

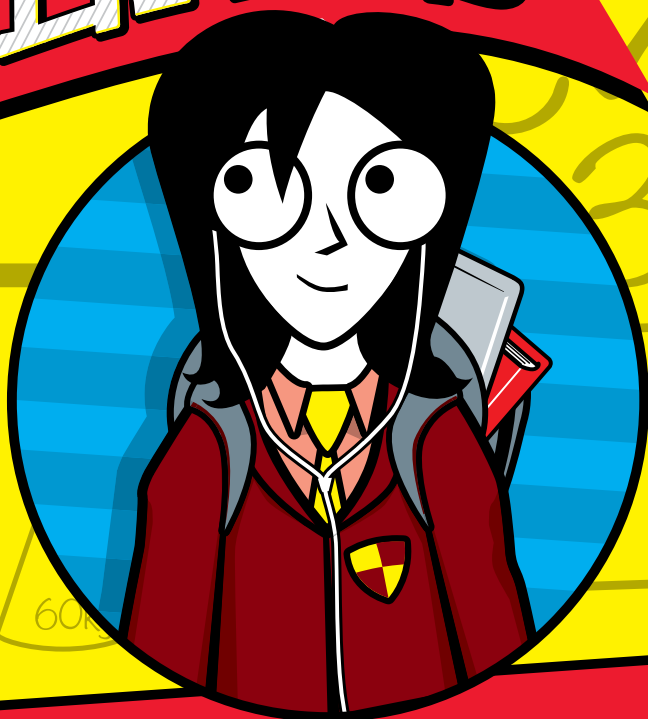
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Years 6-8 Maths

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CHAPTER



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Years 6–8 Maths for Students®

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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 three years old and your grandparents were visiting. You sat next to them on the couch and recited the numbers from 1 to 10. Grandma and Grandpa were proud of you and — be honest — you were proud of yourself, too. Or maybe you were five and discovering how to write numbers, trying hard not to print your 2 and 7 backward.

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 take away a 25 per cent discount from the cost of a purchase? Reading a graph? Converting miles to kilometres? Trying to find that most dreaded value of x ? Wherever it started, you began to suspect that maths didn't like you — and you didn't like maths very much, either.

Why do people often enter kindergarten excited about learning how to count and, somewhere along the line, become convinced that they can't do maths? The answer to this question would probably take 20 books this size, but solving the problem can begin right here.

I ask you to put aside any doubts. Remember, just for a moment, an innocent time — a time before maths 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 mathematics class and succeed.

About This Book

Along the road from counting to algebra, most people experience the Great Maths Breakdown. This feels something like when your car begins smoking and sputtering on a 43°C highway somewhere between Noplace and Not Much Else.

Please consider this book your personal roadside helper, and think of me as your friendly maths mechanic (only much cheaper!). Stranded on the

freeway, you may feel frustrated by circumstances and betrayed by your vehicle, but for the person 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 maths in general. I've broken down the concepts into easy-to-understand sections. And because *Years 6–8 Maths for Students* 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 breaks.** Every 20 to 30 minutes, stand up and push in your chair. Then feed the cat, tidy your room (yeah, right!), take a walk, juggle tennis balls, try on last year's Santa's hat — do something to distract yourself for a few minutes. You'll come back to your books more productive than if you just sat 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 it without opening the book. (Remember that, on any tests you're preparing for, peeking is probably not allowed!)

Although every author secretly (or not-so-secretly) believes that each word she 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 grey boxes) where I go off on a tangent — unless you find tangents interesting, of course.

Foolish Assumptions

Making assumptions is always a risky business, but knowing where I'm coming from may put you at ease. So, in writing this book, I assume that:

- ✓ You know how to count and are familiar with the symbols for the numbers.
- ✓ You understand the idea of money and changing a banknote for an equivalent value of coins.

- ✓ You know what some basic shapes look like.
- ✓ You're prepared to think fairly hard about maths and want either to pass an upcoming test or exam or to simply improve your maths skills.

Icons Used in This Book

Throughout the book, I use three 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.



Theories are fine, but anything marked with a Tip icon in this book tells you something practical to help you get to the right answer. These are the tricks of the mathematical trade.



The Warning icon highlights errors and mistakes that can cost you marks or your sanity, or both.

Where to Go From Here

This book is set up so you can jump right into the topics that interest you. If you feel like an absolute beginner in maths, I recommend you read Parts I and II to build a foundation for the other topics. If you're pretty comfortable with the mechanics of maths, use the table of contents and index to find the subject you have questions about right now. This book is a reference — keep it with your maths kit and turn to it whenever you have a question about maths.

Chapter 2

Getting Bigger and Smaller: Sequences, Addition and Subtraction

In This Chapter

- ▶ Tuning into number sequences
 - ▶ Starting to get your head around addition and subtraction
 - ▶ Working with the number line
 - ▶ Understanding some simple tricks to remember simple sums
 - ▶ Working up to adding and subtracting bigger numbers
-

One useful characteristic about numbers is that they're *conceptual*, which means that, in an important sense, they're all in your head. (This fact probably won't get you out of having to know about them, though — nice try!) For example, you can picture three of anything: Three cats, three cricket balls, three cannibals, three planets. But just try to picture the concept of three all by itself, and you find it's impossible. Oh, sure, you can picture the numeral 3, but the *threeness* itself — much like love or beauty or honour — is beyond direct understanding. But when you understand the *concept* of three (or four, or a million), you have access to an incredibly powerful system for understanding the world of mathematics.

In this chapter, I discuss a few common *number sequences* and show you how these connect with simple math *operations* like addition and subtraction.

Adding things up and taking them away are the two most fundamental skills in arithmetic. If you master these skills — just two sides of the same coin — you'll find the rest of this book much, much easier than it would be without them.

