# Chapter 1

# Getting Down to the Terms of Geometry

### In This Chapter

- The in-a-nutshell version of what geometry is
- Undefined but describable terms (a point, a line, and a plane)
- Defined terms (a line segment, a ray, and an angle)
- Postulates and theorems (they're like black and white)

You know that geometry is a math thing. That much you've got nailed down. But what you *don't* know is what geometry is exactly — or what kinds of things are involved with it. Well, you're at the right place. This chapter cuts to the chase with the basics. It explains the concept of geometry and defines the various thingamabobs that are used with it, plain and simple.

## So What Exactly Is Geometry?

Well, how about the literal definition first: Geometry's origins come from the Greek word *geōmetria*. *Gē* means "earth," and *metre* means "measure." So, if we're talking literally here, *geometry* means "earth measure."

That aside, here's a doozie of a real-world definition, highbrow though it is: *Ordinary plane geometry* generally deals with the application of definitions, postulates, and theorems and is based on Euclid's work, *Elements,* from about 300 B.C.

## Euclid: The father of geometry

Euclid was a Greek mathematician who lived around 300 B.C. The exact dates of his life aren't known, but his bounty of work surely is. Euclid's best-known work is *Stoicheia,* which is Greek for "elements." In the twelfth century, Euclid's *Elements* was translated into Latin and took on the title *Elementa*. By whatever name, the work still marks the cornerstone of traditional geometry. Euclid's *Elements* contains 13 books and outlines postulates, theorems, and definitions for use within proofs. Two additional books, Books 14 and 15, are usually included in the text, but they aren't authored by Euclid. These books weren't part of his original work; they were added at a later point.

The following books from *Elements* are of particular interest to the development of geometry. You'll see the parallel as you explore the chapters of this book.

Book 1 contains info on triangles, including their construction and properties and the relation of their sides and angles to each other.

Book 3 contains the elementary geometry of the circle, including info on chords, secants, and tangents.

Book 4 explores problems resulting from inscribing polygons within circles and circumscribing polygons about circles. In particular, triangles and regular polygons are addressed.

Book 5 presents proportions and ratios, the basis for similar triangles.

Book 6 applies the theory of proportion from Book 5 to plane geometry. The info in this book was introduced by Pythagoras but tweaked by Euclid.

Books 11 through 13 deal with solid geometry.

And here, finally, is what you really need: In a nutshell, *geometry* is a section of math that involves the measurements, properties, and relationships of all shapes and sizes of things — from the tiniest triangle to the largest circle to the rectangle, and much more.

# Terms Related to Geometry

This section defines the various terms that are involved with geometry. Well, wait. I need to modify that. Because geometry involves some things called *undefined terms,* this section defines various terms involved with geometry *and* describes other terms that are pretty much undefinable.

## Terms so basic they can only be described

Geometry uses lots of defined terms, but many of those defined terms make use of undefined terms in their definitions. That may sound perplexing, but it's really not a big deal. Basically, *undefined terms* are words that are already so basic that they can't be defined in simpler terms, so they're described instead of defined. Undefined terms include a point, a line, and a plane.

### A point

A *point* is represented by a dot, like a period on a page (see Figure 1-1). You name it by using a single uppercase letter. A point has no size and no dimension. Plainly put, that means it has no width, no length, and no depth. It only indicates a definite location or position. Essentially, other than indicating a location, a point has no physical existence.


**Figure 1-1:** A point.

### A line

What's the quickest way to get from one place to another? A straight line. Yes, a concept of geometry can actually help you get to class on time. A *line* is straight and has no thickness (see Figure 1-2), and it's made up of a set of points that extends infinitely in both directions. The points that make up the line are called collinear points (see Figure 1-3). A line can be named by a lowercase letter, but, more commonly, it's named by any two points on the line.

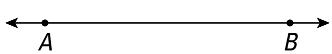


**Figure 1-2:** A line.


**Figure 1-3:** Collinear points, which make up a line.

### A plane

No airports, no runways, no luggage. This plane doesn't fly. It only exists in two-dimensional (2-D) space, which means it has length and width but no depth. A *plane* in geometry is an infinite flat surface that has no boundaries and may be extended infinitely in any direction (see Figure 1-4). It is a set of all the lines that can be drawn through two intersecting lines. It is determined by exactly three non-collinear points. The flip-flop is also true; exactly one plane contains three non-collinear points (see Figure 1-5). A plane is indicated by a closed four-sided polygon and is named by a capital letter in one of its corners (as shown in Figure 1-4).

