

# 1 Introduction

These exercises are to get you familiar with some simple calculations in C++. You have probably done similar calculations in other languages. For this series of exercises you can put all of them into one project file, that is a single cpp file.

## 2 Exercises

1. For this segment of code have the user input the number of miles and then have the program convert this to the equivalent number of feet and print out the answer. The conversion factor for miles to feet must be stored as a constant at the top of the main. For example, in the following run the user types in 5. Note that this input could be a decimal like 7.31.

```
Input the number of miles: 5
There are 26400 feet in 5 mile(s).
```

2. For this segment of code have the user input the number of feet and then have the program convert this to the equivalent number of miles and print out the answer. The conversion factor for feet to miles must be stored as a constant at the top of the main. For example, in the following run the user types in 36000. Note that this input could be a decimal like 7127.925.

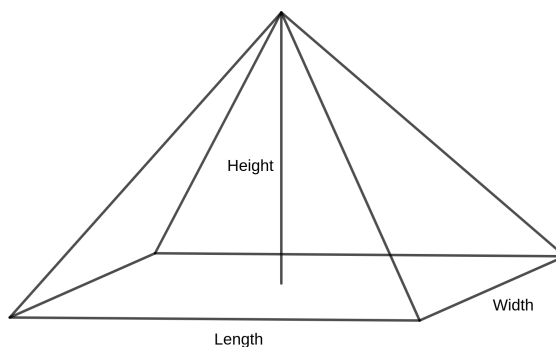
```
Input the number of feet: 36000
There are 6.81818 miles in 36000 feet.
```

3. For this segment of code have the user input the number of feet and then have the program represent this in feet and inches. In the example run below the user typed in 23.79.

```
Input the number of feet: 23.79
There are 23 feet and 9.48 in 23.79 feet.
```

4. For this segment of code have the program calculate the volume of a pyramid. In a pyramid the base is a rectangle with sides of length, Length and Width, the other faces are triangles from each of the four sides of the base to a point above the base. The distance (perpendicular distance) from the top point to the base is of length, Height. The volume of a pyramid is one third the product of the length, width, and height. For this segment the user will input the length, width and the height. In the example below the user typed in the 12.43, 62.91, and 55.55.

```
Input the length: 12.43
Input the width: 62.91
Input the height: 55.55
The volume of the pyramid is 14479.5.
```



5. For this segment of code have the program calculate the volume of a sphere. The volume of a sphere with radius  $r$  is  $\frac{4}{3}\pi r^3$ . The user should input the length of the radius. As with the feet and miles conversions the value of  $\pi$  must be a constant at the top of the main. A sufficient approximation of  $\pi$  is 3.141592653589793. In the following run the user typed in 5. Again this could have been a decimal number input.

```
Input the radius: 5
The volume of the sphere is 523.599.
```

6. In the game of Dungeons and Dragons the dice that are used are the five platonic solids, one has 4 faces, one has 6 faces, one has 8 faces, one has 12 faces, and the final one has 20 faces. For the next segment of code have the program simulate the rolling of the five dice and print out the results in the above order. The dice are numbered starting at 1 going through the number of sides. There is no user input for this segment, just output.

```
Dice: 2 5 1 8 13
```

7. For this segment of code have the program generate a random integer between a lower and upper bound that the user defines, inclusively. The user input 4 and 25 in this example, the possible values for the output would be any integer between 4 and 25 including 4 and 25.

```
Input the lower bound: 4
Input the upper bound: 25
Random Number: 7
```

8. For this segment of code have the program take as input the total on a bill at a restaurant (before tax) and outputs the bill amount, the tax (assume 6%), the tip which is 15% of the pre-tax bill, and the total amount the dinner is going to cost you (that is, the bill amount with both tax and tip included).

For example, say that your food costs \$35, then this is your pre-tax bill. The tax will be  $35 \cdot 0.06 = 2.10$ . The tip is off of the pre-tax bill (the \$35 not \$37.10), so it would be  $35 \cdot 0.15 = 5.25$ . So the total amount would be  $35 + 2.10 + 5.25 = 42.35$ . Two sample runs of the program are below. Note that the decimal points line up.

```
What is the bill amount? 35
Bill      35.00
Tax       2.10
Tip       5.25
Total     42.35
```

```
What is the bill amount? 89.23
Bill      89.23
Tax       5.35
Tip      13.38
Total    107.97
```

9. For this segment of code have the program take as input a person's informal name and convert it to their formal name. You may assume that the user inputs just their first and last names, no middle name or suffix. In the following example the user typed in Don Spickler.

```
Input informal name: Don Spickler
Spickler, Don
```

