

ES1036: Programming Fundamentals – **Winter 2018**

Lab01: Standard input-output and simple arithmetic expressions in C++

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Work on the lab well ahead of time. Contact your instructor/TA as soon as you find any of the following materials confusing.

A. Rationale and Background

Welcome to ES1036 Lab01. In Lab00 you've learned how to create a solution and a project in Visual Studio 2015 or Xcode. You are encouraged to revisit Lab00. In this lab you will open your **existing solution** *ES1036Labs* and create your **second project** *Lab01*. Using the same solution will help you keep your lab work from this course organized.

In this lab you will write your own simple programs by declaring variables and writing simple arithmetic expressions. Once you complete the lab you will be able to

- Write and execute a simple C++ program
- Use `cin` and `cout` statements
- Do your own calculations in C++ using arithmetic expressions

B. How to Get Full Credit for this Lab

You will get credit for your lab when you demonstrate it to your TA, and get your TA's approval. During code-demonstration, your TA will ask you some questions on your code and request you to modify your code and/or write some other simple codes. When you finish working on Lab 01, you will be required to upload your .cpp files (**no other file types are accepted!**) to OWL after changing the file name by following the naming convention in Lab 00. A zero grade will be awarded for a **missing OWL submission** or **missing the lab demonstration session**.

B.1. Submission Instructions

Number of files	:	3
Files to be submitted	:	.cpp files for E.1, E.2, and E.3
Rename these files as	:	your_uwo_user_name_lab01_q1.cpp, your_uwo_user_name_lab01_q2.cpp, your_uwo_user_name_lab01_q3.cpp

C. Good Programming Practice (Very Important Reading)

- Include comments in your program; **YOU WILL BE MARKED ON THIS!**
- Choose meaningful and descriptive names for the variables.
- Initialize your variables appropriately.
- Indent your code. YOU WILL BE MARKED ON THIS! You have learned how to fix indentation problems in the previous lab. Refer to the Lab0 instruction file if you need to refresh your memory.

D. Pre-lab Questions

It is important that you read and understand the lab beforehand. Answering the following questions will help you get ready. You do not have to submit the pre-lab but be ready for a simple lab quiz.

**** Also see section 'F' of this file for fantastic *practice questions* for your quiz, demo, and midterm preparation! ****

- What is the purpose of the function `main()` in the following code?

```
#include <iostream>

int main()
{
    std::cout << "Welcome to ES1036 labs!" << std::endl;
    return 0;
}
```

- Explain the purpose of each line in the above code.
- When do you use `cout` and `cin`?
- How do you declare variables in C++?
- How do you include comments in C++?
- What are the variables declared in the following code?

```
#include <iostream>
#include <string>
int main()
{
    int age;           //a variable named age of type int
    string name;       //a variable named name of type string

    std::cout << "Tell me your name please:";    //prints on screen
    std::cin >> name;                            //waits for keyboard input
    std::cout << "Tell me your age please:";     //prints on screen
    std::cin >> age;                             //waits for keyboard input
    std::cout << "Hello" << name << "you are" << age << "years old." <<
    std::endl;

    return 0;
}
```

- What is the purpose of the above code?

- What does the line before the `return 0` do?
- What is the major difference between the data-types `int` and `double`?
- What is the limitation of integer division?
- Important note:
 - We need to include the library file `<string>` to be able to use any `string` type data.
 - String type data can only handle any string input **without any white space characters**, i.e., space, keyed in by space-bar, Enter-key or tab-key when entered from the keyboard in response to the `cin` statement.
 - If you assign any string to a string variable during code-writing, you can use white space characters inside the string: e.g., `string message = "This is a string";`
 - String data declaration and string assignment can be done in two different statements.
E.g., `string message;`
`int k = 10;`
`message = "This is a string";`

E. Lab Questions

***** These are the parts that you need to complete to obtain full credit*****

E.1. Question 1: Grade calculator

Requirement:

Write a program (according to the specifications outlined below) that calculates a weighted grade of 4 assignments.

