**Background:**

The Blue Ridge Gourmet Spirits company has hired you to solve a critical business problem. In recognition of completing their first year in business, the owner is having custom commemorative beer mugs made. The design team is evaluating several different logos that may appear on the mugs. Each logo under consideration requires a different amount of space on the mug. The design team needs a computer application that they can use to quickly determine how big the beer mug must be to accommodate a logo of given height and width. There are two primary design constraints:

1. The diameter of the mug must be 1.5 times the width of the logo
2. The height of the mug must be 2.0 times the height of the logo

Using a right circular cylinder to represent the dimensions of the mug, these constraints are shown in Figure 1 below.

![Figure 1 Commemorative Mug Design](image-url)
Given Figure 1, and the design constraints, the following relations must hold:

\[ d_m = 1.5 \times w_l \]
\[ h_m = 2.0 \times h_l \]
\[ r_m = 0.5 \times d_m \]

where,
- \( d_m \) is the mug diameter
- \( h_m \) is the mug height
- \( r_m \) is the mug radius
- \( w_l \) is the logo width
- \( h_l \) is the logo height

Additionally, the design team needs to know the surface area of the mugs \((S_1)\), the lateral surface area \((S_2)\), and the volume \((V)\) as given by the following equations:

\[ S_1 = 2\pi r_m (h_m + r_m) \]
\[ S_2 = 2\pi r_m h_m \]
\[ V = \pi (r_m)^2 h_m \]

(Note \( S_1 \) includes the area of the base and top whereas \( S_2 \) does not. These quantities will provide the design team with a rough estimate of the upper and lower bounds on the amount of glass necessary to produce the mugs.)

**Programming Skills**

The programming skills required to complete this assignment include:

- Declaring variables and constants
- Properly naming C++ identifiers
- Basic Input/Output
  - Reading input data from the user (keyboard)
  - Printing output information to the terminal window
- Converting algebraic equations to C++ statements
- Basic problem solving
Requirements:

Your job is to write three computer programs. Each program will prompt the user to enter the dimensions of the logo to be evaluated ($w_l$ and $h_l$). Once the required data have been entered, the program must compute the associated dimensions of the mug ($h_m$, $d_m$, and $r_m$). All three programs will have this functionality.

Your first program will also compute $S_1$, your second program will compute $S_2$, and your final program will compute $V$.

Each program will output to the computer screen the following information:

- The dimensions entered by the user
- The computed dimensions of the mug
- The final computation ($S_1$, $S_2$, or $V$) as applicable.

Below is an example of how running the first program might look.

![Screenshot of program output]

You entered the following logo dimensions:

Height = 2.5000
Width = 1.7500

For this size logo, your mug dimensions must be:

Height = 5.0000
Diameter = 2.6250
Radius = 1.3125

The surface area ($S_1$) of the mug is 52.0572 units squared.

Thank you for using the Blue Ridge Gourmet Spirits
Mug Dimension Calculation Engine version 2.0
Extra Credit

For 10 points extra credit, submit a fourth program that computes $S_{1b}$. Where $S_{1b}$ is the exact surface area of the mug. You are expected to derive the formula for this quantity on your own. Include comments within the program that fully describe the methodology followed to compute this value.

Due Date

This assignment is due on Monday, January 30, 2012 at no later than 11:59 pm. In general, requests for additional time will not be considered. Early submissions are encouraged. Late penalties will be assessed as stated in the course syllabus.

What To Submit

You must submit one .zip compressed file that contains the source code files for all three of your programs (or four if you complete the extra credit requirement).

File Naming

Please follow the file naming conventions listed below:

- Program 1 file name: <netID>P1a.cpp
- Program 2 file name: <netID>P1b.cpp
- Program 3 file name: <netID>P1c.cpp
- Program 4 file name: <netID>P1Ex.cpp (this file is optional)
- Compressed file name: <netID>P1.zip

Note that you must replace <netID> with your actual netID. Do not include the angle brackets in your file names (e.g. waw23P1a.cpp).

Academic Integrity

This is an individual project and all work must be your own. No documentation of references is required for this project. Otherwise, you must follow all guidelines specified in the Academic Honesty section of this course syllabus.
Grading

This graded assignment is worth 100 points and will be counted as part of the Programming Projects category for the course. Points are allocated as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program compiles and runs</td>
<td>45</td>
</tr>
<tr>
<td>Variables and constants are correctly declared and of correct type</td>
<td>12</td>
</tr>
<tr>
<td>Computations are accurate</td>
<td>12</td>
</tr>
<tr>
<td>Screen output is complete and accurate</td>
<td>12</td>
</tr>
<tr>
<td>File naming conventions are followed exactly</td>
<td>9</td>
</tr>
<tr>
<td>Correct file, in correct format, with complete contents, is posted to Blackboard</td>
<td>9</td>
</tr>
<tr>
<td>Comments</td>
<td>1</td>
</tr>
</tbody>
</table>

With the exception of the Comments category, all values are evenly divisible by 3. One third of the points in each category above will be allocated to each of the three required programs. For example if your first program compiles and runs, that is worth 15 points; if all variables and constants are correctly declared in your first program, that is worth 4 points, etc. As stated in the course syllabus a penalty of 2.5 points per quarter hour will be assessed to late submissions.

The Comments category is worth minimal points for this project. Moving forward comments will become much more significant in your programs. In this project you must include the following comments at the start of each program:

```
/******************************************************************************
 *                                                                     *
 *  <FileName>.cpp                                                      *
 *                                                                     *
 *  COSC 051 Spring 2012                                               *
 *  Project #1                                                         *
 *                                                                     *
 *  Due on:               JAN 30, 2012                                   *
 *  Created on:           MMM DD, 2012                                  *
 *  Last edited on:       MMM DD, 2012                                 *
 *  Author: <your name>                                               *
 *  netID: <your netID>                                               *
 *                                                                     *
*******************************************************************************/
```