically in San Francisco, California.

Dedication

I dedicate this book to the memory of my mother, Sally Ann Zegarelli (Joan Bernice Hanley).

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Introduction

Once upon a time, you loved numbers. This isn't the first line of a fairy tale. Once upon a time, you really did love numbers. Remember?

Maybe you were 3 and your grandparents were visiting. You sat next to them on the couch and recited the numbers from 1 to 10. They were proud of you and — be honest — you were proud of yourself, too. Or maybe you were 5 and discovering how to write numbers, trying hard not to get your *bs* and *as* backwards.

Learning was fun. *Numbers* were fun. So what happened? Maybe the trouble started with long division. Or sorting out how to change fractions to decimals. Could it have been figuring out how to add 8 percent sales tax to the cost of a purchase? Reading a graph? Converting miles to kilometers? Trying to find that most dreaded value of x ? Wherever it started, you began to suspect that math didn't like you — and you didn't like math very much, either.

Why do people often enter preschool excited about learning how to count and leave high school as young adults convinced that they can't do math? The answer to this question would probably take 20 books this size, but solving the problem can begin right here.

I humbly ask you to put aside any doubts. Remember, just for a moment, an innocent time — a time before math inspired panic attacks or, at best, induced irresistible drowsiness. In this book, I take you from an understanding of the basics to the place where you're ready to enter any algebra class and succeed.

About This Book

Somewhere along the road from counting to algebra, most people experience the Great Math Breakdown. This feels something like when your car begins smoking and sputtering on a 110-degree highway somewhere between Noplace and Not Much Else!

Please consider this book your personal roadside helper, and think of me as your friendly math mechanic (only much cheaper!). Stranded on the interstate, you may feel frustrated by circumstances and betrayed by your vehicle, but for the guy holding the toolbox, it's all in a day's work. The tools for fixing the problem are in this book.

Not only does this book help you with the basics of math, but it also helps you get past any aversion you may feel toward math in general! I've broken down the concepts into easy-to-understand sections. And because *Basic Math & Pre-Algebra For Dummies* is a reference book, you don't have to read the chapters or sections in order — you can look over only what you need. So feel free to jump around. Whenever I cover a topic that requires information from earlier in the book, I refer you to that section or chapter in case you want to refresh yourself on the basics.

Here are two pieces of advice I give all the time — remember them as you work your way through the concepts in this book:

- ✓ **Take frequent study breaks.** Every 20 to 30 minutes, stand up and push in your chair. Then feed the cat, do the dishes, take a walk, juggle tennis balls, try on last year's Halloween costume — do *something* to distract yourself for a few minutes. You'll come back to your books more productive than if you were to just sit there hour after hour with your eyes glazing over.
- ✓ **After you've read through an example and think you understand it, copy the problem, close the book, and try to work it through.** If you get stuck, steal a quick look — but later, try that same example again to see whether you can get through without opening the book. (Remember that on any tests you're preparing for, peeking is probably not allowed!)

Conventions Used in This Book

To help you navigate your way through this book, I use the following conventions:

- ✓ *Italicized* text highlights new words and defined terms.
- ✓ **Boldfaced** text indicates keywords in bulleted lists and the action part of numbered steps.
- ✓ `Monofont` text highlights Web addresses.
- ✓ Variables, such as *x* and *y*, are in italics.

What You're Not to Read

Although every author secretly (or not-so-secretly) believes that each word he pens is pure gold, you don't have to read every word in this book unless you really want to. Feel free to skip over sidebars (those shaded gray boxes) where I go off on a tangent — unless you find tangents interesting, of course. Paragraphs labeled with the Technical Stuff icon are also nonessential.

Foolish Assumptions

If you're planning to read this book, you're likely

- ✓ A student who wants a solid understanding of the basics of math for a class or test you're taking
- ✓ An adult who wants to improve skills in arithmetic, fractions, decimals, percentages, weights and measures, geometry, algebra, and so on for when you have to use math in the real world
- ✓ Someone who wants a refresher so you can help another person understand math

My only assumption about your skill level is that you can add, subtract, multiply, and divide. So to find out whether you're ready for this book, take this simple test:

$$5 + 6 = \underline{\quad}$$

$$10 - 7 = \underline{\quad}$$

$$3 \times 5 = \underline{\quad}$$

$$20 \div 4 = \underline{\quad}$$

If you can answer these four questions, you're ready to begin.

How This Book Is Organized

This book is organized into six parts, starting you off at the very beginning of math — with topics such as counting and the number line — and taking you all the way into algebra.

