10.1 Coding practice problems overview

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LAB ACTIVITY | 10.1.1: Coding practice problems overview 0 / 3

Why use Coding Practice Problems?

Research shows that repeated practice moves knowledge into the long-term region of the brain, making tasks easier (compare the ease of driving now vs. when you first learned) and enabling new learning on top of that knowledge.

This material is designed for students to practice the most fundamental programming concepts via short coding problems. The auto-grading provides immediate feedback of correctness, so students can instantly find/fix bugs.

Many problems were adapted from exam questions at various universities, so practicing may **improve exam performance**. Problems focus on core skills, so practicing may improve a student's ability to efficiently **complete programming assignments**. Students preparing for job interviews may also find the practice helps them **answer common interview coding questions**.

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Coding Practice for C++

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Hints and solutions

Many problems includes hints at the bottom of the specification. Students are encouraged to NOT read those hints initially. If stuck on a problem, students might read just the NEXT hint, not all the hints. Trying to figure out how to solve the problems is working your brain in the necessary ways; reading how someone else solved the problem is a different skill. It's like trying to solve a riddle versus being told the answer to a riddle.

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Each problem includes a solution by an experienced programmer. Programming is like an essay answering a question: Numerous correct answers exist. Comparing your solution to experienced programmer may yield insights. As with hints, students are encouraged NOT to view the solution until done, or if stuck.

Most solutions have ending comments that describe key decisions, common issues, etc.

Difficulty and time

An estimate of each problem's difficulty is indicated using asterisks in the problem's title (*, **, or ***). These are based on a person who is just learning that topic. Ex: When learning branches, a problem may be of medium difficulty and thus have two asterisks, but by the time a student has learned loops, that branching problem may be easy.

Each problem is estimated to take between 5 minutes (one asterisk) to perhaps 20 minutes (three asterisks) for a student. Sometimes a problem will take longer, especially in the presence of bugs. That is perfectly normal. Just remember, every time you get stuck on a programming problem, you become a slightly stronger programmer. It's like lifting weights: Hurts, but strengthens.

Now start practicing!

Below is an example problem, with hints, results from automated grading of a student's, and the solution (with explanation notes) that a student can view at any time. The student's submission is close, but is failing some tests; from those test cases, the student realizes he/she isn't handling exclamation points correctly, so goes back and fixes his/her submission and submits again (as many times as desired).

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Example problem, to get you warmed up

Given an input integer, output two times that integer. End with newline. (NOTE: Nearly every problem expects the student to follow the good practice of always ending output with a newline, so the newline won't be explicitly stated). Do not prompt the user to enter the integer; just read the integer. Ex: If the input is 3, the output should be 6.

HINTS:

- A series of hints would normally appear here. This problem is very simple so not many hints appear, and they are very basic.
- Read the integer into a variable using cin, as in: cin >> userInt; Then, use cout to output 2 times that integer.
- Don't forget to end with newline.
- When using "Develop" mode, remember to *pre-enter the needed input values*. Otherwise you may get weird behavior when running.

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main.cpp

```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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Coding trail of your work What is this?

```
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```

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10.2 PRACTICE: Input/Output* Welcome Message

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LAB ACTIVITY 10.2.1: PRACTICE: Input/Output* Welcome Message 0 / 3

Write a program which takes your first name as input and outputs a welcome message to yourself.

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Run History Tutorial

main.cpp

```
#include <iostream>
using namespace std;

int main() {

   string name;
   /* Type your code here. */

   cout << "Hello " << name << ", welcome to CS010V!" << endl;

   return 0;
}
```

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10.3 PRACTICE: Input/Output* Mad Libs

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LAB ACTIVITY | 10.3.1: PRACTICE: Input/Output* Mad Libs

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0 / 3

Mad Libs are word games which require a person to provide various words to complete a short and fun story. Complete the following program to make a Mad Lib of your own.

Run History Tutorial

main.cpp

```
#include <iostream>
using namespace std;

int main() {

   string name;
   string location;
   int number;
   string pluralNoun;
   /* Type your code here. */

   cout << name << " went to " << location << " to buy " << number << " differe

   return 0;
}
```

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```
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```

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10.4 PRACTICE: Input/Output* Percentages

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LAB ACTIVITY 10.4.1: PRACTICE: Input/Output* Percentages 0 / 4

Given an input as a percentage, write a program which converts the percentage into decimal form and outputs the result.

Ex: If the input is:

```
54
```

the output is

```
0.54
```

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Run History Tutorial

main.cpp

```
#include <iostream>
using namespace std;

int main() {

   double percentage;
   /* Type your code here. */

   return 0;
}
```

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10.5 PRACTICE: Input/Output* Inches to feet

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LAB ACTIVITY | 10.5.1: PRACTICE: Input/Output* Inches to feet

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0 / 4

Given a total amount of inches, convert the input into a readable output in feet and inches.

Ex: If the input is:

```
55
```

the output should be:

```
4 ' 7 "
```

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```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.6 PRACTICE: Expressions*: Simple floating-point expression

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LAB ACTIVITY | 10.6.1: PRACTICE: Expressions*: Simple floating-point expression

0 / 4

Write an assignment statement for the following mathematical equation:

y = (1/3)x + (x/4) + 2x

Keep x as an integer. Use an expression that matches the equation's right side as closely as possible. If the input is -1, the output is -2.58333.

Hints:

- Don't rearrange the equation or try to simplify it.
- If both operands of division (or other operators) are integers, integer division is performed, which rounds down; so for example 1/2 is 0. So make at least one operand a floating-point type, as in 1.0/2, or 1.0/2.0, to cause floating-point division.

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```
#include <iostream>
using namespace std;

int main() {
   int x;
   double y;

   cin >> x;

   // Type your code here

   cout << y << endl;

   return 0;
}

```

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10.7 PRACTICE: Expressions*: Test

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LAB ACTIVITY | 10.7.1: PRACTICE: Expressions*: Test

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0 / 4

Given your current grade as the input, write a program to help you determine what score you need to get on a final to get an A (90% or higher) in a class. The syllabus states that the final is worth 40% of the overall grade.

- The input is an integer.
- The output should be a percentage rounded to one decimal place. Ex: 85.5%

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```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.8 PRACTICE: Expressions*: Distance formula

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Map/GPS applications commonly compute the distance between two points. A point may be a coordinate on an x-y plane like (1.5, 2.0). The distance formula is d = Ã¢Â Â ((x2 - x1)^2 + (y2 - y1)^2) (basically, Pythagorean's Theorem). Given two points, output the distance between them. If the input is (1.5, 2.0) (4.5, 6.0), the output is 5. Note: End with a newline.

Hints:

- Read in the parentheses and commas as in cin >> c to skip over them, and read in the numbers as doubles.
- Add `#include <cmath>` and then use the sqrt() function. For squaring, you might use the pow() function with a second parameter of 2.

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```
#include <iostream>
#include <cmath>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.9 PRACTICE: Expressions* Proper name layout

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LAB ACTIVITY | 10.9.1: PRACTICE: Expressions* Proper name layout 0 / 4

Many documents require a specific format for listing a person's name. Assume you are given a person's full name (ie. first name, middle name, and last name). Output the full name in the following format: "lastName, firstName middleInitial.".

Ex: If the input is:

```
John Jane Doe
```

the output should be:

```
Doe, John J.
```

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```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.10 PRACTICE: Branches: Airfare

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An airline describes airfare as follows. A normal ticket's base cost is $300. Persons aged 60 or over have a base cost of $290. Children 2 or under have $0 base cost. A first checked bag is free, second is $25, and each additional is $50. Given inputs of age and checked bags (0 or greater), compute the total airfare.

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Hints (these hints would probably not be given on the test):

- First use an if-else statements to assign airFare with the base cost.
- Then use another if-else statement to update airFare for checked bags.
- Think carefully about what expression correctly calculates checked bag cost when bags are 3 or more.

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LAB ACTIVITY | 10.10.1: PRACTICE: Branches: Airfare 0 / 8

main.cpp Load default template...