10. For this segment of code you will write a small version of a mail merge feature from a word processor. When you do a mail merge you create a generic letter and in the letter you put special fields that will read in (usually from a file) a person's name, address, personal pronoun, and what other information is needed. In this program you will allow the user to type in a sentence where one field will be XXX and another will be YYY, then have the user type in the data for the XXX replacement and the YYY replacement. The program should replace the XXX and YYY in the string and print out the resulting string. In the following example the user typed in the sentence,

```
XXX said that YYY was going to the concert.
```

as well as the two replacements of George and he

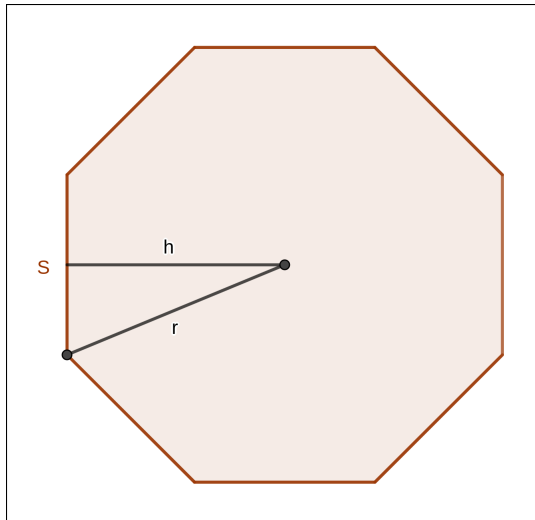
```
Input merge format sentence: XXX said that YYY was going to the concert.
Input XXX replaceemnt: George
Input YYY replaceemnt: he
George said that he was going to the concert.
```

You may assume that the sentence has only one occurrence of XXX and one of YYY.

11. For this segment of code you will have the user input a sentence and a phrase, both may be several words long. You may also assume that the user's phrase is in the sentence. The program will then break the sentence at the phrase and print out the beginning of the sentence up to but not including the phrase and the end of the sentence which is the phrase to the end of the sentence. In the following example the user typed in This is a set of test words with little meaning. along with the phrase of.

```
Input sentence: This is a set of test words with little meaning.
Input phrase: of
This is a set
of test words with little meaning.
```

12. In a regular octagon, pictured below, the length  $r$  is the length from the center of the octagon to one of the vertices,  $h$  is the perpendicular length from the center to one side, and the length of one side is  $S$ .



The side length  $S$  can be calculated as  $r \cdot \sqrt{2 - \sqrt{2}}$ . The length  $h$  can be calculated as  $\sqrt{r^2 - \left(\frac{S}{2}\right)^2}$ . The area of the triangle with sides  $h$  and  $r$  can be calculated as  $\frac{1}{2} \cdot b \cdot h$ , where  $b$  is half of  $S$ . There are 16 of these triangles inside the octagon and of course there are 8 sides.

For this segment of code have the user input length  $r$  and calculate the area of the octagon and the perimeter (total distance around) of the octagon using these formulas. Also output 15 decimal places in the calculations. In the following example the user typed in 5.

```
Input radius: 5
Area = 70.710678118654741
Perimeter = 30.614674589207176
```

13. For this segment, write a program that helps the cashier at a store count back change. The program should ask for the amount of money to give back in change for a purchase (for example, \$5.47) and then output the number of twenties, tens, fives, one dollars, quarters, dimes, nickels, and pennies. You do not need to go higher than a twenty dollar bill in change but the program should handle amounts like \$125.24. The output should always use the highest denomination possible, an output of 12524 pennies does not solve the problem. For example, for an input of \$5.47, the program should output 1 five, 1 quarter, 2 dimes and 2 pennies. For the input of \$125.24, the program should output 6 twenties, 1 five, 2 dimes, and 4 pennies. In the following example the user typed in the amount of change back as 45.82.

```
Amount to change: 45.82
Change:
```

```

Twenties: 2
Tens: 0
Fives: 1
Ones: 0
Quarters: 3
Dimes: 0
Nickels: 1
Pennies: 2

```

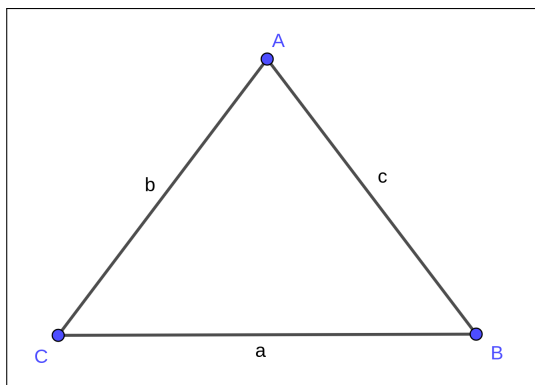
14. The next segment of code will take as input the three sides of a triangle and calculate the measures of the internal angles of the triangle.