This chapter covers adding and taking away using a number line for small values. I also give you some hints on memorising some important sums. After all, counting on your fingers is totally acceptable — but it's much slower than being able to recall facts straightaway.

Finally in this chapter, you get some practice at dealing with big numbers. I take some time to show you not only how to add and subtract big numbers but also why the methods work.

Understanding Number Sequences

Historians believe that the first number systems came into being at the same time as agriculture and commerce. Before that, people in prehistoric, hunter-gatherer societies were pretty much content to identify bunches of things as 'a lot' or 'a little'. Moving on from counting commodities, humans soon put numbers to use in a wide range of applications. Numbers were useful for measuring distances, counting money, amassing an army, levying taxes, building pyramids, and lots more.

But beyond their many uses for understanding the external world, numbers have an internal order all their own. So numbers are not only an *invention*, but equally also a *discovery*: A landscape that seems to exist independently, with its own structure, mysteries and even perils.

One path into this new and often strange world is the *number sequence*: An arrangement of numbers according to a rule. In the following sections, I introduce you to a variety of number sequences that are useful for making sense of numbers.

Evening the odds

One of the first facts you probably heard about numbers is that all of them are either even or odd. For example, you can split an even number of marbles *evenly* into two equal piles. But when you try to divide an odd number of marbles the same way, you always have one *odd*, leftover marble. Here are the first few even numbers:

2 4 6 8 10 12 14 16 ...

You can easily keep the sequence of even numbers going as long as you like. Starting with the number 2, keep adding 2 to get the next number.

Similarly, here are the first few odd numbers:

1 3 5 7 9 11 13 15 ...

The sequence of odd numbers is just as simple to generate. Starting with the number 1, keep adding 2 to get the next number.

Patterns of even or odd numbers are the simplest number patterns around, which is why kids often figure out the difference between even and odd numbers soon after learning to count.



When I planned this chapter, I thought there could be hardly any real-life use for knowing about even and odd numbers. Then, this morning, I went out to try to find a new student's house. Wandering down the student's road, I noticed a sign saying 'ODD NUMBERS 15–37' — so I knew Eric's house (number 29) was in that particular side street. But odd and even numbers have more use than simply finding a friend's house. You can also use the concept of odd and even numbers to check whether your answer to an addition or take-away sum makes sense.

Try adding two numbers of the same 'flavour' — an odd number plus an odd number, or an even number plus an even number. Here are a few examples:

$$7 + 5 = 12$$

$$14 + 6 = 20$$

$$9 + 9 = 18$$

The answer is always an even number.

The same happens if you take away an odd number from an odd number, or an even number from an even number:

$$7 - 5 = 2$$

$$14 - 6 = 8$$

$$9 - 9 = 0$$

The answer is always an even number.

Now see what happens when we work with numbers of mixed flavours:

$$4 + 7 = 11$$

$$16 - 7 = 9$$

$$12 + 3 = 15$$

You get odd numbers. Perhaps you saw that coming. Whenever you add or take away numbers of different flavours, you get an odd number.

Counting by threes, fours, fives and so on

When you get used to the concept of counting by numbers greater than 1, you can run with it. For example, here's what counting by threes, fours and fives looks like:

- Threes: 3 6 9 12 15 18 21 24 ...
- Fours: 4 8 12 16 20 24 28 32 ...
- Fives: 5 10 15 20 25 30 35 40 ...

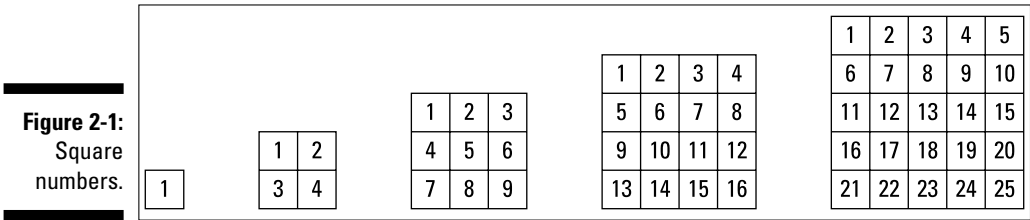


Counting by a given number is a good way to begin learning the multiplication table for that number, especially for the numbers you're kind of sketchy on. (In general, people seem to have the most trouble multiplying by 7, but 8 and 9 are also unpopular.) In Chapter 3, I show you a few tricks for memorising the multiplication table once and for all.

Getting square with square numbers

When you study maths, sooner or later, you probably want to use visual aids to help you see what numbers are telling you. (Later in this book, I show you how one picture can be worth a thousand numbers when I discuss geometry in Chapter 12 and graphing in Chapter 13.)

The tastiest visual aids you'll ever find are those little square cheese-flavoured crackers. (You probably have a box sitting somewhere in the pantry. If not, plain crackers or any other square food works just as well.) Shake a bunch out of a box and place the little squares together to make bigger squares. Figure 2-1 shows the first few.



Voilà! The square numbers:

1 4 9 16 25 36 49 64 ...

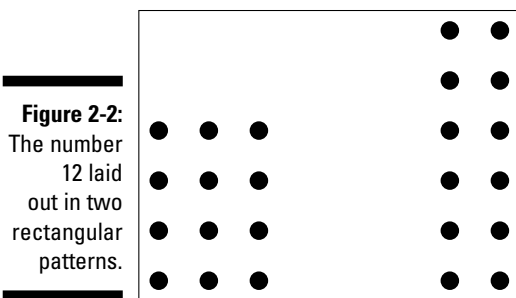


You get a *square number* by multiplying a number by itself, so knowing the square numbers is another handy way to remember part of the multiplication table. Although you probably remember without help that $2 \times 2 = 4$, you may be sketchy on some of the higher numbers, such as $7 \times 7 = 49$. Knowing the square numbers gives you another way to etch that multiplication table forever into your brain, as I show you in Chapter 3.