```
#include <iostream>
using namespace std;

int main() {
   int passengerAge;
   int checkedBags;
   int airFare;

   cin >> passengerAge;
   cin >> checkedBags;

   /* FIXME: Type your code here. */

   cout << airFare << endl;
```

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Develop mode Submit mode

Run your program as often as you'd like, before submitting for grading. Below, type any needed input values in the first box, then click **Run program** and observe the program's output in the second box.

Enter program input (optional)

If your code requires input values, provide them here.

Run program

Input (from above) → main.cpp (Your program) → Outp

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Program output displayed here

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```
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```

Solution Show

10.11 PRACTICE: Branches*: Shape display

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LAB ACTIVITY 10.11.1: PRACTICE: Branches*: Shape display 0 / 2

A user inputs the name of a shape (square or triangle). The program outputs the shape using asterisks. For input square, the output is:

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```
***
* *
***
```

If the input is triangle, the output is:

```
  *
 * *
```

```
*****
```

Run

History Tutorial

```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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```
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```

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10.12 PRACTICE: Branches**: Caption punctuation

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LAB ACTIVITY | 10.12.1: PRACTICE: Branches**: Caption punctuation 0 / 10

A user is asked to type a caption for a photo in a web form's text field. If the caption didn't end with a punctuation mark (. ! ?), a period should automatically be added. A common error is to end with a comma, which should be replaced by a period. Another common error is to end with two periods, which should be changed to one period (however, ending with three periods (or more) indicates elipses so should be kept as is). The corrected caption is output.

If the input is "I like pie", the output is "I like pie." If the input is "I like pie!", the output remains "I like pie!" If the input is "Coming soonâ€¦", the output remains "Coming soonâ€¦"

Hints:

- Start by checking for ! or ? which don't require any action.
- Then check for , which requires the simple action of replacing by a period.
- Then check for two ending periods (making sure the caption is at least 2 characters long). If found, check for three ending periods (making sure caption is at least 3 characters long), in which case no action required. Otherwise, remove the last period.
- Use pop_back() to remove the last period.

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```
#include <iostream>
using namespace std;

int main() {
   string userCaption;

   getline(cin, userCaption);

   /* Type your code here. */

   return 0;
}
```

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10.13 PRACTICE: Branches*: Guitar tabs

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LAB ACTIVITY | 10.13.1: PRACTICE: Branches*: Guitar tabs

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0 / 4

A guitar has 6 strings that play the notes E (lowest), A, D, G, B, and e (highest). A guitar's neck has regions called frets. A musical chord like a "G" or "C" is a combination of notes, and can be played by pressing certain strings at certain frets and then strumming all 6 strings. To quickly learn to play chords, people share "tabs" -- visual indications of what strings to press. To enable easy sharing over the internet, tabs are usually shared as text files. Write a program that takes a string input representing one of three chords (G, C, D) and outputs the corresponding tab. If the input is G, the output is:

```
e|-3-
B|-0-
G|-0-
D|-0-
A|-2-
E|-3-
```

0 means to strum the string open (without pressing). 1 means to press the string at the first fret, 2 at the second fret, 3 at the third fret.

If the input is C, the output is:

```
e|-0-
B|-1-
G|-0-
D|-2-
A|-3-
E|---
```

The - on the E string below the numbers means to not strum that string for that chord.

If the input is D, the output is:

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```
e|-2-
B|-3-
G|-2-
D|-0-
A|---
E|---
```

If the user enters an unrecognized chord like Am, the output should be: Am is not a supported chord.

For more info, see How to read tabs. (The above three chords, G C D, is the sequence of chords in the classic song "Sweet Home Alabama".

Hints:

- Use an if-else that outputs the appropriate text per chord input.
- Using for newlines may make creating the output statements simpler, using a single output string per chord. In fact, you can copy-paste the above output examples between " ", then delete the new lines and spaces and replacing with .
- Use an ending "else" branch to output the error message.

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Run History Tutorial

```
#include <iostream>
using namespace std;

int main() {
   string userChord;

   cin >> userChord;

   /* Type your code here. */

   return 0;
}
```

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```
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```

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10.14 PRACTICE: Branches**: 24-hour time

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LAB ACTIVITY 10.14.1: PRACTICE: Branches**: 24-hour time 0 / 6

24-hour time (also known in the U.S. as military time) is widely used around the world. Time is expressed as hours since midnight. The day starts at 00:00, and ends at 23:59. Write a program that converts am/pm time to 24-hour time. The input is two numbers and a string. If the input is 2 30 pm, the output should be 14:30. If the input is 12 01 am, the output should be 00:01.

Hints:

- Think of how each hour should be handled. 12 00 am -12 59 am becomes what? 8 00 am becomes what? 12 00 pm? 1 00 pm? Group the hours into cases that should be handled similarly (e.g., 1 00 am to 11 00 am are handled the same).
- Declare variables for hoursAmPm, minAmPm, and hours24. Note that minutes for 24-hour time remain the same as for am/pm, so no extra variable is needed.
- Use an if-else statement to detect each case, and set the hours24 appropriately.
- When outputting hour24, check if the hour is 0-9 (just check for < 10). If so, output a "0". So 7 will be output as 07. Do the same when outputting the minutes.

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```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.15 PRACTICE: Branches**: Next date

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LAB ACTIVITY | 10.15.1: PRACTICE: Branches**: Next date 0 / 16

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Many websites let users make reservations (hotel, car, flights, etc.). When a user selects a date, the next day is often automatically selected (for hotel checkout, car return, flight return, etc.). Given a date in the form of three integers, output the next date. If the input is 1 15 2017, the output should be 1 16 2017. If the input is 8 31 2017, the output should be 9 1 2017. Ignore leap years.

Hints:

- Group the months based on number of days. Then create an if-else statement for each case.
- Note that 12 (December) is a special case; after the last day, the next month is 1 (January) and is the next year.

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Run History Tutorial

```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.16 PRACTICE: Branches**: Runway headings

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Airport runways are numbered using a 2-digit number, like 09. The meaning generally is that planes taking off or landing on that runway will be facing 090 or 90 degrees rotated right from north, namely facing east. Given a runway number (integer), output the degrees followed by the closest direction indication (north, northeast, east, southeast, south, southwest, west, or northwest). If the input is 03, the output is: 30 degrees (northeast).

Hints:

- First just read the input number, multiply by 10 to yield runwayDeg.
- Next, create an if-else statement to compare runwayDeg's value with ranges for each direction. For north, the value should be within -22.5 and +22.5. For northeast, the value should be between 45 - 22.5 and 45 + 22.5. And so on.
- Based on the range in which the value falls, update a string variable with the direction. Then after the if-else, have a single output statement that outputs "270 degrees (north)" or whatever value and direction are correct.
- Don't forget that ranges use &&. An expression detecting a value x is between 1 and 10 is (x > 1) && (x < 10).
- Because the input is an integer which is multiplied by 10 to yield runwayDeg, the comparisons with floating-point values like 22.5 will never result in equality. Hence, the ranges don't have to account for such quality.

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```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.17 PRACTICE: Branches*: Listing names

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LAB ACTIVITY | 10.17.1: PRACTICE: Branches*: Listing names

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0 / 4

A university has a web page that displays the instructors for a course, using the following algorithm: If only one instructor exists, the instructor's first initial and last name are listed. If two instructors exist, only their last names are listed, separated by /. If three exist, only the first two are listed, with "/ â€¦" following the second. If none exist, print "TBD". Given six words representing three first and last names (each name a single word; latter names may be "none none"), output one line of text listing the instructors' names using the algorithm. If the input is "Ann Jones none none none none", the output is "A. Jones". If the input is "Ann Jones Mike Smith Lee Nguyen" then the output is "Jones / Smith / â€¦".

Hints:

- Use an if-else statement with four branches. The first detects the situation of no instructors. The second one instructor. Etc.
- Detect whether an instructor exists by checking if the first name is "none".