Part I: Arming Yourself with the Basics of Basic Math

In Part I, I take what you already know about math and put it in perspective.

Chapter 1 gives you a brief history of what numbers are and where they came from. I discuss how number sequences arise. I show you how important sets of numbers — such as the counting numbers, the integers, and the rational numbers — all fit together on the number line. I also show you how to use the number line to perform basic arithmetic.

Chapter 2 discusses how digits are the building blocks of numbers, much the same as letters are the building blocks of words. I show you how the number system you use every day — the Hindu-Arabic number system (also called *decimal numbers*) — uses place value based on the number 10 to build digits into numbers.

Finally, Chapter 3 focuses on what I call the Big Four operations — adding, subtracting, multiplying, and dividing. I give you a refresher on how to do column addition with carrying, subtraction with borrowing, multiplication of large numbers, and the ever-dreaded long division.

Part II: Getting a Handle on Whole Numbers

In Part II, you take a leap forward in your understanding of how to work with the Big Four operations. In Chapter 4, I cover inverse operations, the commutative, associative, and distributive properties, and working with negative numbers. You discover how to use inequalities such as greater than ($>$) and less than ($<$). I also introduce you to more-advanced operations, such as powers (exponents), square roots, and absolute value.

Chapter 5 introduces what I call the *three Es of math*: expressions, equations, and evaluation. The rest of the chapter focuses on an all-important skill: evaluating mathematical expressions using the order of operations. In Chapter 6, you discover how to solve *word problems* (also called *story problems*) by creating word equations.

Chapter 7 takes a detailed look at divisibility. I show you a bunch of tricks for finding out whether one number is divisible by another. I also discuss prime numbers and composite numbers. Finally, Chapter 8 discusses factors and multiples, showing you how these two concepts are connected. I show you how to decompose a number to its prime factors. I also show you how to find the greatest common factor (GCF) and least common multiple (LCM) of two or more numbers.

Part III: Parts of the Whole: Fractions, Decimals, and Percents

Part III focuses on how mathematics represents parts of the whole as fractions, decimals, and percents and on how these three ideas are connected.

Chapters 9 and 10 focus on fractions, including increasing and reducing the terms of fractions. From there, I show you how to multiply and divide fractions,

plus a variety of ways to add and subtract fractions. Finally, I show you how to work with mixed numbers. In Chapter 11, the topic is decimals. I show you how to add, subtract, multiply, and divide decimals and how to convert fractions to decimals and vice versa. I also give you an understanding of repeating decimals.

Chapter 12 discusses percentages. I show you how to convert percentages to both fractions and decimals, and vice versa. I follow up with a variety of ways for finding percentages, including a simple but powerful tool called the percent circle. Finally, Chapter 13 focuses on solving word problems that involve fractions, decimals, and percents.

Part IV: Picturing and Measuring — Graphs, Measures, Stats, and Sets

Part IV contains a variety of topics that build upon the skills you gain in the first three parts of the book.

In Chapter 14, I show you how scientific notation makes very large and very small numbers more manageable by combining decimals and powers of ten. In Chapter 15, I discuss two important systems of weights and measures: the English system (used mostly in the United States) and the metric system (used throughout the world). I give you a variety of conversion equations and show you how to convert units of measurement. I also give you a few rules of thumb for estimating metric units.

Chapter 16 discusses geometry, giving you a variety of formulas to find the perimeter and area of basic shapes and the surface area and volume of a few important solids.

Chapter 17 introduces you to graphing, first showing you three important types of graphs — the bar graph, the pie chart, and the line graph. I also give you the basics of the most common graphing method used in math, the Cartesian graph. I show you how to plot points, draw lines, and solve problems using this graph. Chapter 18 gives you still more practice solving word problems, especially those focusing on geometry and on weights and measures.

Chapter 19 introduces you to statistics and probability. You discover the difference between qualitative data and quantitative data and how to calculate both the mean average and the median average. I also show you how to calculate probability by counting possible outcomes and favorable outcomes.

In Chapter 20, I give you the basics of set theory, including how to define a set, identify elements and subsets, and understand the empty set. I also show you how to perform some basic operations on sets, including the union and the intersection of sets.

Part V: The X-Files: Introduction to Algebra

Part V is your introduction to algebra. Chapter 21 provides an overview of algebra, showing you the basics of declaring a variable (such as x) and then using it in expressions, making connections with what you already know about expressions from Chapter 5.