Square numbers are also a great first step on the way to understanding exponents, which I introduce later in this chapter and explain in more detail in Chapter 3.

Composing yourself with composite numbers

Some numbers can be placed in rectangular patterns. Mathematicians probably should call numbers like these ‘rectangular numbers’, but instead they chose the term *composite numbers*. For example, 12 is a composite number because you can place 12 objects in rectangles of two different shapes, as in Figure 2-2.



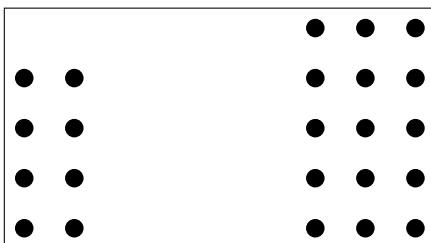
As with square numbers, arranging numbers in visual patterns like this tells you something about how multiplication works. In this case, by counting the sides of both rectangles, you find out the following:

$$3 \times 4 = 12$$

$$2 \times 6 = 12$$

Similarly, other numbers such as 8 and 15 can also be arranged in rectangles, as in Figure 2-3.

Figure 2-3:
Composite
numbers,
such as
8 and 15,
can form
rectangles.



As you can see, both these numbers are quite happy being placed in boxes with at least two rows and two columns. And these visual patterns show this:

$$2 \times 4 = 8$$

$$3 \times 5 = 15$$

The word *composite* means that these numbers are *composed of* smaller numbers. For example, the number 15 is composed of 3 and 5 — that is, when you multiply these two smaller numbers, you get 15. Here are all the composite numbers from 1 to 16:

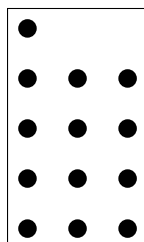
4 6 8 9 10 12 14 15 16

Notice that all the square numbers (refer to the preceding section) also count as composite numbers, because you can arrange them in boxes with at least two rows and two columns. Additionally, a lot of other non-square numbers are also composite numbers.

Stepping out of the box with prime numbers

Some numbers are stubborn. Like certain people you may know, these numbers — called *prime numbers* — resist being placed in any sort of a box. Look at how Figure 2-4 depicts the number 13, for example.

Figure 2-4:
Unlucky
13, a prime
example of
a number
that refuses
to fit in
a box.



Try as you may, you just can't make a rectangle out of 13 objects. (That fact may be one reason the number 13 got a bad reputation as unlucky.) Here are all the prime numbers fewer than 20:

2 3 5 7 11 13 17 19

As you can see, the list of prime numbers fills the gaps left by the composite numbers (refer to the preceding section). Therefore, every counting number is either prime or composite. The only exception is the number 1, which is neither prime nor composite.

Multiplying quickly with exponents

Here's an old question with an answer that may surprise you: Suppose you took a job that paid you just 1 cent the first day, 2 cents the second day, 4 cents the third day, and so on, doubling the amount every day, like this:

1 2 4 8 16 32 64 128 256 512 ...

As you can see, in the first ten days of work, you would've earned a little more than \$10 (actually, \$10.23 — but who's counting?). How much would you earn in 30 days? Your answer may well be, 'I wouldn't take a lousy job like that in the first place.' At first glance, this looks like a good answer, but here's a glimpse at your second ten days' earnings:

... 1,024 2,048 4,096 8,192 6,384 32,768 65,536 131,072
262,144 524,288 ...

By the end of the second 10 days, your total earnings would be over \$10,000. And by the end of 30 days, your earnings would top out around \$10,000,000! How does this happen? Through the magic of exponents

(also called *powers*). Each new number in the sequence is obtained by multiplying the previous number by 2:

$$2^1 = 2$$

$$2^2 = 2 \times 2 = 4$$

$$2^3 = 2 \times 2 \times 2 = 8$$

$$2^4 = 2 \times 2 \times 2 \times 2 = 16$$

As you can see, the notation 2^4 means *multiply 2 by itself 4 times*.

You can use exponents on numbers other than 2. Here's another sequence you may be familiar with:

$$1 \quad 10 \quad 100 \quad 1,000 \quad 10,000 \quad 100,000 \quad 1,000,000 \quad \dots$$

In this sequence, every number is 10 times greater than the number before it. You can also generate these numbers using exponents:

$$10^1 = 10$$

$$10^2 = 10 \times 10 = 100$$

$$10^3 = 10 \times 10 \times 10 = 1,000$$

$$10^4 = 10 \times 10 \times 10 \times 10 = 10,000$$

This sequence is important for defining *place value*, the basis of the decimal number system, which shows up when I discuss decimals in Chapter 7. You find out more about exponents in Chapter 3.

It All Adds Up: Addition and Subtraction

Adding is what happens when you combine two groups of similar objects together. If I own four books and I buy two more, I end up with six of them: $4 + 2 = 6$. You add up when you gain or increase something.

One of the neat things about maths is that the rules hold whatever you add — it doesn't have to be books. If you start with four cups of coffee and drink two more, you've drunk six cups of coffee. If you walk 4 kilometres and then walk two more, you've walked 6 kilometres. Whatever the things are, if you start with four of them and add two more, you end up with six.



You have to be careful when you're adding and taking away that the things you're working with are similar — you can't really add two apples to four oranges and get a meaningful answer without bending the rules (you could say it makes six pieces of fruit, but that's a bit of a cheat). It really doesn't make sense to add two clouds to four phones, or to add 2 kilometres to 4 grams.

You probably have a good idea about taking away too. Taking away, or subtracting, happens when you decrease, lose or spend things. If I have six books and my cheapskate friend borrows two of them, I wind up with four books: $6 - 2 = 4$.