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```
#include <iostream>
using namespace std;

int main() {
   string firstName1, lastName1;
   string firstName2, lastName2;
   string firstName3, lastName3;

   cin >> firstName1;   cin >> lastName1;
   cin >> firstName2;   cin >> lastName2;
   cin >> firstName3;   cin >> lastName3;


   /* Type your code here. */

   return 0;
}
```

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10.18 PRACTICE: Branches***: Next license plate number

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LAB ACTIVITY | 10.18.1: PRACTICE: Branches***: Next license plate number

0 / 5

A state's Department of Motor Vehicles needs a program to generate license plate numbers. A license plate number consists of three letters followed by three digits, as in CBJ523. (So "number" is a bit inaccurate, but that's the standard word used for license plates). The plate numbers are given out in sequence, so given the current number, the program should output the next number. If the input is CBJ523, the output should be CBJ524. If the input is CBJ999, the output should be CBK000. For the last number ZZZ999, the next is AAA000.

Hints:

- Treat each character individually.
- Initially, don't try to create an "elegant" solution. Just consider each of the six places one at a time, starting from the right.
- For each place, if less than the max for that place ('9' for digits, 'Z' for letters), just increment that place. Note that you can just type c = c + 1 to get the next higher character for a digit like '5' or for a letter like 'K').
- If a place is at the max, set it with the '0' or 'A', and then set a boolean variable to true to indicate a "carry" is needed. (If a carry isn't needed, set to false).
- With the above process, you'll have 6 separate if-else statements.

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```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.19 PRACTICE: Branches** Leap Year

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LAB ACTIVITY | 10.19.1: PRACTICE: Branches** Leap Year

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In the modern day Gregorian Calendar, a year consists of 365 days. In reality, the earth takes a little longer to rotate around the sun. If we did not account for the additional time, the calendar would be off! To fix this problem, every 4 years a leap year takes place. A leap year is when there are 366 days in the year - an extra day, February 29th, is added to the calendar. The requirements for a given year to be a leap year are:

1) The year must be divisible by 4.

2) If the year is a century year (1700, 1800, etc.), the year must be evenly divisible by 400.

Some example leap years are 1712, 1944, and 2000.

Write a program that takes in a year and determines whether it is a leap year or not. Output "true" if the given year is a leap year and output "false" if the given year is not a leap year.

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```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.20 PRACTICE: Loops (for)*: Output sequence

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LAB ACTIVITY | 10.20.1: PRACTICE: Loops (for)*: Output sequence 0 / 5

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(1) Given an integer n, write a for loop that outputs the numbers from -n to +n. Assume n is nonnegative. End the sequence with a newline.

```
Enter an integer:
2
Sequence: -2 -1 0 1 2
```

(2) If n is negative, treat as the absolute value. So n of -2 is the same as n of 2. *Hint: Use an if statement before the for loop, to compute the absolute value of n.*

```
Enter an integer:
-2
Sequence: -2 -1 0 1 2
```

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```
#include <iostream>
using namespace std;

int main() {
   int n;
   int i;

   cout << "Enter an integer:" << endl;
   cin >> n;

   cout << "Sequence: ";
   /* Type your code here. */

   return 0;
}

```

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10.21 PRACTICE: Loops (for)*: Output evens

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LAB ACTIVITY | 10.21.1: PRACTICE: Loops (for)*: Output evens

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0 / 5

(1) Given positive integer n, write a for loop that outputs the even numbers from n down to 0. If n is odd, start with the next lower even number. *Hint: Use an if statement and the % operator to detect if n is odd, decrementing n if so.*

```
Enter an integer:
7
Sequence: 6 4 2 0
```

(2) If n is negative, output 0. *Hint: Use an if statement to check if n is negative. If so, just set n = 0.*

```
Enter an integer:
-1
Sequence: 0
```

Note: For simplicity add a space after each output value, including the last value.

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```
#include <iostream>
using namespace std;

int main() {
   int n;
   int i;

   cout << "Enter an integer:" << endl;
   cin >> n;

   cout << "Sequence: ";
   /* Type your code here. */

   return 0;
}
```

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10.22 PRACTICE: Loops: Output rocket height

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Suppose a launched toy rocket's height is computed as h = vi*t - $5t^2$. vi is the initial velocity, and t is time in seconds since the launch (starting at 0). Write a program to read the initial velocity, then output the time and the rocket's height once per second. Stop when the height would be negative, meaning the rocket hit the ground (don't print the negative). Assume all values are integers. Ex: For input 20, the output is:

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```
0 0
1 15
2 20
3 15
4 0
```

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LAB ACTIVITY | 10.22.1: PRACTICE: Loops: Output rocket height 0 / 3

main.cpp Load default template...

```
#include <iostream>
using namespace std;

int main() {
   int rocketHeight = 0;
   int initialVelocity = 0;
   int timeSinceLaunch = 0;

   /* Type your code here. */

   return 0;
}
```

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Develop mode Submit mode

Run your program as often as you'd like, before submitting for grading. Below, type any needed input values in the first box, then click **Run program** and observe the program's output in the second box.

Enter program input (optional)

If your code requires input values, provide them here.

Run program

Input (from above) → main.cpp (Your program) → Outp

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Program output displayed here

Coding trail of your work What is this?

```
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on this zyLab.
```

Solution Show

10.23 PRACTICE: Loops: Compute modified average

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Compute the average of a list of user-entered integers representing rolls of two dice. The list ends when 0 is entered. Integers must be in the range 2 to 12 (inclusive); integers outside the range don't contribute to the average. Output the average, and the number of valid integers (excluding the ending 0). If only 0 is entered, output 0. The output may be a floating-point value. Ex: If the user enters 8 12 13 0, the output is:

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```
Average: 10
Valid: 2
```

HINTS (these hints would not be provided on the test)

- Use a while loop with expression (userInt != 0)

- Read the user's input into userInt before the loop, and also at the end of the loop body
- In the loop body, use an if-else to distinguish integers in the range and integers outside the range
- For integers in the range, keep track of the sum, and number of integers.
- Use a static cast to get a floating-point output: (static_cast (sum)) / num
- Whenever dividing, be sure to handle the case of the denominator being 0.

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LAB ACTIVITY | 10.23.1: PRACTICE: Loops: Compute modified average 0 / 4

main.cpp Load default template...

```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

Develop mode | Submit mode

Run your program as often as you'd like, before submitting for grading. Below, type any needed input values in the first box, then click **Run program** and observe the program's output in the second box.

Enter program input (optional)

If your code requires input values, provide them here.

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Run program

Input (from above) → main.cpp (Your program) → Outp

Program output displayed here

Coding trail of your work What is this?

```
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```

Solution

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Show

10.24 PRACTICE: Loops (nested)**: Sum a given number of integers

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LAB ACTIVITY | 10.24.1: PRACTICE: Loops (nested)**: Sum a given number of integers

0 / 4

A user will enter an initial number, followed by that number of integers. Output those integers' sum. Repeat until the initial number is 0 or negative. Ex: If the user enters 3 9 6 1 0, the output is:

```
16
```

Ex: If the user enters 3 9 6 1 2 5 3 0, the output is:

```
16
8
```

Hints:

- Use a while loop as an outer loop. Get the user's initial number of ints before the loop, and at the end of the loop body.
- Use a for loop as an inner loop, inside the while loop body. Loop from i = 0, to i < (the number of ints).
- In the for loop, first read the next integer, then update the sum. After the for loop, output the sum.

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```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.25 PRACTICE: Loops**: Output integer's digits

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LAB ACTIVITY | 10.25.1: PRACTICE: Loops**: Output integer's digits 0 / 3

Given an input positive integer, output each digit on its own line, starting with the rightmost digit.
Ex: If the input is 935, the output is:

