CS120 - Computer Science I
Lab #5
Fall 2014

Due: At the end of lab.

For this lab you will be rewriting Lab #2, calculating the volume and surface area of different solids, as a menu-driven program with functions (similar to the the calculator program from the text). You will also be working in pairs using pair programming. In pair programming there are two programmers that alternate between different roles. One role is the "driver" who sits at the keyboard and types and the other role is the "navigator" who watches for typos and similar errors and makes sure the program follows the overall design. The programmers periodically switch roles, which is what you will be doing with your teammate for this lab. The exact "schedule" for trading roles is given below.

Overall the program your teams creates should allow the user to pick a shape to calculate the volume and surface area of (the list of shapes and the relevant formulas are given below). Then the program should ask the user for the data needed for the calculations (for example, the height and radius), perform the calculations, and print the answer. You should use a `switch` statement, as in the calculator program, and functions to perform the actual calculations.

To make sure both teammates get programming time follow the following schedule:
1) Begin by having one team member act as the driver and program the basic structure of `main()`, but only for the right circular cylinder. `main()` should call functions, which are written in the next step, to get the user's input and to calculate the surface are and volume of the cylinder.
2) Switch roles and have the other team member program the functions to get a value from the user, to calculate the surface area (i.e. two separate functions).
3) Switch roles again and have the first "driver" write the function to calculate the *volume* of the right circular cylinder and extend `main()` to also print the ratio of the volume to surface area.
4) Switch roles again and extend `main()` to include the right circular cone.
5) Switch roles and write the functions to calculate the surface area and volume of the right circular cone and make any changes to `main()` that are needed.
6) Do the same thing for the sphere.

- 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
```

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