Adding things up

Addition is the first operation you find out about, and it's almost everybody's favourite. It's simple, friendly and straightforward. No matter how much you worry about maths, you've probably never lost a minute of sleep over addition. Addition is all about bringing things together, which is a positive goal. For example, suppose you and I are standing in line to buy tickets for a movie. I have \$30 and you have only \$10. I could lord it over you and make you feel crummy that I can go to the movies and you can't. Or, instead, you and I can join forces, adding together my \$30 and your \$10 to make \$40. Now, not only can we both see the movie, but we may even be able to buy some popcorn, too.

Addition uses only one sign — the plus sign (+): Your equation may read $2 + 3 = 5$, or $12 + 2 = 14$, or $27 + 44 = 71$, but the plus sign always means the same thing.



When you add two numbers together, those two numbers are called *addends*, and the result is called the *sum*. So, in the first example, the addends are 2 and 3, and the sum is 5.

Take it away: Subtracting

Subtraction is usually the second operation you discover, and it's not much harder than addition. Still, there's something negative about subtraction — it's all about who has more and who has less. Suppose you and I have been running on treadmills at the gym. I'm happy because I ran 5 kilometres, but then you start bragging that you ran 12 kilometres. You subtract and tell me that I should be very impressed that you ran 7 kilometres farther than I did. (But with an attitude like that, don't be

surprised if you come back from the showers to find your running shoes filled with liquid soap!)

As with addition, subtraction has only one sign: The minus sign ($-$). You end up with equations such as $4 - 1 = 3$, and $14 - 13 = 1$, and $93 - 74 = 19$.



When you subtract one number from another, the result is called the *difference*. This term makes sense when you think about it: When you subtract, you find the difference between a higher number and a lower one.

One of the first facts you probably heard about subtraction is that you can't take away more than you start with. In that case, the second number can't be larger than the first. And if the two numbers are the same, the result is always 0. For example, $3 - 3 = 0$; $11 - 11 = 0$; and $1,776 - 1,776 = 0$. Later someone breaks the news that you *can* take away more than you have. When you do, though, you need to place a minus sign in front of the difference to show that you have a negative number — that is, a number below 0:

$$4 - 5 = -1$$

$$10 - 13 = -3$$

$$88 - 99 = -11$$



When subtracting a larger number from a smaller number, remember the words *switch* and *negate*: You *switch* the order of the two numbers and do the subtraction as you normally would, but at the end, you *negate* the result by attaching a minus sign. For example, to find $10 - 13$, you switch the order of these two numbers, giving you $13 - 10$, which equals 3; then you negate this result to get -3 . That's why $10 - 13 = -3$.



The minus sign does double duty, so don't get confused. When you stick a minus sign between two numbers, it means the first number minus the second number. But when you attach it to the front of a number, it means that this number is a negative number.

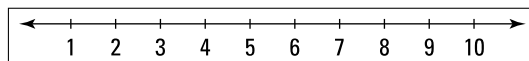
I also go into more detail on negative numbers in Chapter 4.

Looking at the number line

As kids outgrow counting on their fingers (and use them only when trying to remember the names of all seven dwarfs), teachers often substitute a picture of the first ten numbers in order, like the one in Figure 2-5.

This way of organising numbers is called the *number line*. People often see their first number line — usually made of brightly coloured construction paper — pasted above the blackboard in school. The basic number line

Figure 2-5:
Basic
number line.
Numbers go
on forever,
so the line
doesn't stop
here —
but you
probably
don't need
to go any
higher.



provides a visual image of the *counting numbers* (also called the *natural numbers*), the numbers greater than 0. You can use it to show how numbers get bigger in one direction and smaller in the other.

Some people like to draw the number line vertically, starting with zero at the bottom of the page and counting up the line, like counting floors in a skyscraper. In this book, I work from left to right, mainly because it takes up less space.

I like to remember which way round the number line goes by saying ‘the left is less (or lower)’ — the three Ls.



You don't actually need to draw a number line. A ruler serves as a perfectly good substitute. A 30-centimetre ruler has all the numbers from 0 to 30 written out ready for you to count on as you please.

In this section, I show you how to use the number line to understand a few basic but important ideas about numbers.

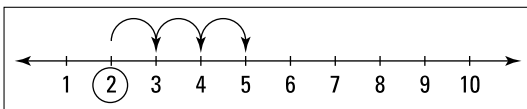
Adding and subtracting on the number line

You can use the number line to demonstrate simple addition and subtraction. These first steps in maths become a lot more concrete with a visual aid. Here's the main point to remember:

- ✓ As you go *right*, the numbers go *up*, which is *addition* (+).
- ✓ As you go *left*, the numbers go *down*, which is *subtraction* (-).

For example, $2 + 3$ means you *start at 2* and *jump up 3 spaces* to 5, as Figure 2-6 illustrates.

Figure 2-6:
Moving
through the
number line
from left to
right.

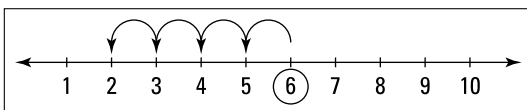


Here, in full, is the method for adding:

1. Put your pen on the number line on the first number in your sum.
2. Move to the right by the number of spaces indicated by the second number in your sum.
3. Where you end up on the number line is the answer.

As another example, $6 - 4$ means *start at 6* and *jump down 4 spaces* to 2. That is, $6 - 4 = 2$. See Figure 2-7.

Figure 2-7:
Moving
through the
number line
from right
to left.



Here, in full, are the steps for taking away:

1. Put your pen on the number line on the first number in your sum.
2. Move to the left by the number of spaces indicated by the second number in your sum.
3. Where you end up on the number line is the answer.



The steps for adding and taking away are very similar — the only difference is the direction in which you move.