In the triangle below the side lengths are  $a$ ,  $b$ , and  $c$  as labeled. The angles at the vertices are  $A$ ,  $B$ , and  $C$ . Note the labeling, the side  $a$  is opposite the angle  $A$ , as well as for  $B$  and  $C$ . The law of cosines states  $c^2 = a^2 + b^2 - 2ab \cos(C)$ . So if we solve for the angle  $C$  we get the formula,

$$\cos(C) = \frac{a^2 + b^2 - c^2}{2ab}$$

and hence

$$C = \arccos\left(\frac{a^2 + b^2 - c^2}{2ab}\right)$$



The other angles can be calculated the same way just using the corresponding sides for those angles. In C++ the arccos function is `acos`. Have the program take the values of  $a$ ,  $b$ , and  $c$  from the user and return the three angle measures of the internal angles. Note that the `acos` function returns the angle measures in radians. Also have the program return the angles in degrees. You can convert a radian angle to degrees by multiplying by  $\frac{180}{\pi}$ . As with the octagon exercises have 15 decimal places of accuracy. In this example the user typed in 5, 6, and 7, the inputs could have been decimal numbers here.

```

Side length a: 5
Side length b: 6
Side length c: 7
Angles in radians: 0.775193373310361 0.996960874274866 1.369438406004566
Angles in degrees: 44.415308597192976 57.121650435622513 78.463040967184526

```

15. One question I frequently get from students close to final exam time is “What to I need to get on the final to pass the class?” This is actually an easy calculation, here is how to do it. In my classes, your final average is the number of points you earn divided by the number possible. This would be a decimal form of the final percentage. For example, say there were 735 total points and you earned 642 points. Then your final average would be,

$$\frac{642}{735} = 0.873469388$$

That is,  $87.3469388\% = 0.873469388 \cdot 100 = \frac{642}{735} \cdot 100$ . Now let's say that we are not at the end of the semester and there are still some assignments and/or exams left to do. Then the number of points you earned is the number you have earned so far plus the number you earn from now to the end of the semester. We will denote this as  $ppe + fpe$  for past points earned plus future points earned. The total number of points in the class is the total number of points so far plus the remaining number of points. We will denote this as  $tp + rp$  for total points plus remaining points. The target percentage average you want will be denoted as  $T$ . Then we have the formula,

$$T = 100 \cdot \frac{ppe + fpe}{tp + rp}$$

For example, if you want an  $A$  then you would let  $T$  be 90, the lowest percentage to get an  $A$ . For example, say you have earned 503 points out of 570 total so far, there is a 200 point final exam and you want an  $A$  in the class. Your calculation would be,

$$90 = 100 \cdot \frac{503 + fpe}{570 + 200}$$

Solving for  $fpe$  you would have

$$fpe = 0.9 \cdot (570 + 200) - 503 = 190$$

So you would need 190 points out of 200 on the final exam, which is  $\frac{190}{200} = 0.95 = 95\%$ . Generalizing the formula above we have that the number of future points you need is,

$$fpe = \frac{T}{100} \cdot (tp + rp) - ppe$$

and hence the average you need to do from now to the end of the semester is

$$\frac{fpe}{rp} \cdot 100$$

in a percentage form. Write a segment of code that will ask the user for the total points so far, their earned points so far, the number of points remaining, and their target percentage. Then have the program calculate the number of points they need and the percentage they need for the rest of the semester to get their target average.

### 3 Program Run

Input the number of miles: 5  
There are 26400 feet in 5 mile(s).

Input the number of feet: 36000  
There are 6.81818 miles in 36000 feet.

Input the number of feet: 23.79  
There are 23 feet and 9.48 in 23.79 feet.

Input the length: 12.43  
Input the width: 62.91  
Input the height: 55.55  
The volume of the pyramid is 14479.5.

Input the radius: 5  
The volume of the sphere is 523.599.

Dice: 2 5 1 8 13

Input the lower bound: 4  
Input the upper bound: 25  
Random Number: 7

What is the bill amount? \$ 123.45  
Bill 123.45  
Tax 7.41  
Tip 18.52  
Total 149.37

Input informal name: Don Spickler  
Spickler, Don

Input merge format sentence: XXX said that YYY was going home.  
Input XXX replacement: Jack  
Input YYY replacement: Jill  
Jack said that Jill was going home.

Input sentence: This is a set of test words with little meaning.  
Input phrase: of  
This is a set  
of test words with little meaning.

Input radius: 5  
Area = 70.710678118654741  
Perimeter = 30.614674589207176

Amount to change: 45.82  
Change:  
Twenties: 2  
Tens: 0  
Fives: 1  
Ones: 0  
Quarters: 3  
Dimes: 0  
Nickels: 1  
Pennies: 2

Side length a: 5  
Side length b: 6  
Side length c: 7  
Angles in radians: 0.775193373310361 0.996960874274866 1.369438406004566  
Angles in degrees: 44.415308597192976 57.121650435622513 78.463040967184526

```
Input the number of points on all assignments so far: 570
Input the number of points you have earned so far: 503
Input the number of points remaining: 200
Input your target percentage: 90
You need 190 out of 200 to have a 90% at the end of the semester.
So you need to do an average of 95% from now to the end of the semester.
```

## 4 Submit Your Work

As before, submit the code file through the file uploads to the MyClasses system.