```
5
3
9
```

Hints:

- Use the mod operator (%) to get the rightmost digit.
- Mod by 10 to get the rightmost digit.
- Use a loop that keeps a current dividend (the number being divided). In each iteration, output the rightmost digit, then update the divisor by dividing by 10.
- End the loop when the divisor is 0.

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```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.26 PRACTICE: Loops**: Removing leading/trailing whitespace

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LAB ACTIVITY | 10.26.1: PRACTICE: Loops**: Removing leading/trailing whitespace

0 / 6

Users may type or copy-paste in a text box of a web form, perhaps a name like "Joe Smith". The user sometimes has whitespace before or after the text, like " Joe Smith ". A program typically strips such leading and trailing whitespace. Given a string, create a new string that lacks any leading or trailing spaces. Given " Joe Smith ", the new string should be "Joe Smith". Be sure to handle the case of the user entering only whitespace, or entering nothing, which each should yield an empty string "".

Hints:

- Initially, try to find the index of the first non-space character. Set the index to 0, then use a while loop to check each character.
- Your while loop expression should first check that the index is valid for the size of the string.
- The size() function of a string returns an unsigned int, so declare your index variable as an unsigned int so you can compare without a compiler warning.
- Next, try to find the index of the last non-space character. Use a different index variable. You while loop expression should first check that it is greater-than-or-equal to 0 to ensure it is valid.
- Once you know the first and last non-space characters, you can use a for loop to copy those characters to the new string.
- After the first while loop, be sure to check if any non-space character was found (by checking if the index is less than the string's last element). If no non-space character was found, just return.

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```
#include <iostream>
#include <string>
using namespace std;

int main() {
   string userText;
   string cleanedText;
   // Hint: Add declarations as needed


   getline(cin, userText);

   /* Type your code here. */

   cout << cleanedText << endl;

   return 0;
}
```

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10.27 PRACTICE: Loops*: Password requirements

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LAB ACTIVITY | 10.27.1: PRACTICE: Loops*: Password requirements 0 / 6

Websites commonly require a password that satisfies several requirements. Write a program that checks if an input string satisfies the following (error message is shown for each)

- At least 8 characters (Too short)
- At least one letter (Missing letter)
- At least one number (Missing number)
- At least one of these special characters: !, #, % (Missing special)

Output OK, or all related error messages (in above order). If the input string is "Hello", the output is:

```
Too short
Missing number
Missing special
```

Hints:

- Declare a boolean variable for each requirement.
- Use a for loop to visit each character, setting the corresponding boolean to true if satisfied (length is done differently though).
- Use functions in the cctype library (must include the library first) to detect if a character is a letter or a number.

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```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.28 PRACTICE: Loops (nested)**: HTML table

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LAB ACTIVITY | 10.28.1: PRACTICE: Loops (nested)**: HTML table 0 / 1

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HTML is the language of web pages. Items start and end with tags. A table starts with <table> and ends with </table>. In a table, a row starts with <tr> and ends with </tr>. In a row, a column starts with <td> and ends with </td>. Given two integers for rows and columns, generate an appropriately sized html table. Place the character c in each table cell. If the input is 2 3, the output is:

```
<table>
<tr> <td> c </td> <td> c </td> <td> c </td> </tr>
<tr> <td> c </td> <td> c </td> <td> c </td> </tr>
</table>
```

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```
#include <iostream>
using namespace std;

int main() {
   int userRows;
   int userCols;

   cin >> userRows;
   cin >> userCols;

   /* Type your code here. */

   return 0;
}
```

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10.29 PRACTICE: Loops*: Output integers as comma-separated list

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LAB ACTIVITY | 10.29.1: PRACTICE: Loops*: Output integers as comma-separated list

0 / 3

Given a list of integers, output those integers separated by a comma and space, except for the last which should be followed by a period (and newline). The first integers indicates how many integers are in the subsequent list. If the input is 4 1 7 3 5, the output should be: 1, 7, 3, 5.

Hints:

- Read in the first integer as numInts, followed by a for loop that loops numInts times.
- Decide whether to print the comma and space AFTER printing the current integer, or BEFORE. For each possibility, figure out how you'll handle the special cases of the first and last items, and then decide whether after or before is the best approach.
- You can print the period and newline after the above for loop.

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```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.30 PRACTICE: Loops**: Customer lookup

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LAB ACTIVITY | 10.30.1: PRACTICE: Loops**: Customer lookup

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0 / 4

A customer database file named CustomerDb.txt contains a list of customers (one per line), each customer consisting of a unique customer id followed by a first and last name. Given an id, output the customer's first and last name. If the id is not found, output "Not found". If the input id is 27, the output might be "Sarah Lee" (if found).

FYI, the customer database's contents happen to be: 42 Mike Jones 16 Al Garcia 27 Sarah Lee 12 Stan Lee 99 Amy Hernandez

Hints:

- The template code has functions for opening and closing the customer database file. You need not understand those functions. Just know that customerDb can be read just like cin. So customerDb >> x gets the next value from the file into variable x, just like cin >> x. You might also note that the expression evaluates to 0 when the end of file is reached, so the while loop will exit.
- In the while loop, you'll want to skip the first and last names for that id, since that line's id didn't match the id to find.
- After the while loop, check if the id was found (you can compare idToFind with dbId to detect this). If so, read the first and last name, and print them. Else, print "Not found".

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IDE settings requiring a reload have been updated. Click here to reload the IDE. Reload

Run History Tutorial

```
#include <iostream>
#include <fstream>
#include <string>
using namespace std;

int main() {
   string idToFind; // Using string for id in case has both numbers and letters
   string dbId;
   string dbFirstName;
   string dbLastName;
   ifstream customerDb;

   cin >> idToFind;

   // You need not understand the file open and close functions to complete thi
   // customerDb can be read just like cin can be read. cin >> x   CustomerDb >:

```

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10.31 PRACTICE: Loops**: Word count

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LAB ACTIVITY | 10.31.1: PRACTICE: Loops**: Word count

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0 / 7

Many text processing tools like Microsoft Word or Google Docs will count the number of "words" in text. A word is a sequence of any characters other than a space. Write a program that reads an input line of text, and outputs the number of words in that text. If the input is "I have a bike." then the output is 4.

Hints:

- Use getline to read the line of text
- Use a for loop to walk through each character in the string. Count the words as you go through that loop. You'll need a variable to keep that count. Initialize it to 0 before the loop, and then increment it whenever you see a new word.
- Use a boolean variable to indicate whether you are currently "in" a word or not. If you see a space, set that variable with false. Else, set it to true.
- There are actually three cases to consider in each loop iteration. Either you are at a space (so are not in a word), you are not at a space and you are NOT already in a word (so you found a new word), or you are not at a space and you ARE already in a word (so there's nothing to do). So create an if -- else if -- else branch statement.

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Run History Tutorial

```
#include <iostream>
#include <string>
using namespace std;