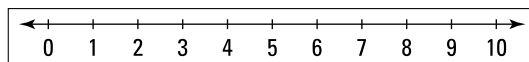
You can use these simple up and down rules repeatedly to solve a longer string of added and subtracted numbers. For example, $3 + 1 - 2 + 4 - 3 - 2$

means 3, *up* 1, *down* 2, *up* 4, *down* 3 and *down* 2. In this case, the number line shows you that $3 + 1 - 2 + 4 - 3 - 2 = 1$.

Getting a handle on nothing, or zero

An important addition to the number line is the number 0, which means *nothing*, *zilch*, *nada*. Step back a moment and consider the bizarre concept of nothing. For one thing — as more than one philosopher has pointed out — by definition, *nothing* doesn't exist! Yet we routinely label it with the number 0, as in Figure 2-8.

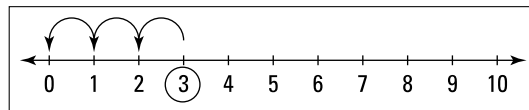
Figure 2-8:
The number line starting at 0 and continuing with 1, 2, 3, ... 10.



Actually, mathematicians have an even more precise labelling of *nothing* than zero. It's called the *empty set*, which is sort of the mathematical version of a box containing nothing.

Nothing sure is a heavy trip to lay on little kids, but they don't seem to mind. They understand quickly that when you have three toy trucks and someone else takes away all three of them, you're left with zero trucks. That is, $3 - 3 = 0$. Or, placing this on the number line, $3 - 3$ means start at 3 and go down 3, as in Figure 2-9.

Figure 2-9:
Starting at 3 and moving down three.



Seeing how close numbers are

Using the number line for taking away lets you see how far apart two numbers are. Some people call taking away 'finding the difference' — this method shows you why.

If you need to figure out $19 - 17$, you don't really want to have to count back 17 spaces. Instead, look at the number line and see directly that you'd need to take two steps to get from 17 to 19 — so $19 - 17 = 2$.



This technique works only with taking away. Don't be tempted to try it with adding.

Adding and subtracting with two rulers

You can, with a bit of work, use two rulers to add and take away small numbers. To add two numbers (let's say $7 + 5$, as in Figure 2-10), here's what you do:

- 1. Find the first number on one ruler.**

For our sum, this number is seven.

- 2. Find the second number on the other ruler.**

For our sum, this number is five.

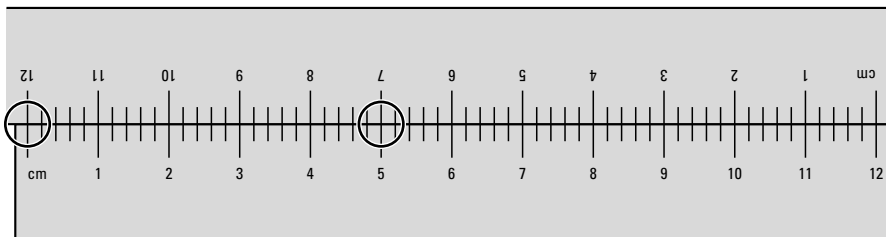
- 3. Put the two numbers next to each other.**

- 4. Find the zero on either ruler and read the number it's next to.**

For our sum, this number is 12. So, $7 + 5 = 12$.

Some rulers have centimetres on one side and inches on the other — make sure you use the centimetre side of both rulers!

Figure 2-10:
Adding
seven and
five with the
help of two
rulers.



Taking away two numbers is slightly different. Let's do $7 - 5$, as in Figure 2-11:

- 1. Find the first number on one ruler.**

For our sum, this number is seven.

- 2. Put the zero of the other ruler next to the first number.**

For our sum, put the zero next to the seven.

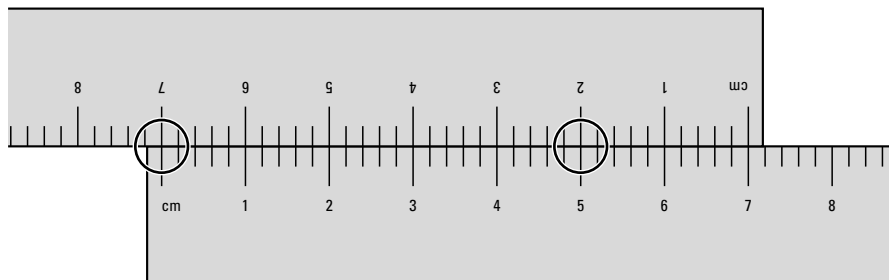
3. Find the second number on the second ruler.

For our sum, this number is five.

4. Read off the number the second number is next to.

For our sum, this number is 2. So, $7 - 5 = 2$.

Figure 2-11:
Doing the
sum $7 - 5$
with two
rulers.



Remembering Some Simple Sums

Using the number line or the ruler method that I describe in the preceding sections is all well and good if you have all the time in the world. But when your sums involve big numbers, you may need to do several small-number sums one after the other. Before you know it, you've spent hours on a sum when you could have been taking a walk in the park.

I don't usually recommend remembering things you can easily look up, but you can save yourself literally days of work if you know your number facts — that is, all of the adding sums up to $10 + 10$.

If you think this sounds like a lot of work, I'm afraid you're right: There are 100 of those pesky sums. I have some good news, though: Addition is symmetrical — it doesn't matter which way round you add things. For example, $4 + 7$ is the same as $7 + 4$ (they both make 11). So at least you only have to remember about half as many facts as you thought.

Meeting the adding table

Figure 2-12 shows an adding table to help you learn your number facts. Adding with the table is easy — you find the first number you want to add in the top row and the second number you want to add in the far-left column, and then follow down and across with your fingers until they meet.

