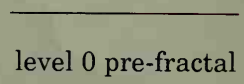
3. Draw a circle of radius 3 in. Use the compass method with rulers 4 in., 2 in., and 1 in. to approximate the circumference as if the circle were a coastline. Create a table of data.
   a. Does the approximate length of the circumference increase as the ruler length decreases?
   b. Will it continue to increase, or will it stop at a certain length?
   c. How is a circle's circumference different from a jagged coastline's length?

How to Generate Fractals

The study of real-world irregular forms led Mandelbrot to explore some curves of infinite length that were easy to generate and describe mathematically, using a process called *iteration*. The process of iteration is used to generate the three examples of fractals that follow.

Example 1 The Koch Curve

1. Draw a segment three units long. This figure is called the *level 0 pre-fractal*, or an *initiator*.
2. Trisect the segment and erase the middle third.
3. Construct two sides of an equilateral triangle with vertices at the inner ends of the two remaining pieces. This is called the *level 1 pre-fractal*, or a *generator*. Notice that a segment of length 3 has been replaced by four connected segments, each with length 1 unit. Each of the four segments is $\frac{1}{3}$ as long as the original segment.
4. To construct a level 2 pre-fractal, replace every segment of length 1 unit in the level 1 pre-fractal by using the process described in steps 2 and 3.
5. To construct a level 3 pre-fractal, replace every segment of length $\frac{1}{3}$ unit in the level 2 pre-fractal by again using the process described in steps 2 and 3.



level 0 pre-fractal

level 1 pre-fractal

level 2 pre-fractal

level 3 pre-fractal

As the level n gets larger, the pre-fractal curves approach a curve that is called a *fractal*. The fractal in the example above is called the *Koch*, or "snowflake," *curve*. It was created in 1904 by the Swedish mathematician Helge von Koch. The following table gives the length of an edge, the number of edges, and the total length of each pre-fractal for the Koch curve.