Specifications:

1. The program will print your info and a message that describes its mission as shown in the output example.
2. It will prompt the user for four project marks, along with their grade weight.
3. A final course grade will be computed based on the user inputs, and will be shown to the user as demonstrated in the sample output, where Final Grade = $\text{grade1} * \text{grade1 weight} + \dots + \text{grade4} * \text{grade4 weight}$, and '*' sign represents the multiplication operator.
4. Do not worry if the grade weights do not add to one for this question, we will trust the user to input correct values.

Design:

Draw a flow chart (see **lecture Unit 2: slide #42-44**) on paper and show it to your TA during lab-demonstration.

Implementation Hints:

- Refer to the lecture notes for capturing user input in a C++ program
- Remember to declare variables before attempting to use them in a program
- Pay close attention to different variable types, and when it is appropriate to use them

Ask yourself the following questions:

- If you change the data-type of the variable that stores a project weight from double to integer (int),
 - Will the code compile? If NOT, why?
 - Will the code run? If NOT, why?
 - Will the code give out a correct result? If NOT, why?

Sample output:

```
*****
ES1036b: Lab 01 Q1
Date:
Name:
Student Number:
Program's mission: This program calculates
the volume and surface area of a Cylinder
*****
Input the first grade:
80
Input the first grade weight:
0.2
Input the second grade:
70
Input the second grade weight:
0.3
Input the third grade:
90
Input the third grade weight:
0.1
Input the fourth grade:
60
Input the fourth grade weight:
0.4
The course grade is: 70
Press any key to continue . . .
```

E.2. Question 2: Convert a Character to Uppercase

Requirement:

Write a program that will convert a lowercase character input by the user to an uppercase character.

Below you will find some useful ASCII values that your computer can interpret as characters.

Lowercase values:

Character	a	b	c	d	e	f	g	h	i	j	k	l	m
ASCII	97	98	99	100	101	102	103	104	105	106	107	108	109

Character	n	o	p	q	r	s	t	u	v	w	x	y	z
ASCII	110	111	112	113	114	115	116	117	118	119	120	121	122

Uppercase values:

Character	A	B	C	D	E	F	G	H	I	J	K	L	M
ASCII	65	66	67	68	69	70	71	72	73	74	75	76	77

Character	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
ASCII	78	79	80	81	82	83	84	85	86	87	88	89	90

Specifications:

1. Use “cout” statements to print a header similar to the sample below.
 2. The user must be allowed to enter a single character and the program will output the uppercase variant of the same character similar to the sample below.
 3. **Hint:** To get the ASCII value of a character, it can be cast to an integer using the cast operator. For example,

```
char inputCharacter = 'c';  
int asciiValue = (int)inputCharacter;
```

Similarly, an integer ASCII value can be cast to a character to represent the char value.
- You must find a relation between the lowercase and uppercase ASCII values of characters and use this information to modify the character displayed.

Sample Output:

```
*****  
ES1036b: Lab 01 Q2  
Date:  
Name:  
Student Number:  
Program's mission:  
*****  
  
Input a character:  
S  
The uppercase character is: S  
Press any key to continue . . .
```

E.3. Question 3: Arithmetic in C++ Using the <cmath> library

Requirement:

Calculate the Euclidean distance between two points in three dimensions, input by the user.

Specifications:

1. Use “cout” statements to print a header similar to the sample below.
2. Ask the user to input an x, y and z value for two points $P_1(x_1, y_1, z_1)$ and $P_2(x_2, y_2, z_2)$.
3. Compute the Euclidean distance between P_1 and P_2 using the formula:

$$distance = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$$

4. You must output the difference in the x-direction, y-direction and z-direction separately as well as showing the user the Euclidean distance.
5. The user should be able to input real numbers (both integer and decimal numbers) for the point coordinates and the program should output the distances in real numbers, if applicable.

Design:

Draw a flow chart on paper explaining your program steps and show it to your TA during lab-demonstration.