+	0	1	2	3	4	5	6	7	8	9	10
0	0	1	2	3	4	5	6	7	8	9	10
1	1	2	3	4	5	6	7	8	9	10	11
2	2	3	4	5	6	7	8	9	10	11	12
3	3	4	5	6	7	8	9	10	11	12	13
4	4	5	6	7	8	9	10	11	12	13	14
5	5	6	7	8	9	10	11	12	13	14	15
6	6	7	8	9	10	11	12	13	14	15	16
7	7	8	9	10	11	12	13	14	15	16	17
8	8	9	10	11	12	13	14	15	16	17	18
9	9	10	11	12	13	14	15	16	17	18	19
10	10	11	12	13	14	15	16	17	18	19	20

Figure 2-12:
The adding
table for
numbers
1–10.

You can take away with the table too, but this takes a little more practice: Find the first number in the body of the table, and notice how that number is repeated through the grid in a diagonal stripe. Go along the stripe until the column you're in has the second number at the top of it. Read across to the left — the answer is at the start of the row. I show you how to solve $16 - 8$ using this method in Figure 2-13.

+	0	1	2	3	4	5	6	7	8	9	10
0	0	1	2	3	4	5	6	7	8	9	10
1	1	2	3	4	5	6	7	8	9	10	11
2	2	3	4	5	6	7	8	9	10	11	12
3	3	4	5	6	7	8	9	10	11	12	13
4	4	5	6	7	8	9	10	11	12	13	14
5	5	6	7	8	9	10	11	12	13	14	15
6	6	7	8	9	10	11	12	13	14	15	16
7	7	8	9	10	11	12	13	14	15	16	17
8	8	9	10	11	12	13	14	15	16	17	18
9	9	10	11	12	13	14	15	16	17	18	19
10	10	11	12	13	14	15	16	17	18	19	20

Figure 2-13:
Solving
 $16 - 8$ using
the adding
table.

Unfortunately, you won't always have the adding table with you. So you really do need to learn all the sums in it.



You might think that spending time on adding and taking away small numbers seems a bit basic. Don't beat yourself up about having to learn stuff that seems simple. If you ever watch a football team training, you'll see the players spend hours making simple kicks and passes to each other and running back and forth. Most of the players have done this stuff since they were six (or younger), but they still practise so that kicking, marking and running is natural and easy when they play in a real match. Spending time reminding yourself how to do the basics of maths is absolutely fine. In fact, I wish all my students would spend some time on this!

Learning your adding facts

Luckily, you can break down the adding table a bit. Start with the first column — adding one. You already know how to do that without thinking: You just go to the next number. So you hardly need to learn that column of the table.

Now look at the last row — adding ten. Adding ten is simple: You just put a one in front of the original number. For example, $2 + 10 = 12$. And $7 + 10 = 17$. (The exception is $10 + 10 = 20$, but you probably know that.)

If you're happy to count backwards, you can add nine — just add ten and count back by one. So, to do $6 + 9$, you can say ' $6 + 10$ is 16. Count back 1 to get 15.' You can check this idea works with some of the other sums in the adding table.

So, now you actually only have 28 number facts to learn — but you may wonder how you will learn them.

I suspect that if you enjoy sitting in rows at school reciting 'seven plus one equals eight, seven plus two equals nine ...' for hours on end, you probably aren't reading this chapter. That method is effective ... but deadly dull.

My way of teaching makes things a bit more interesting: I want you to play some cards:

- 1. Find a pack of cards.**
- 2. Deal two cards.**
- 3. Find the score of each of the cards.**

An ace is worth one, and the court cards (jack, queen and king) are all worth ten.

- 4. Add up the scores of the two cards.**

If you can work out the score in your head without looking at the adding table or counting, pat yourself on the back. If not, write the sum in your notebook to look back at later.

- 5. Go back to Step 2 until you run out of cards.**

Play this card game every day for a week or so. The more you do it, the fewer questions you will need to write down in your book — which means you're learning. Go you!

Tackling your take-away facts

To learn the take-away facts, I need you to play some more cards — with a twist (see what I did there?):

1. Find a pack of cards.
2. Deal three cards — two of them together and one below them.
3. Figure out the score of each of the cards.
An ace is worth one and the court cards are worth ten each.
4. Add up the scores on the first two cards.
5. If the third card is smaller than your two-card total from Step 4, take away the third card score from the two-card score. If the third card is bigger than your two-card total, take away the two-card score from the third card score.

For example, if you deal 6, 7 and 4, your sums are $6 + 7 = 13$, and then $13 - 4 = 9$. If you deal 2, 3 and a king, your sums are $2 + 3 = 5$, and then $10 - 5 = 5$.

If you work out the score in your head without looking at the adding table or counting, pat yourself on the back. If not, write down the sum in your notebook.

6. Go back to Step 2 until you run out of cards.

You'll have one card left over, so just ignore that one. Do this subtraction game every day for a week — you'll quickly get the hang of taking away.

Increasing your success with flash cards

I like to use flash cards — little cards with a question or sum on one side and the answer on the back. You can buy ready-made flash cards, find free printable ones online, or make your own out of index cards or cut-up paper.

Here's how to use your flash cards to help your adding and taking away sums:

1. Shuffle all the flash cards you want to practise.
2. Answer the question on the top one.

3. Check the answer.

If you get it right straightaway, put that card to one side; if not, put the card to the back of the pile.

4. Go back to Step 2 until you've put all the cards to one side.

The neat thing about the flash-card method is that it makes you practise the sums you need to practise more than the ones you know by heart.



Try working with flash cards against the clock. Seeing how quickly you get through the pack as you practise can be a great motivator.

What to do when you forget

Even with all the preparation in the world, you sometimes forget your sums. It happens to me, it'll happen to you, it happens to Stephen Hawking. Instead of getting upset or frustrated, finding other ways to approach a question is a good idea.



The best strategy is probably to go back to the two-rulers method or simply count on your fingers. But although these are perfectly good once-in-a-while strategies, you probably don't want to be doing them every time — otherwise, your sums take hours.

When you forget a sum, write it down in your notebook. Simply writing down the sum and flagging it up as something you'd like to know better helps your brain get hold of the information.