int main() {

   /* Type your code here */

   return 0;
}
```

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10.32 PRACTICE: Loops**: Academic index score table

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LAB ACTIVITY | 10.32.1: PRACTICE: Loops**: Academic index score table

0 / 2

Many universities calculate a weighted sum of an applicant's high school GPA and standardized test scores, whose value (called an Academic Index Score or AIS) must exceed a minimum threshold to be considered for admission. Ex: AIS = 2.5 * (GPA / 4.0) * 100 + (test_score / 1600) * 100 must be at least 270. Write a program that, given a threshold, prints a table indicating the minimum GPA / test score combinations that meet the threshold. Use doubles for all values. Each row is GPA then test score. GPA should range from 3.0 to 4.0 in increments of 0.1.

Hints:

- Do some algebra first to solve the above equation for test_score.
- Write a for loop that iterates 11 times, for 3.0 to 4.0 in 0.1 increments. For each iteration, print the row GPA, then calculate the test_score using the equation you created.
- Be careful to avoid integer division, which yields a different result than floating-point division.

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```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.33 PRACTICE: Loops**: TV aspect ratios

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LAB ACTIVITY 10.33.1: PRACTICE: Loops**: TV aspect ratios

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0 / 2

A TV's size indicates the TV's diagonal. Thus, one 60" TV could have a different width and height than another 60" TV, both yielding a 60" diagonal. For a given TV diagonal, output a table listing possible widths and heights, each row increasing width by 1 inch. Only list rows where width is greater than height. Define diagonal, width, and height variables as doubles, but note that width will only take on rounded values like 20.0, 21.0, etc.

Hints:

- Use Pythagorean's Theorem, solving for height. Use the cmath library to compute the needed square root.
- Write a for loop that iterates for widths ranging from 1 to the diagonal (you could define tighter bounds, but the program works with those looser bounds and is simpler).
- In the loop, compute the height for the given diagonal and width, using your height equation. Then use an if statement to output only if the width is greater than the height.

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```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.34 PRACTICE: Loops*: Biggest difference

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LAB ACTIVITY | 10.34.1: PRACTICE: Loops*: Biggest difference

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0 / 6

Write a program that outputs the biggest difference (absolute value) between any successive pair of numbers in a list. Such a list might represent daily stock market prices or daily temperatures, so the difference represents the biggest single-day change. The input is the list size, followed by the numbers. If the input is 5 60 63 68 61 59, the output is 7.

Hints:

- Declare a variable for the current number, and another for the previous number. At the start of each loop iteration, set prevNum = currNum, then get the next number into currNum.
- Maintain a max difference variable. Initialize it with 0. In each loop iteration, check if the difference between currNum and prevNum exceeds maxDiff; if so, update maxDiff with that difference.
- Don't forget to take the absolute value of the difference before the above comparison.
- Don't try to check the max difference for the first number in the list, since no previous number exists.

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```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.35 PRACTICE: Loops*: Check if sorted

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LAB ACTIVITY | 10.35.1: PRACTICE: Loops*: Check if sorted

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0 / 7

Given a list of unique numbers, write a program that outputs Sorted if the numbers are in ascending order, Unsorted otherwise. If the input is 5 1 3 6 7 9, output Sorted. If the input is 3 10 8 2, output: Unsorted. A list of size 0 or 1 is sorted.

Hints:

- Remember that only one violation makes the entire list unsorted.
- For simplicity, you don't have to don't break out of the loop if you find two numbers aren't ascending. Instead, use a bool variable, initialize it to true, and set it to false if you find any violation.

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```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.36 PRACTICE: Vectors*: Find max

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LAB ACTIVITY | 10.36.1: PRACTICE: Vectors*: Find max

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0 / 5

Traversing a vector to find the max (or min) is common. Given a vector of integers, output the maximum integer found in the vector. If the input is 4 3 8 2 6, the output is 8.

Hints:

- Declare a variable named maxItem to hold the max value seen so far. Update that value if you ever see a larger value.
- Initialize that variable to any element's value, NOT to 0.

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```
#include <iostream>
#include <vector>
using namespace std;

int main() {
   int numItems;
   vector<int> listItems;
   int currItem;
   int i;

   // Get items
   cin >> numItems;
   for (i = 0; i < numItems; ++i) {
      cin >> currItem;
      listItems.push_back(currItem);
   }

   /* Type your code here */

   return 0;
```

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10.37 PRACTICE: Vectors*: Outputting multiple elements per line

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LAB ACTIVITY | 10.37.1: PRACTICE: Vectors*: Outputting multiple elements per line

0 / 2

12 values have been input into vector yearlyValues. Output all 12 elements, with 4 per line. If the elements are 10 20 30 40 50 60 70 80 90 100 110 120, the output is:

```
10 20 30 40
50 60 70 80
90 100 110 120
```

Hints:

- Use a for loop with increment i += 4, rather than ++i.
- Inside the for loop, just print all four elements using four cout statements. An inner loop could be used, but isn't necessary.

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```
#include <iostream>
#include <vector>
using namespace std;

int main() {

   vector<int> yearlyValues(12);
   int i;

   // Get vector values
   for (i = 0; i < 12; ++i) {
      cin >> yearlyValues.at(i);
   }

   /* Type your code here. */

   return 0;
}
```

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10.38 PRACTICE: Vectors*: Copying only negative values

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LAB ACTIVITY | 10.38.1: PRACTICE: Vectors*: Copying only negative values

0 / 3

A list of 6 integers is input into vector listInts. Complete the program to copy only the negative integers to a new vector listNegInts. Output the number of negative elements, and the negatives list. Ex: For input 5 -2 0 9 -66 -4, output is:

```
3
-2
-66
-4
```

Hints:

- When declaring listNegInts, don't specify a size. Instead, add elements using listNegInts.push_back(â€¦)
- Write a first for loop that copies only the negative integers to listNegInts, then write a second for loop that outputs.
- Your copying for loop should have an if statement that only copies the current listInts element if negative.
- The number of items in listNegInts can be determined using listNegInts.size(). No need to have a separate variable keeping track.

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Run History Tutorial

```
#include <iostream>
#include <vector>
using namespace std;

int main() {

   vector<int> listInts(6);
   // Hint: Declare listNegInts
   unsigned int i;

   // Get input integers
   for (i = 0; i < 6; ++i) {
      cin >> listInts.at(i);
   }

   /* Type your code here. */

   return 0;
}
```

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10.39 PRACTICE: Arrays: Output only negative values

A list of 6 integers is input into array listInts. Complete the program to output the number of negative elements, and the negatives list. Ex: For input 5 -2 0 9 -66 -4, output is:

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```
3
-2
-66
-4
```

Hints:

- Write a first for loop that counts only the negative integers, then write a second for loop that outputs.

602398.4584902.qx3zqy7

LAB ACTIVITY | 10.39.1: PRACTICE: Arrays: Output only negative values 0 / 3

main.cpp Load default template...

```
#include <iostream>
using namespace std;

int main() {

   int listInts[6];

   // Get input integers
   for (int i = 0; i < 6; ++i) {
      cin >> listInts[i];
   }

   /* Type your code here. */

   return 0;
```

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Develop mode Submit mode

Run your program as often as you'd like, before submitting for grading. Below, type any needed input values in the first box, then click **Run program** and observe the program's output in the second box.

Enter program input (optional)

If your code requires input values, provide them here.

Run program

Input (from above) → main.cpp (Your program) → Outp

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Program output displayed here

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```
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```

Solution Show

10.40 PRACTICE: Vectors**: Binary to decimal conversion

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LAB ACTIVITY | 10.40.1: PRACTICE: Vectors**: Binary to decimal conversion 0 / 3

A binary number's digits are only 0's and 1's, with each digit's weight being an increasing power of 2. Ex: 110 is $1*2^2 + 1*2^1 + 0*2^0 = 1*4 + 1*2 + 0*1 = 4 + 2 + 0 = 6$. A user enters an 8-bit binary number as 1's and 0's separated by spaces. Then compute and output the decimal equivalent. Ex: For input 0 0 0 1 1 1 1 1, the output is:

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```
31
```

(16 + 8 + 4 + 2 + 1)

Hints:

- Store the bits in reverse, so that the rightmost bit is in element 0.

- Write a for loop to read the input bits into a vector. Then write a second for loop to compute the decimal equivalent.
- To compute the decimal equivalent, loop through the elements, multiplying each by a weight, and adding to a sum.
- Use a variable to hold the weight. Start the weight at 1, and then multiply the weight by 2 at the end of each iteration.

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Run History Tutorial

```
#include <iostream>
#include <vector>
using namespace std;

int main() {

   vector<int> binaryNum(8);
   int digitWeight;
   int decimalSum;
   int i;

   // Get user's binary number. Store leftmost bit in element 7, rightmost in 0
   // Hint: for (...) {
      cin >> binaryNum.at(i);
   }