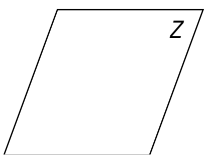


**Figure 1-4:** A plane.

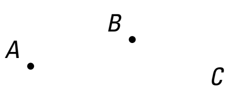


**Figure 1-5:** Exactly one plane contains three non-collinear points.

## Terms that do have definitions

*Defined terms* in geometry can be defined (OK, yes, that's pretty intuitive). Defined terms include a line segment, a ray, and an angle.

### A line segment

A line segment, unlike a line, is not a never-ending story. It has a beginning, and it has an end. A *line segment* is a part of a line that has two endpoints that mark its finite length (see Figure 1-6). The names of these endpoints taken together are used to name the segment. Although the line segment may be identified by only two points, it is made up of not only those two endpoints but all the points between them. Because a line segment has a finite length, it can — unlike a line — be measured.

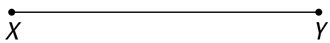


**Figure 1-6:** A line segment.

### A ray

A ray of sunshine begins at the sun and extends out into the sky. A ray has a beginning — it starts somewhere — but it has no end. A *ray* is a part of a line that has only one endpoint and extends infinitely in one direction (see Figure 1-7). Similar to a line segment, a ray has an infinite number of points on it. A ray is named by its endpoint and a point on the ray. In the letter pair that names the ray, the letter of the endpoint appears first.

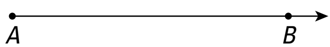


**Figure 1-7:** A ray.

### An angle

If lines meet, they can form a relationship. In the social world of lines, this meeting is called an angle. The stereotypical angle looks something like the letter *V* (see Figure 1-8). An *angle* is the union of two rays or two line segments that meet at the point of the V. This point is called a common endpoint. The rays or line segments form the sides of the angle; the common endpoint, called the *vertex* of the angle (the vertex is the tip of the V), is used to name the angle. I just want to mention real quick that not all angles look like "V's." Which one's do and which don't are explored in Chapter 2.

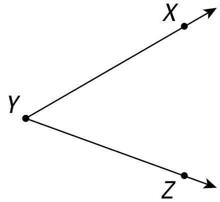


**Figure 1-8:** An angle.

## Postulates: A matter of trust

With life, it's easy to assume that something is true because it appears to be true. Same goes with geometry. In geometry, you can accept some statements or basic assumptions as being true without having to go to all the trouble of proving them. For those of you with trust issues, this concept may be a bit difficult to accept at first. But when you realize how much work it saves you, I'm sure you'll come around. The statements or basic assumptions that you can accept as being true are called *postulates.* Sometimes you see them referred to as *axioms.* And other times you may even see postulates and axioms separated out as two different kinds of statements. Regardless, the most important thing to remember about these statements is that you do *not* have to prove them. By learning these statements, you can save yourself a lot of time and aggravation when solving geometry problems.

Here's an example — your first postulate. It contains information about a line, and it's something that is self-evident but may actually be quite difficult to prove:

***Postulate 1-1:*** Two points determine a line.

Translation? You need to identify two points in order to draw a straight line.

The word *postulate* actually comes from the Latin word *postulatus,* meaning "self-evident truth." The word *axiom* has its roots in the Latin word *axioma,* meaning "self-evident thing." I just know that explaining this kind of stuff will make the exploration of geometry just that much more fulfilling for you. Really.

## Theorems: Prove it, babe

A theorem is in a way the opposite of a postulate. While a postulate is a statement accepted as true without proof, a *theorem* is a statement that you have to prove to be true. Postulates are actually used in the process of proving theorems. Proving a theorem is part of a process, one in which the next logical step is a geometric proof. I hesitate to say anything more here. (I go into all this proof stuff in Chapter 4.) I have included an example of a theorem below so that you can get a glimpse of all the fun to come!

***Theorem 1-1:*** If two lines intersect, then they do so at exactly one point.

Closely related to the theorem is the corollary. It is a theorem that can be easily proved with the assistance of another theorem or postulate.

OK, that's a wrap. You're now acquainted with the basic terms you will encounter while studying geometry. It is time to put these terms to good use.