Chapter 22 gives you a variety of ways to solve algebraic equations. Finally, Chapter 23 puts it all together, showing you how to solve algebra word problems from beginning to end.

Part VI: The Part of Tens

Just for fun, this part of the book includes a few top-ten lists on a variety of topics, including key math concepts and number sets.

Icons Used in This Book

Throughout the book, I use four icons to highlight what's hot and what's not:



This icon points out key ideas that you need to know. Make sure you understand before reading on! Remember this info even after you close the book.



Tips are helpful hints that show you the quick and easy way to get things done. Try them out, especially if you're taking a math course.



Warnings flag common errors that you want to avoid. Get clear about where these little traps are hiding so you don't fall in.



This icon points out interesting trivia that you can read or skip over as you like.

Where to Go from Here

You can use this book in a few ways. If you're reading this book without immediate time pressure from a test or homework assignment, you can certainly start at the beginning and keep on going through to the end. The advantage to this method is that you realize how much math you *do* know — the first few chapters go very quickly. You gain a lot of confidence as well as some practical knowledge that can help you later on, because the early chapters also set you up to understand what follows.

Or how about this: When you're ready to work, read up on the topic you're studying. Leave the book on your nightstand and, just before bed, spend a few minutes reading the easy stuff from the early chapters. You'd be surprised how a little refresher on simple stuff can suddenly cause more-advanced concepts to click.

If your time is limited — especially if you're taking a math course and you're looking for help with your homework or an upcoming test — skip directly to the topic you're studying. Wherever you open the book, you can find a clear explanation of the topic at hand, as well as a variety of hints and tricks. Read through the examples and try to do them yourself, or use them as templates to help you with assigned problems.

Here's a short list of topics that tend to back students up:

- ✓ Negative numbers (Chapter 4)
- ✓ Order of operations (Chapter 5)
- ✓ Word problems (Chapters 6, 13, 18, and 23)
- ✓ Factoring numbers (Chapter 8)
- ✓ Fractions (Chapters 9 and 10)

Most of these topics are in Parts II and III, but they're foundational to what's covered later in the book. Generally speaking, any time you spend building these five skills is like money in the bank as you proceed in math, so you may want to visit these sections several times. As soon as you feel comfortable adding negative numbers or multiplying fractions, your confidence soars. Moreover, everything that I cover in the rest of the book should seem much simpler.

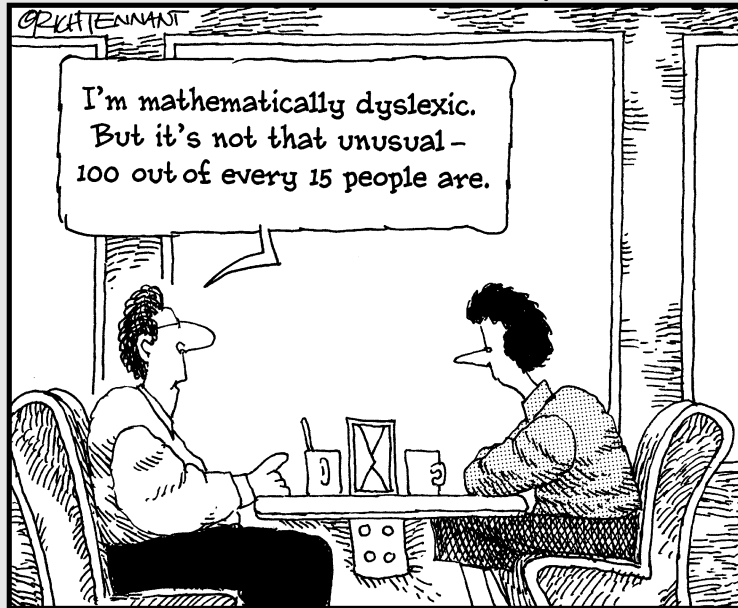
If you get stuck along the way, take a break and come back to the problem; you may find that the answer suddenly clicks for you as soon as you read it again with a refreshed mind. If you still feel stuck, you may need to drop back a few pages and read from the beginning of the section or chapter. Sometimes, working through a few easier examples is the best way to prepare for when the going gets tough.

Part I

Arming Yourself with the Basics of Basic Math

The 5th Wave

By Rich Tennant



In this part . . .

You already know more about math than you think you know. Here, you review and gain perspective on basic math ideas such as number patterns, the number line, how place value based on the number ten turns digits into numbers, and how zero functions as a placeholder. I also reintroduce you to what I call the Big Four operations (adding, subtracting, multiplying, and dividing).