Implementation hints:

- For more information on how to use the <cmath> library, please see: <http://www.cplusplus.com/reference/cmath/sqrt/>

Sample Output:

```
*****
ES1036: Lab 01 Q3
Date:
Name:
Student Number:
Program's mission:
*****

Please enter coordinates for the first point:
X: -17.8
Y: 25.32
Z: -2

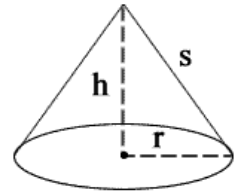
Please enter coordinates for the second point:
X: 4.93
Y: 12.64
Z: 7

The two points are separated by 22.73 units in the
x-direction, -12.68 units in the y-direction, 9 units
in the z-direction, and they have a Euclidean distance
of 27.54 units.

Press any key to continue . . .
```

F. Additional Questions (Optional)

These problems are for you to practice at home. You do not need to demonstrate or submit them online.



Level 1

- Write a program that prompts the user to enter the speed of a car in miles per hour which converts it to kilometers per hour where, miles = kilometers x 0.6213712.
- Write a program that converts the temperature in Celsius to Fahrenheit and displays the value. Ask the user to enter a temperature in degrees Celsius. Hint: the conversion formula is $^{\circ}\text{F} = ^{\circ}\text{C} \times 9/5 + 32$
- Write a program that prompts the user to input height and width of a rectangle to print its area (Height x width) and perimeter ($2 \times (\text{height} + \text{width})$) on the screen.
- Write a C++ program that would ask the user to input an integer and displays the square of the input integer.

Level 2

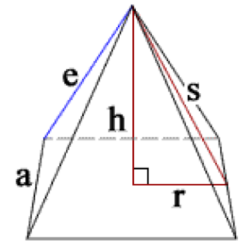
- Write a program that prompts the user to enter a weight in **pounds** and height in **inches** and display the BMI (http://en.wikipedia.org/wiki/Body_mass_index) which is calculated as:

BMI = m/h^2 , where m is the mass in **kilograms** and h is the height in **meters**. *Hint*: one pound = 453.59237 grams; one inch = 2.54 centimeter.
- Write a C++ program that would calculate the period of oscillation (in seconds) of a simple pendulum given by the equation $T = 2\pi\sqrt{l/g}$ where l represents the length of the pendulum to be inputted by the user. Additionally, assume that the acceleration due to gravity is $g = 9.81 \text{ ms}^{-2}$ and $\pi = 3.1416$. *Hint*: We have to use the `sqrt` function to calculate the square root.
- Write a program that calculates the volume and surface area of a cone with height h and radius r . Ask the user to input the values of radius and height.
 - Volume of a cone = $(1/3) \times \pi \times \text{radius}^2 \times \text{height}$
 - Total Surface Area of a cone = $\pi \times \text{radius}(\text{radius} + \sqrt{\text{radius}^2 + \text{height}^2})$

d. Write a program that calculates the volume and surface area of a pyramid

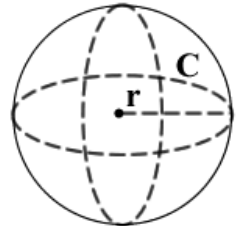
- Volume of pyramid = $(1/3) * \text{width}^2 * \text{height}$
- Total Surface Area of pyramid = $\text{width} * (\text{width} + \sqrt{\text{width}^2 + 4\text{height}^2})$

Ask the user to input the values of width and height.



e. Write a program that calculates the volume and surface area of a sphere.

- Volume of a sphere = $(4/3) * \pi * \text{radius}^3$
- Surface Area of a sphere = $4 * \pi * \text{radius}^2$



- f. Write a program that reads an integer between 0 and 999 inclusive and adds all the digits in the integer. For example, if an integer is 932 the sum of all its digits is 14.
- g. Write a program to print a block F using letter 'F', where F is 7 characters high and 5 characters wide, as shown below. Can you display your first name in this form?

```
FFFFF
F
F
FFF
F
F
F
Press any key to continue
```

Level 3

- a. You want to buy a computer and a textbook. You want to know how much total cost of the two will be and see whether or not you can afford to buy either or both. Write a C++ program that allows you to input the price for each of these items and calculates the total cost with tax of the potential purchase (Assume your province of residence is Ontario and you only pay 13% tax). The program will ask you to input the prices separately and calculates and prints the final cost for you on the screen.
- b. Write a program that asks the user to enter 5 integers and display the sum of the squares of the entered numbers.