# Assignment #2: Simple Java Programs
Due: 3:15pm on Monday, October 15th

Your job in this assignment is to write programs to solve each of these six problems.

1. Write a **GraphicsProgram** subclass that draws a pyramid consisting of bricks arranged in horizontal rows, so that the number of bricks in each row decreases by one as you move up the pyramid, as shown in the following sample run:
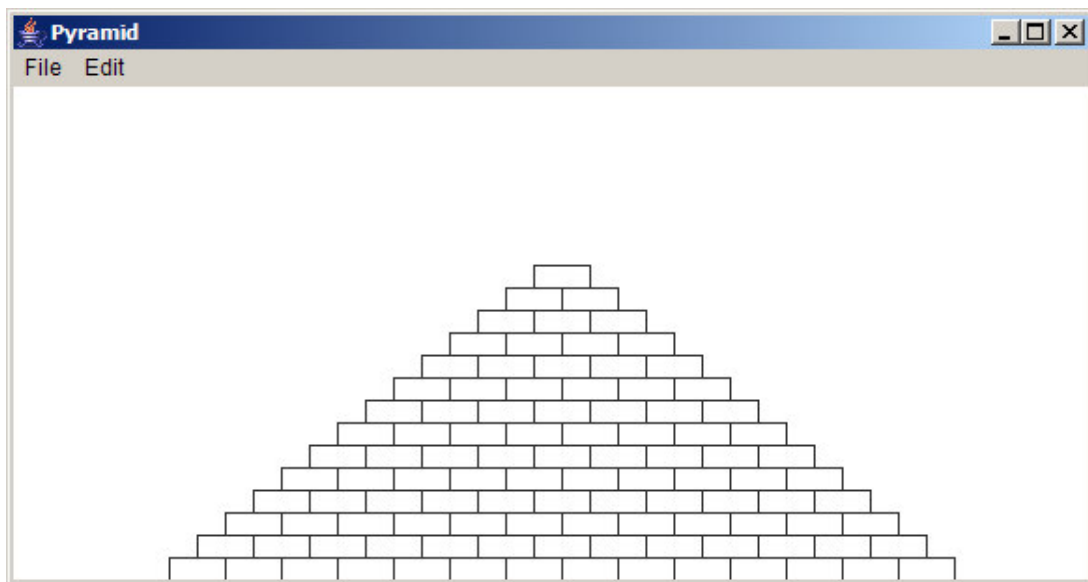
The pyramid should be centered at the bottom of the window and should use constants for the following parameters:

|	
BRICK_WIDTH	The width of each brick (30 pixels)
BRICK_HEIGHT	The height of each brick (12 pixels)
BRICKS_IN_BASE	The number of bricks in the base (14)

The numbers in parentheses show the values for this diagram, but you must be able to change those values in your program.

2. Suppose that you've been hired to produce a program that draws an image of an archery target—or, if you prefer commercial applications, a logo for a national department store chain—that looks like this:

This figure is simply three **GOval** objects, two red and one white, drawn in the correct order. The outer circle should have a radius of one inch (72 pixels), the white circle has a radius of 0.65 inches, and the inner red circle has a radius of 0.3 inches. The figure should be centered in the window of a **GraphicsProgram** subclass.

3. Write a **GraphicsProgram** subclass that draws a partial diagram of the **acm.program** class hierarchy, as follows:
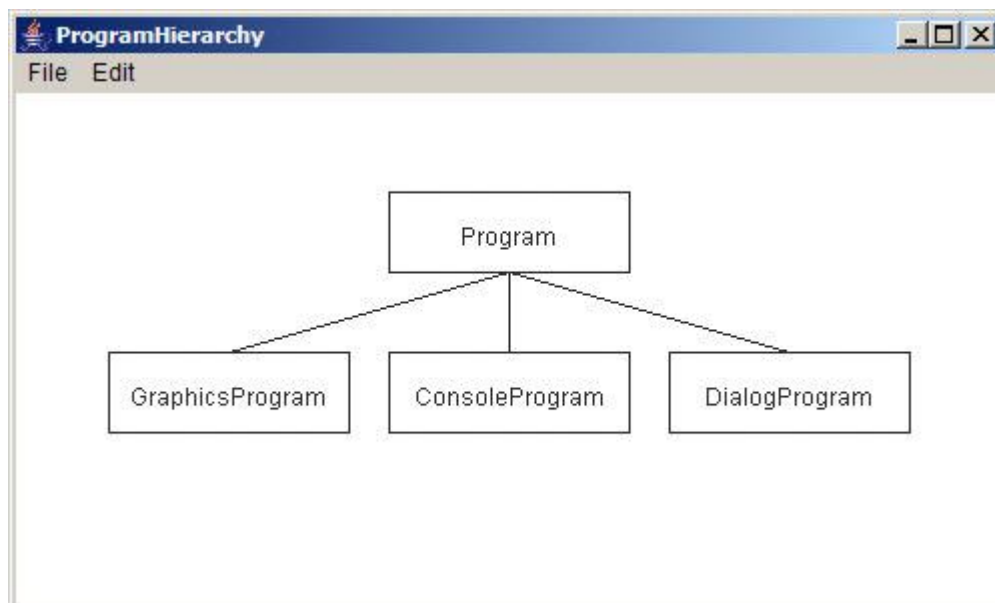
The only classes you need to create this picture are **GRect**, **GLabel**, and **GLine**. The major part of the problem is specifying the coordinates so that the different elements

of the picture are aligned properly. The aspects of the alignment for which you are responsible are:

- The **width** and **height** of the class boxes should be specified as named constants so that they are easy to change.

- The labels should be centered in their boxes. You can find the width of a label by calling `label.getWidth()` and the height it extends above the baseline by calling `label.getAscent()`. If you want to center a label, you need to shift its origin by half of these distances in each direction.

- The connecting lines should start and end at the center of the appropriate edge of the box.

- The entire figure should be centered in the window.

4. In high-school geometry, you learned the Pythagorean theorem for the relationship of the lengths of the three sides of a right triangle:

$$a^2 + b^2 = c^2$$
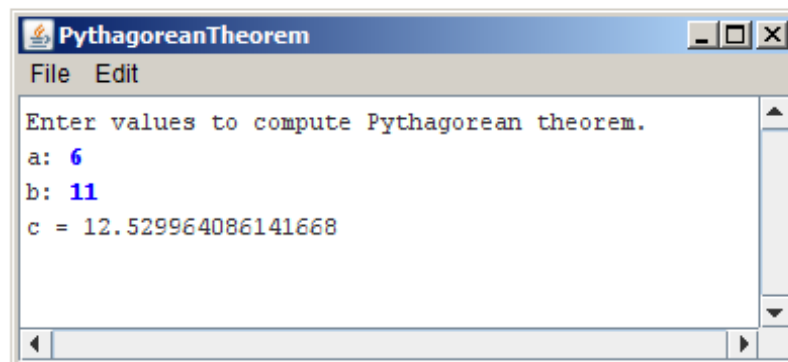
which can alternatively be written as:

$$c = \sqrt{a^2 + b^2}$$

Most of this expression contains simple operators covered in Chapter 3. The one piece that's missing is taking square roots, which you can do by calling the standard function `Math.sqrt`. For example, the statement
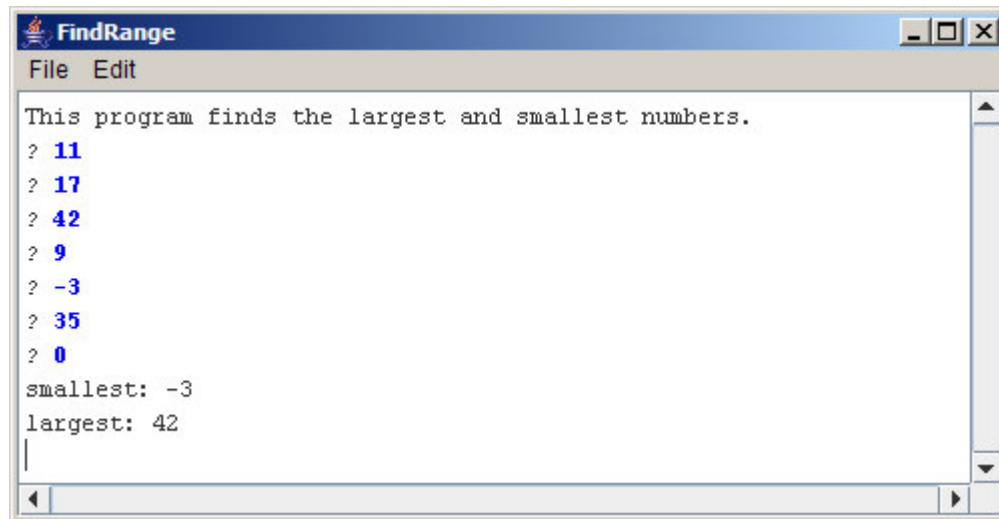
```
double y = Math.sqrt(x);
```

sets `y` to the square root of `x`.

Write a `ConsoleProgram` that accepts values for `a` and `b` as `int`s and then calculates the solution of `c` as a `double`. Your program should be able to duplicate the following sample run:

```
PythagoreanTheorem                        _ □ ×
File  Edit

Enter values to compute Pythagorean theorem.
a: 6
b: 11
c = 12.529964086141668
```

5. Write a `ConsoleProgram` that reads in a list of integers, one per line, until a sentinel value of 0 (which you should be able to change easily to some other value). When the sentinel is read, your program should display the smallest and largest values in the list, as illustrated in this sample run:

```
FindRange                                          _ □ ×
File  Edit

This program finds the largest and smallest numbers.
? 11
? 17
? 42
? 9
? -3
? 35
? 0
smallest: -3
largest: 42
```

Your program should handle the following special cases:

*   If the user enters only one value before the sentinel, the program should report that value as both the largest and smallest.