   /* Type your code here. */

   return 0;
}
```

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```
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```

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10.41 PRACTICE: Vectors***: Bowling score

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LAB ACTIVITY | 10.41.1: PRACTICE: Vectors***: Bowling score 0 / 4

Bowling involves 10 frames. Each frame starts with 10 pins. The bowler has two throws to knock all 10 pins down. The total score is the sum of pins knocked down, with some special rules.

For the first 9 frames:

- If all 10 pins are knocked down on a frame's first throw (a "strike"), that frame's score is the previous frame plus 10 *plus the next two throws*. (No second throw is taken).
- If all 10 pins are knocked down after a frame's second throw (a "spare"), that frame's score is the previous frame plus 10 *plus the next throw*.

In the 10th frame, if the bowler's first throw is a strike, or the first two throws yields a spare, the bowler gets a third throw. The 10th frame's score is the previous frame's score plus the pins knocked down in the 10th frame's two or three throws.

Given integers represents all throws for a game, output on one line each frame's score followed by a space (and end with a newline). Note that the number of throws may be as few as 11 (strikes in first 9 frames, and no strike/spare in 10th frame), or as many as 21 (2 throws in first 9 frames, then 3 in 10th).

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For simplicity, the input will always have 21 integers. If the game ended with fewer than 21 throws, the remaining integers will be 0's and can be ignored.

Ex: A perfect game is one where every throw is a strike. The 21 input integers will be: 10 10 10 10 10 10 10 10 10 10 10 10. The output will be: 30 60 90 120 150 180 210 240 270 300.

Hints:

- A first for loop should just read in the 21 scores in the first vector.

- A second for loop should fill the second vector's first 9 elements (first 9 frames).
- Additional code should compute the 10th frame, which is unique.

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Run History Tutorial

```
#include <iostream>
#include <vector>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.42 PRACTICE: Vectors**: Min, max, average

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LAB ACTIVITY | 10.42.1: PRACTICE: Vectors**: Min, max, average

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0 / 3

Given 10 input integers, output the minimum, maximum, and average of those integers. If the input is 1 1 1 1 1 3 3 3 3 3, the output is:

```
1 3 2
```

If the input is 9 8 7 6 5 4 3 2 1 0, the output is:

```
0 9 4.5
```

Hints:

- Use a single for loop and update variables minVal, maxVal, and sumVals on each iteration. (You could use three loops instead).
- Initialize variables minVal and maxVal each to the first integer, NOT to 0. 0 is wrong, because integers could be negative. Then update those values if a smaller or larger integer is seen (respectively).
- Don't forget to use floating-point division, not integer division, when computing the average (use / 10.0, not / 10).

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Run History Tutorial

```
#include <iostream>
#include <vector>

using namespace std;

int main() {
   vector<int> userValues(10);
   int i;

   for (i = 0; i < 10; ++i) {
      cin >> userValues.at(i);
   }

   /* Type your code here */

   return 0;
}
```

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10.43 PRACTICE: Vectors**: Mode

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LAB ACTIVITY | 10.43.1: PRACTICE: Vectors**: Mode

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0 / 4

The "mode" is a statistical summary of data (as are min, max, and average) representing the most commonly-occurring value. Given 10 integers ranging from 0 to 99, output the mode and its frequency. If the input is 1 1 1 1 2 2 9 8 7 6, the output is:

```
1 4
```

If any integer is outside 0-99, output an error. If an input is 105, the output is:

```
Invalid input: 105 is not in 0-99
```

Hints:

- Knowing that integers are in 0-99 enables creating a vector with 100 elements to count the occurrences of each value.
- Traverse the userValues vector and keep count by incrementing the appropriate element in a counts vector. If the input is 27, then increment element 27's value.
- While traversing userValues, check for an integer outside the range. If found, print the error message, and immediately return.
- After done counting, use another loop to traverse the counts vector and find the max. Also keep track of the index where max was found.

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Run History Tutorial

```
#include <iostream>
#include <vector>
using namespace std;

int main() {
   vector<int> userValues(10);
   int i;

   for (i = 0; i < 10; ++i) {
      cin >> userValues.at(i);
   }

   /* Type your code here. */

   return 0;
}
```

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10.44 PRACTICE: Vectors***: Grouping into ranges

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LAB ACTIVITY | 10.44.1: PRACTICE: Vectors***: Grouping into ranges 0 / 8

A publisher may allow a reader to select a subset of chapters to purchase. Given 15 integers that are 0 or 1 indicating whether or not to include chapters 1 to 15, output the selection using shorthand for ranges of 3 or more (11, 12, 13 becomes 11-13). If the input is 1 1 1 1 0 1 0 1 1 0 1 1 1 0 0, the output should be: 1-4 6 8 9 11-13 If no chapters are selected, output: None For simplicity, follow every term including the last by one space (and end with newline).

Hints:

- This problem is hard. Start by creating a for loop that just prints the selected chapters one by one, without shorthands for ranges. Your program will pass a few test cases.
- Next, extend the loop body to handle the case for a range of 3. Use an if statement to lookahead from index i to i+1 and i+2. If all three elements are 1's, print the range. Be careful to only do the lookahead if the current i is 13 or less. If the current index is 14 (or 15), there's no need to lookahead; the range can't be 3 or more because only 15 chapters exist.
- If your loop body printed a range like 2-4, don't forget to update your loop's index i to be 4 (don't leave it at 2).
- One you get the above working, then use a nested while loop to detect even larger ranges, such as 2-7. And don't forget to update the for loop index i to the detected range end.
- Use a boolean variable, initialized to false, and in your for loop set it to true if any chapter is selected. After your for loop above, if the variable is still false, print "None ".

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```
#include <iostream>
#include <vector>
using namespace std;

int main() {
   vector<bool> chptList(16); // Valid chapters are 1-15. 1 means include, 0 ex
   bool includeChpt;
   int i, j;

   // Get the chapter selections
   for (i = 1; i <= 15; ++i) {
      cin >> includeChpt;
      if (includeChpt) {
         chptList.at(i) = true;
      }
      else {
         chptList.at(i) = false;
      }
   }

```

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10.45 PRACTICE: Vectors**: Longest sequence

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LAB ACTIVITY | 10.45.1: PRACTICE: Vectors**: Longest sequence 0 / 5

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A common statistic of interest is the longest sequence of some pattern in a list of items. For example, in football, one may be interested in the longest sequence of consecutive complete passes. Given a list in which each item is either the letter "I" (for an incomplete pass) or a number (for a completed pass), output the length of the longest sequence of complete passes. The list is preceded by the number of items. Given 8 4 15 9 I 30 2 I 20, the output is 3 (because the longest sequence of complete passes is 4 15 9).

Hints:

- Use two variables, one that keeps track of the current sequence length, and another for the longest sequence length.
- In a for loop that iterates through the vector, if you see an "I", set the current sequence length to 0.
- Otherwise, you are in sequence (either at the beginning or later in the sequence), so increment the current sequence length.
- A simple way to compute the longest sequence is to potentially update that variable every time you update the current sequence length. Check if the current is greater than the longest -- if so, update the longest.
- When done iterating, just output the value of the longest sequence length variable.

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```
#include <iostream>
#include <vector>
#include <string>
using namespace std;

int main() {
   int numItems;
   vector<string> listItems;
   string currItem;
   int i;

   // Get items
   cin >> numItems;
   for (i = 0; i < numItems; ++i) {
      cin >> currItem;
      listItems.push_back(currItem);
   }

   /* Type your code here */
```

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10.46 PRACTICE: Vectors**: Reverse in place

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0 / 4

Reversing a vector is a common task. One approach copies to a second vector in reverse, then copies the second vector back to the first. However, to save space, reversing a vector without using a second vector is sometimes preferable. Write a function that reverses a given vector, without using a second vector. If the original vector's values are 2 5 9 7, the vector after reversing is 7 9 5 2.

Hints:

- Use this approach: Swap the first and last elements, then swap the second and second-to-last elements, etc.
- Stop when you reach the middle; else, you'll reverse the vector twice, ending with the original order.
- Think about the case when the number of elements is even, and when odd. Make sure your code handles both cases.

