

CS120 - Computer Science I

Lab #2

Fall 2014

Due: At the end of lab.

The purpose of this lab is to create and execute a C++ program that calculates some somewhat complex mathematical formulas, and to get more practice using C++ stream I/O.

Computers are often used for *solids modeling*. Basic shapes, called *primitives*, are created, intersected, added and subtracted to produce more complex shapes. Two common calculations that are of interest in solids modeling programs are the volume and surface area of the solid.

For this lab, you are to write a program that prompts the user for values of radius and height, and outputs the volume and surface area for the following solids:

- Right circular cylinder:

$$V = \pi r^2 h$$

$$S = 2\pi r(r + h)$$

- Right circular cone:

$$V = \frac{1}{3}\pi r^2 h$$

$$S = \pi r(r + \sqrt{r^2 + h^2})$$

- Sphere (does not use height)

$$V = \frac{4}{3}\pi r^3$$

$$S = 4\pi r^2$$

In addition to volume and surface area, the *ratio* of the two is often of interest, since it provides a measure of the relative “efficiency” of the solid, i.e., how much volume can be enclosed by a certain amount of surface material. For instance, in the case of a pop can (a right circular cylinder), the ratio would give some indication of the amount of liquid that can be enclosed by a certain amount of aluminum sheet - the larger the number, the more “efficient” the can will be. For this assignment, also output the ratio of volume to surface area for each solid.

The above formulas contain a mathematical operation (square root) that is rather difficult to compute using just the basic arithmetic operators. Other examples of such operations include the trigonometric functions (sine, cosine, tangent, etc.) and logarithms. To solve this problem, the designers of C provided *library functions* for us to use. To use the library functions, you need to `#include <cmath>` in your program (the name of the library includes a *c* to indicate that the library functions come from the original C language), then know the name of the library function you wish to use. Similar to use in mathematics, the *arguments* to the library functions are enclosed in parentheses.

For this lab, input your program using a text editor, compile it, and try it on several test cases (i.e., several sets of input values). Use the value of 3.14159 for π . Use proper style and commenting in your program. It is recommended that you place each lab and assignment in a separate subdirectory; for example, a possible directory name for this assignment might be `assignment2`. Once you are sure that the program works properly, use `cscheckin` to submit the *source code* (**not** the executable or script).

An example compilation and execution of the program might look like:

```
$ g++ assignment2.cpp
$ ./a.out
Enter values for radius and height: 2.0 3.1

For a right circular cylinder:
    The volume is:                38.9557
    The surface area is:          64.0884
    The ratio of volume to surface area is: 0.607843

For a right circular cone:
    The volume is:                12.9852
    The surface area is:          35.7461
    The ratio of volume to surface area is: 0.363263

For a sphere
    The volume is:                33.5103
    The surface area is:          50.2654
    The ratio of volume to surface area is: 0.666667
$
```