*   If the user enters the sentinel on the very first input line, then no values have been entered, and your program should display a message to that effect.

6. Douglas Hofstadter's Pulitzer-prize-winning book *Gödel, Escher, Bach* contains many interesting mathematical puzzles, many of which can be expressed in the form of computer programs. In Chapter XII, Hofstadter mentions a wonderful problem that is well within the scope of the control statements from Chapter 4. The problem can be expressed as follows:

> Pick some positive integer and call it n.
> If n is even, divide it by two.
> If n is odd, multiply it by three and add one.
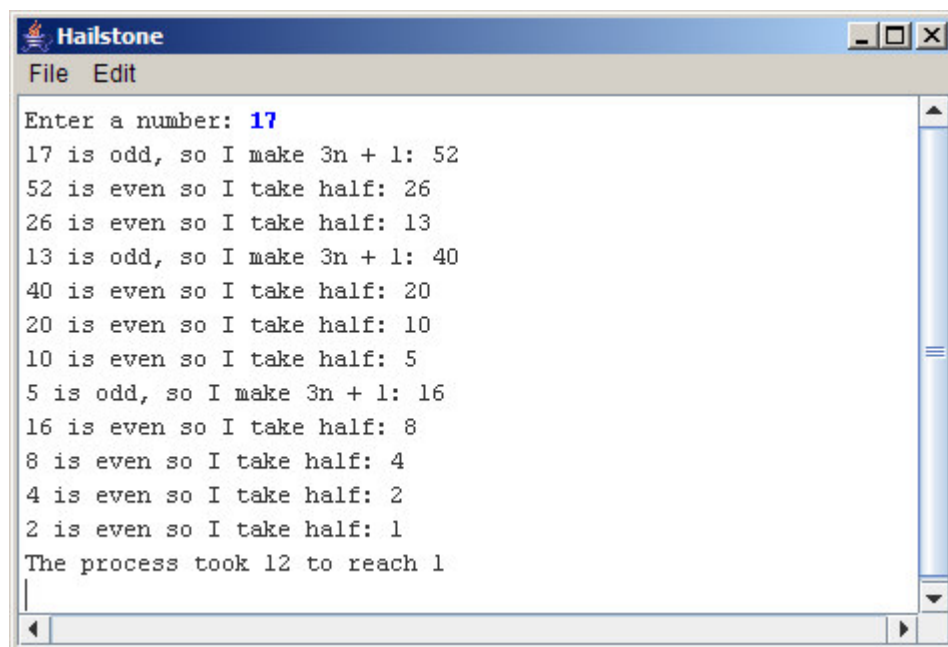> Continue this process until n is equal to one.

On page 401 of the Vintage edition, Hofstadter illustrates this process with the following example, starting with the number 15:

15	is odd, so I make $3n+1$:	46
46	is even, so I take half:	23
23	is odd, so I make $3n+1$:	70
70	is even, so I take half:	35
35	is odd, so I make $3n+1$:	106
106	is even, so I take half:	53
53	is odd, so I make $3n+1$:	160

160	is even, so I take half:	80
80	is even, so I take half:	40
40	is even, so I take half:	20
20	is even, so I take half:	10
10	is even, so I take half:	5
5	is odd, so I make $3n+1$:	16
16	is even, so I take half:	8
8	is even, so I take half:	4
4	is even, so I take half:	2
2	is even, so I take half:	1

As you can see from this example, the numbers go up and down, but eventually—at least for all numbers that have ever been tried—comes down to end in 1. In some respects, this process is reminiscent of the formation of hailstones, which get carried upward by the winds over and over again before they finally descend to the ground. Because of this analogy, this sequence of numbers is usually called the **Hailstone sequence,** although it goes by many other names as well.

Write a `ConsoleProgram` that reads in a number from the user and then displays the Hailstone sequence for that number, just as in Hofstadter's book, followed by a line showing the number of steps taken to reach 1. For example, your program should be able to produce a sample run that looks like this:

```
Hailstone                                    _ □ ×
File  Edit

Enter a number: 17
17 is odd, so I make 3n + 1: 52
52 is even so I take half: 26
26 is even so I take half: 13
13 is odd, so I make 3n + 1: 40
40 is even so I take half: 20
20 is even so I take half: 10
10 is even so I take half: 5
5 is odd, so I make 3n + 1: 16
16 is even so I take half: 8
8 is even so I take half: 4
4 is even so I take half: 2
2 is even so I take half: 1
The process took 12 to reach 1
```

The fascinating thing about this problem is that no one has yet been able to prove that it always stops. The number of steps in the process can certainly get very large. How many steps, for example, does your program take when n is 27?