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```
#include <iostream>
#include <vector>
using namespace std;

int main() {
   vector<int> listNums;
   unsigned int currNum;
   int i;
   int tmp;
   unsigned int listSize;

   while (cin >> currNum) {
      listNums.push_back(currNum);
   }



   // Reverse listNums in place.
   /* Type your code here. */
```

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10.47 PRACTICE: Functions**: Compute max

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Write a function called MaxFive that returns the maximum of five integer parameters. Ex: MaxFive(3, 5, 1, 0, 2) returns 5.

Hints:

- Use four if statements. (Don't use if-else).
- Use a variable maxFound to keep track of the largest value seen so far.
- Initialize maxFound to one of the parameters. (Not to 0, which wouldn't handle the case when all parameters are negative).
- Don't forget to return maxFound.

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Run History Tutorial

```
#include <iostream>
using namespace std;

// Hint: Define MaxFive

int main() {
   // Don't modify main's code below
   int v, w, x, y, z;
   int maxVal;

   cin >> v; cin >> w; cin >> x; cin >> y; cin >> z;
   maxVal = MaxFive(v, w, x, y, z);
   cout << maxVal << endl;

   return 0;
}
```

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10.48 PRACTICE: Functions**: Sort three values

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LAB ACTIVITY | 10.48.1: PRACTICE: Functions**: Sort three values 0 / 6

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Write a function Ascend3 with three integer reference parameters, that sorts the values into ascending order. Ex: If x = 5, y = 2, and z = 7, after the call Ascend3(x, y, z), the new values will be x = 2, y = 5, and z = 7.

Hints:

- Don't forget to declare Ascend3's parameters as pass-by-reference (using &). Otherwise, the function won't be able to change the values of the passed arguments. Also, return type should be void.
- One approach puts the three values into a vector, then sorts the vector. We won't be describing that approach here. Instead, we'll use branches.
- One solution approach realizes that only 6 possible orderings of xyz exist: xyz, xzy, yxz, yzx, zxy, zyx. An if-else an be used to detect which order x, y, z are initially in.
- Once detected, three variables lowVal, midVal, and highVal can be assigned. Note: Don't assign the parameters right away, because you'll overwrite a value that is still needed.
- After the if-else, those lowVal, midVal, and highVal variables are ready. So just set the x parameter with lowVal, y with midVal, and z with highVal.
- Be aware that two values could be equal. So use <= rather than < in your comparisons.

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```
#include <iostream>
using namespace std;

// Define Ascend3() here

int main() {

   int x, y, z;

   cin >> x;
   cin >> y;
   cin >> z;

   Ascend3(x, y, z);

   cout << x << " " << y << " " << z << endl;


   return 0;
}
```

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10.49 PRACTICE: Functions*: Calorie estimator

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LAB ACTIVITY | 10.49.1: PRACTICE: Functions*: Calorie estimator

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0 / 5

Write a function ActivityCalories that takes a string indicating an activity (sit, walk, run, bike, swim) and duration in minutes (integer), and returns the estimated calories expended (double). Calories per minute for a 150 lb person (source):

sit: 1.4 walk: 5.4 run: 13.0 bike: 6.8 swim: 8.7

If the input is sit 2, the output is 2.8.

Hints:

- Use an if-else statement to determine the calories per minute for the given activity
- Return the calories per minute times the minutes spent.

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```
#include <iostream>
using namespace std;

// Write your function here

int main() {
   int userMinutes;
   string userActivity;

   cin >> userActivity;
   cin >> userMinutes;

   cout << ActivityCalories(userActivity, userMinutes) << endl;

   return 0;
}
```

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10.50 PRACTICE: Functions**: Rideshare pickup time

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LAB ACTIVITY | 10.50.1: PRACTICE: Functions**: Rideshare pickup time 0 / 3

Rideshare companies like Uber or Lyft track the x,y coordinates of drivers and customers on a map. If a customer requests a ride, the company's app estimates the minutes until the nearest driver can arrive. Write a function that, given the x and y coordinates of a customer and the three nearest drivers, returns the estimated pickup time. Assume drivers can only drive in the x or y directions (not diagonal), and each mile takes 2 minutes to drive. All values are integers.

Hints:

- Break the problem into three parts. In the first part, compute the three distances.
- In the second part, determine the minimum distance. In the third part, compute and return the time.
- Don't forget to use absolute value when computing the x distance, and again for the y distance, because direction doesn't matter. You may wish to just write a small absolute value function.

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```
#include <iostream>
using namespace std;


// All x, y coordinates are in miles from the origin 0, 0.
int PickupMinutes(int userX, int userY, int d1X, int d1Y, int d2X, int d2Y, int

   // Finish this function

}


int main() {
   int userX, userY;
   int d1X, d1Y;
   int d2X, d2Y;
   int d3X, d3Y;

   cin >> userX;
   cin >> userY;
```

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10.51 PRACTICE: Functions**: User age

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LAB ACTIVITY | 10.51.1: PRACTICE: Functions**: User age

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0 / 5

Various websites like Wikipedia or IMDB list not just a person's birthdate but also the person's current age. Given a person's birthdate and current date, output the person's age in years. The custom is to round down. If the input is 7 1 2000 2 15 2015, the output is 14 (because the person hasn't yet reached their 15th birthday). A person less than 1 has age 0.

Hints:

- Start by computing currAge just as the difference in years. Then, use an if-else statement to determine whether to decrement currAge.
- One reason to decrement is if the current month is less than the birth month (no birthday yet this year).
- Another reason to decrement is if the current month equals the birth month, but the current day is less than the birth day.

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Run History Tutorial

```
#include <iostream>
using namespace std;

int GetAge(int birthMonth, int birthDay, int birthYear, int currMonth, int curr

   /* Type your code here. */

}


int main() {
   int birthMonth, birthDay, birthYear;
   int currMonth, currDay, currYear;

   cin >> birthMonth;  cin >> birthDay;  cin >> birthYear;
   cin >> currMonth;   cin >> currDay;   cin >> currYear;

   cout << GetAge(birthMonth, birthDay, birthYear, currMonth, currDay, currYear

   return 0;
```

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10.52 PRACTICE: Functions**: Simulating waiting time (fast clerk)

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LAB ACTIVITY | 10.52.1: PRACTICE: Functions**: Simulating waiting time (fast clerk)

0 / 4

Programs commonly perform simulations of physical scenarios like cars in traffic, or people waiting at stores. A store wants to understand customer waiting time. A list provides the number of customers that arrive every minute for 10 minutes. The program should output the length of the line at each minute, assuming one clerk serves each customer and takes 1 minute to complete service. If the input is 2 0 0 2 1 0 0 0 1 0, the output should be 2 1 0 2 2 1 0 0 1 0 (At minute 0, 2 customers arrived in line. At minute 1, 1 of those has been served, reducing the line to 1. At minute 2, that customer was served, reducing the line to 0). Output a space after each output integer, including the last (followed by newline).

HINTS:

- Every minute, if the lineLength wasn't 0, you can decrement lineLength because the clerk would have finished serving one customer.
- Every minute, if new customers arrived, just add them to lineLength for that minute.

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Run History Tutorial

```
#include <iostream>
#include <vector>
using namespace std;

void SimulateLine(vector<int> customerArrivals) {

   /* Type your code here. */

}


int main() {
   int i;
   vector<int> customerArrivals(10);

   // Get customer arrival data
   for (i = 0; i < 10; ++i) {
      cin >> customerArrivals.at(i);
   }

```

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10.53 PRACTICE: Functions**: Number to words

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LAB ACTIVITY | 10.53.1: PRACTICE: Functions**: Number to words 0 / 3

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Sometimes numbers are converted to words, like in a wedding invitation. So 23 becomes "twenty three". Write a function DigitToWord that takes a single digit number from 0-9 and returns that number's word: 0 is zero, 1 is one, 2 is two, etc (if the number is outside 0-9, return "error"). Write another function TensDigitToWord that takes a single digit number from 2-9, and returns that number's word when it appears in the tens digit: 2 is twenty, 3 is thirty, etc. If the number is outside 2-9, return "error". Finally, write a function TwoDigitNumToWords that takes a two-digit number from 20-99 and returns that number in words. Your main program should get a user's integer, call TwoDigitNumToWords, and output the resulting string. If the input is 23, the output should be "twenty three".

Do not do any error checking of the input. Note that your program does not support all numbers. 0-19 will yield error output, for example.

HINTS:

- Write DigitToWord first, and test the function (have your main call that function directly) -- you won't pass any of the tests, but you should still start that way. Next, write TensDigitToWord and test it by itself also. Finally, write TwoDigitNumToWords (calling your first two functions) and test the entire program.
- Your TwoDigitNumToWords function should pass the ten's digit to TensDigitToWord. To get the tens digit, divide the number by 10.
- Your TwoDigitNumToWords function should pass the one's digit to DigitToWord. To get the ones digit, mod the number by 10 (num % 10).
- You can concatenate the strings returned by those two functions using the + operator. Ex: "hello" + " " + "there" yields one string "hello there".