Don't beat yourself up about forgetting or making mistakes! Very few people are lucky enough to learn everything perfectly the first time, or even the tenth.

Super-Size Me: Working with Bigger Numbers

The sums up to $10 + 10$ are so important. Most of the sums you do involve small numbers (checking you haven't lost a finger in a washing-up accident, figuring out whether you have enough eggs for an omelette — the sums you do without even thinking about them). Importantly, these small-number sums are key building blocks to working with bigger numbers.

When you have more of a handle on simple addition and subtraction, and some tools for remembering simple sums, you're ready to move on to larger numbers. The following sections show you how.

Adding and taking away bigger numbers

For the purposes of this section, imagine travelling in a country where only three types of banknote are available: \$100, \$10 and \$1.

In your cash drawer you have \$125 — a \$100 note, two \$10 notes and five \$1 notes. You can read the first number of \$125 as how many \$100s you have, the second number as how many \$10s and the third as how many \$1s. For your birthday a generous friend gives you \$213 to celebrate. He gives you two \$100 notes, one \$10 note and three \$1 notes.

You had one \$100 and have just added two, so now you have $1 + 2 = 3$; three \$100 notes. You can do the same for the \$10s: You had two and your friend gave you one, so now you have $2 + 1 = 3$; three \$10 notes. Likewise, you had five \$1 notes. Your friend gave you three, so now you have $5 + 3 = 8$; eight \$1 notes.

Altogether, you have three \$100s, three \$10s and eight \$1s, making a grand total of \$338. Notice how you can just write down the numbers of each note to give you your final answer.

Taking away uses the same kind of idea. You have \$275 saved up and you want to buy a new game for your Xbox, which costs \$64. In your cash drawer you find two \$100 notes. The game doesn't need any of them, so you have $2 - 0 = 2$ left.

You have seven \$10s. You need six of them, so you have $7 - 6 = 1$ left.

And you have five \$1 notes, of which you have to use four, so you have $5 - 4 = 1$ left.

Altogether, that leaves you with \$211.



Knowing your adding and taking-away facts up to $10 + 10$ and $20 - 10$ will be extremely useful in this section. If you're not confident, keep practising — it'll soon come!

The basic recipe for adding numbers is to split them up into hundreds, tens and units — or \$100 notes, \$10 notes and \$1 notes, as per the preceding examples — and add each type (or each kind of banknote) separately.

In line: Adding larger numbers in columns

When you want to add larger numbers, stack them on top of each other so that the ones digits line up in a column, the tens digits line up in another column, and so on. Then add column by column, starting from the ones column on the right. Not surprisingly, this method is called *column addition*. Here's how you add $55 + 31 + 12$. First add the ones column:

$$\begin{array}{r} 55 \\ 31 \\ +12 \\ \hline 8 \end{array}$$

Next, move to the tens column:

$$\begin{array}{r} 55 \\ 31 \\ +12 \\ \hline 98 \end{array}$$



This problem shows you that $55 + 31 + 12 = 98$.

For the sake of your sums, try to keep your columns neat. Give yourself plenty of space so you don't mix up columns. Use grid paper if it helps.

Carry on: Dealing with two-digit answers

Sometimes when you're adding a column, the sum is a two-digit number. In that case, you need to write down the ones digit of that number and carry the tens digit over to the next column to the left — that is, write this digit above the column so you can add it with the rest of the numbers in that column. For example, suppose you want to add $376 + 49 + 18$. In the ones column, $6 + 9 + 8 = 23$, so write down the 3 and carry the 2 over to the top of the tens column:

$$\begin{array}{r} 2 \\ 376 \\ 49 \\ + 18 \\ \hline 3 \end{array}$$

Now continue by adding the tens column. In this column, $2 + 7 + 4 + 1 = 14$, so write down the 4 and carry the 1 over to the top of the hundreds column:

$$\begin{array}{r} 12 \\ 376 \\ 49 \\ + 18 \\ \hline 43 \end{array}$$

Continue adding in the hundreds column:

$$\begin{array}{r} 12 \\ 376 \\ 49 \\ + 18 \\ \hline 443 \end{array}$$

This problem shows you that $376 + 49 + 18 = 443$.

Columns and stacks: Subtracting larger numbers

To subtract larger numbers, stack one on top of the other as you do with addition. (For subtraction, however, don't stack more than two numbers — put the larger number on top and the smaller one underneath it.) For example, suppose you want to subtract $386 - 54$. To start, stack the two numbers and begin subtracting in the ones column: $6 - 4 = 2$:

$$\begin{array}{r} 386 \\ -54 \\ \hline 2 \end{array}$$

Next, move to the tens column and subtract $8 - 5$ to get 3:

$$\begin{array}{r} 386 \\ -54 \\ \hline 32 \end{array}$$

Finally, move to the hundreds column. This time, $3 - 0 = 3$:

$$\begin{array}{r} 386 \\ -54 \\ \hline 332 \end{array}$$

This problem shows you that $386 - 54 = 332$.

Can you spare a ten? Borrowing to subtract

Sometimes the top digit in a column is smaller than the bottom digit in that column. In that case, you need to borrow from the next column to the left. Borrowing is a two-step process:

- 1. Subtract 1 from the top number in the column directly to the left.**

Cross out the number you're borrowing from, subtract 1, and write the answer above the number you crossed out.

- 2. Add 10 to the top number in the column you were working in.**

For example, suppose you want to subtract $386 - 94$. The first step is to subtract 4 from 6 in the ones column, which gives you 2:

$$\begin{array}{r} 386 \\ -94 \\ \hline 2 \end{array}$$

When you move to the tens column, however, you find that you need to subtract $8 - 9$. Because 8 is smaller than 9, you need to borrow from the hundreds column. First, cross out the 3 and replace it with a 2, because $3 - 1 = 2$:

$$\begin{array}{r} 2 \\ \cancel{3}86 \\ -94 \\ \hline 2 \end{array}$$

Next, place a 1 in front of the 8, changing it to an 18, because $8 + 10 = 18$:

$$\begin{array}{r} 2 \\ \cancel{3}186 \\ -94 \\ \hline 2 \end{array}$$

Now you can subtract in the tens column: $18 - 9 = 9$:

$$\begin{array}{r} 2186 \\ -94 \\ \hline 92 \end{array}$$

The final step is simple: $2 - 0 = 2$:

$$\begin{array}{r} 2186 \\ - 94 \\ \hline 292 \end{array}$$

Therefore, $386 - 94 = 292$.

In some cases, the column directly to the left may not have anything to lend. Suppose, for instance, that you want to subtract $1,002 - 398$. Beginning in the ones column, you find that you need to subtract $2 - 8$. Because 2 is smaller than 8, you need to borrow from the next column to the left. But the digit in the tens column is a 0, so you can't borrow from there because the cupboard is bare, so to speak:

$$\begin{array}{r} 1002 \\ - 398 \\ \hline \end{array}$$



When borrowing from the next column isn't an option, you need to borrow from the nearest non-zero column to the left.

In this example, the column you need to borrow from is the thousands column. First, cross out the 1 and replace it with a 0. Then place a 1 in front of the 0 in the hundreds column:

$$\begin{array}{r} 0 \\ \cancel{1} 10 0 2 \\ - 3 9 8 \\ \hline \end{array}$$

Now cross out the 10 and replace it with a 9. Place a 1 in front of the 0 in the tens column:

$$\begin{array}{r} 0 \quad 9 \\ \cancel{1} \quad \cancel{10} \quad 102 \\ - 3 \quad 98 \\ \hline \end{array}$$

Finally, cross out the 10 in the tens column and replace it with a 9. Then place a 1 in front of the 2:

$$\begin{array}{r} 0 \quad 9 \quad 9 \\ \cancel{1} \quad \cancel{10} \quad \cancel{10} \quad 12 \\ - 3 \quad 9 \quad 8 \\ \hline \end{array}$$

At last, you can begin subtracting in the ones column: $12 - 8 = 4$:

$$\begin{array}{r} 0 \ 9 \ 9 \\ + \cancel{10} \ \cancel{10} \ 12 \\ - 3 \ 9 \ 8 \\ \hline 4 \end{array}$$

Then subtract in the tens column: $9 - 9 = 0$:

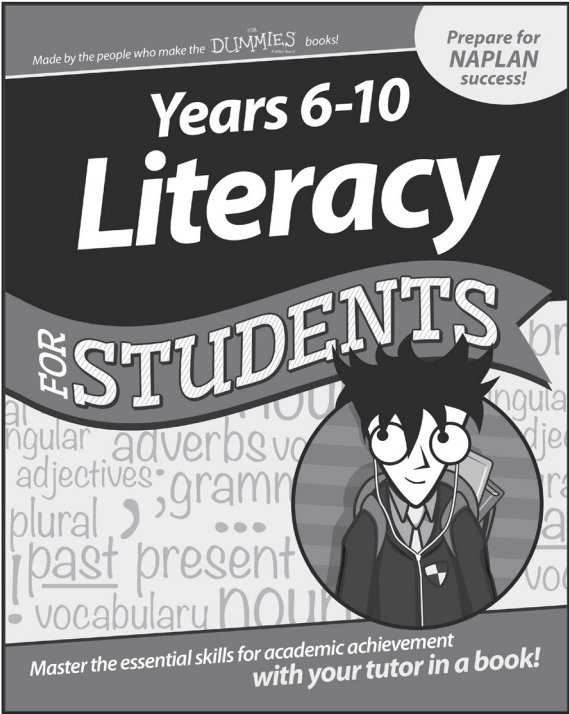
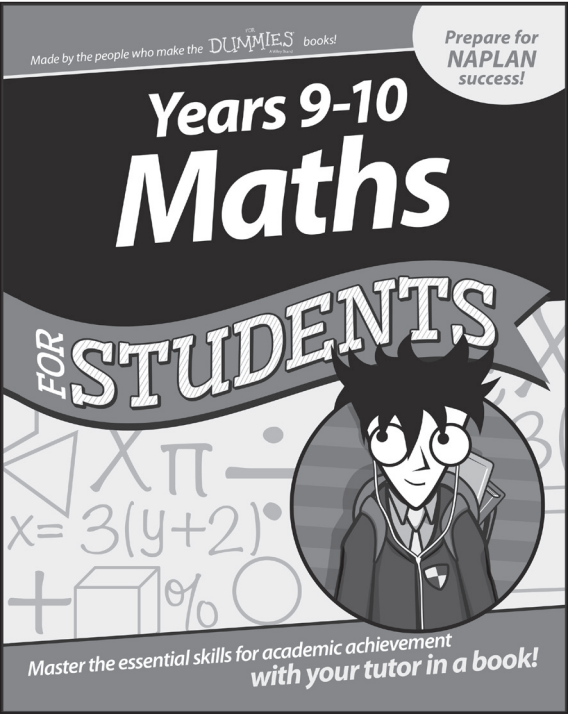
$$\begin{array}{r} 0 \ 9 \ 9 \\ + \cancel{10} \ \cancel{10} \ 12 \\ - 3 \ 9 \ 8 \\ \hline 0 \ 4 \end{array}$$

Then subtract in the hundreds column: $9 - 3 = 6$:

$$\begin{array}{r} 0 \ 9 \ 9 \\ + \cancel{10} \ \cancel{10} \ 12 \\ - 3 \ 9 \ 8 \\ \hline 6 \ 0 \ 4 \end{array}$$

Because nothing is left in the thousands column, you don't need to subtract anything else. Therefore, $1,002 - 398 = 604$.

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