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```
#include <iostream>
#include <string>
using namespace std;

string DigitToWord(int digitIn) {

   // FINISH

}

string TensDigitToWord(int digitIn) {

   // FINISH

}

string TwoDigitNumToWords(int numIn) {

   // FINISH

```

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10.54 PRACTICE: Functions**: Driving cost estimator

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LAB ACTIVITY | 10.54.1: PRACTICE: Functions**: Driving cost estimator 0 / 2

Driving is expensive. Write a function CostForMilesGas that takes miles driven and returns the cents, assuming 30 miles per gallon and a per gallon price of $4. Write a similar function CostForMilesMaintenance that assumes tires last 20,000 miles and cost $500, and that assumes $300 of service every 10,000 miles. Finally, write a function CostForMiles that takes miles driven, and calls those two functions, returning total cents. Use constants in the functions as appropriate, like MILES_PER_GAL, not hardcoded values in the function's statements. Use only integer arithmetic throughout. If the input is 50, the output should be: 941 cents

Hints:

- Because you are only using integer arithmetic, do any divisions as late as possible, to reduce the impact of integer division ignoring fractions
- For gas, use an equation like this: centsGas = (milesDriven * CENTS_PER_GAL) / MILES_PER_GAL;
- For service, use an equation that starts like this: centsMaintenance = ((milesDriven * TIRES_CENTS) / TIRES_MILES) + â€¦ (Finish by adding a similar expression for service.

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Run History Tutorial

```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.55 PRACTICE: Function*: Split cents into dollars and cents

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LAB ACTIVITY | 10.55.1: PRACTICE: Function*: Split cents into dollars and cents

0 / 4

Money is a bit tricky to represent in programs. One naturally wants to use floating-point like 7.52 to represent 7 dollars and 52 cents, but many programmers believe that money should be represented as ints because money is counted (versus being measured like temperature). One approach is to do all money calculations using cents, represented as an integer, like 752 cents. A useful function in such an approach might convert cents into separate dollar and cents values. Write a function CentsToDollarsCents whose first parameter is given cents, and whose second and third parameters (both references) are dollars and remaining cents. If the first parameter is 752, the second parameter becomes 7 and the third 52.

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Run History Tutorial

```
#include <iostream>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.56 PRACTICE: Functions*: Rectangles sizes

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LAB ACTIVITY | 10.56.1: PRACTICE: Functions*: Rectangles sizes 0 / 6

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Suppose a graphics program needs a function to indicate whether one rectangle is smaller than another rectangle. A rectangle is specified by its upper-left coordinate and bottom-right coordinate. If the first rectangle is (1, 1) and (2,3), and the second is (0,0) and (10,10), the function returns true.

Hints:

- Use copy-paste to ensure your parameters exactly match the arguments. You can use the same names for parameters as the arguments.
- Declare local variables r1Area and r2Area to make your comparison expression simpler.
- Use the abs() function in cstdlib (requires #include).
- Take great care to check and recheck that your calculations involve the correct values.

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Run History Tutorial

```
#include <iostream>
#include <cstdlib>
using namespace std;

/* Type your code here */


int main() {
   int r1xul, r1yul, r1xbr, r1ybr; // x upper-left, y upper-left, x bottom-righ
   int r2xul, r2yul, r2xbr, r2ybr;

   cin >> r1xul; cin >> r1yul; cin >> r1xbr; cin >> r1ybr;
   cin >> r2xul; cin >> r2yul; cin >> r2xbr; cin >> r2ybr;

   cout << FirstRectangleSmaller(r1xul, r1yul, r1xbr, r1ybr, r2xul, r2yul, r2xb

   return 0;
}

```

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10.57 PRACTICE: Functions***: Electric bill

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LAB ACTIVITY | 10.57.1: PRACTICE: Functions***: Electric bill

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0 / 4

Southern California's electric company uses a "three tier" cost structure for household electric bills. As of Jan 2017, for a given month, the first 232 kWh is $0.08291/kWh, the next 696 kWh is $0.16838/kWh, and any additional kWh is $0.23336/kWh. Write a function that takes a household month's kWh, and the cutoffs and prices for the tiers, and returns that month's electric cost.

If the input is:

```
1700.0  232  0.08291 696  0.16838  0.23336
```

the output is:

```
$316.58
```

Output each floating-point value with two digits after the decimal point, which can be achieved by executing
`cout << fixed << setprecision(2);` once before all other cout statements.

Hints:

- Think carefully through the logic of calculating the various cost contributions of each tier. We recommend calculating tier 3 first, then tier 2.
- Declare a variable named remainingKWh. Initialize it with the monthKWh. Also declare monthCost, initialized with 0.0. Declare tierKWh to use for computations.
- Start with an if statement if remainingKWh > (tier2Cutoff + tier1Cutoff). If yes, compute just the kWh that are part of tier 3, which is remainingKWh - (tier2Cutoff + tier1Cutoff), and store in tierKWh. Multiply tierKWh by tier3Cost, and add that to the monthCost. Then decrease remainingKWh by tierKWh.
- Repeat for tier2.
- For whatever is left in remainingKWh, multiply by tier1Cost.

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```
#include <iostream>
#include <iomanip>
using namespace std;

double CalculateMonthElectricCost(double monthKWh, double tier1Cutoff, double t
                                  double tier2Cutoff, double tier2Cost, double

   // Type your code here
}


int main() {
   double monthKWh;
   double tier1Cutoff, tier2Cutoff; // In kWh
   double tier1Cost, tier2Cost, tier3Cost; // In $ per kWh
   double monthCost;

   cin >> monthKWh;
   cin >> tier1Cutoff;
   cin >> tier1Cost;
```

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10.58 PRACTICE: Functions*: Digits to number

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LAB ACTIVITY | 10.58.1: PRACTICE: Functions*: Digits to number 0 / 3

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Given a vector of digits (0-9) for a decimal number, write a function that returns a single integer. The 0'th element is the decimal number's one's place. If the vector's elements are 9, 6, 2, the function returns integer 269.

Hints:

- First do the example conversion by hand to ensure you understand how each digit contributes to the total value of the integer.
- The first digit (at element 0) should be multiplied by 1, the second by 10, the third by 100, etc.
- Declare a variable to keep the total value (initialized with 0), and another to keep the current digit's weight (initialized with 1). For the current digit in the vector, multiply by the current weight and add to the total. Then update the weight in preparation for the next iteration.

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```
#include <iostream>
#include <vector>
using namespace std;

// Type your code here


int main() {
   int userDigit;
   vector<int> digitsList;
   int resultNum;

   while (cin >> userDigit) {
      digitsList.push_back(userDigit);
   }

   resultNum = DigitsToNum(digitsList);

   cout << resultNum << endl;
```

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10.59 PRACTICE: Functions***: Commas in integer

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LAB ACTIVITY | 10.59.1: PRACTICE: Functions***: Commas in integer 0 / 8

Commas make large integers easier to read. Ex: 145,020 is easier to read than 145020. Write a function that takes an integer, and returns a string representation of that number with commas appropriately inserted. If the input if 145020, the function returns string "145,020".

Hints:

- Develop incrementally: Start by just converting the integer to a string, without commas. Then update the program to insert commas.
- This problem is hard. Take your time. Do little by little.
- Write a function to convert a single integer digit to a char (DigitToChar). Then use that function in your function that converts an integer to a string.
- Insert one digit at a time into the string, starting with the one's place. Use % 10 to get the rightmost digit. Use / 10 to shift the number right (discarding the current 1's place).
- Use the string's insert() function. Note that insert at the front has a strange syntax. For string str: str.insert(str.begin(), yourChar)

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```
#include <iostream>
#include <string>
using namespace std;

// Type your code here


int main() {
   int userNum;

   cin >> userNum;

   cout << NumToStringWithCommas(userNum) << endl;

   return 0;
}
```

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10.60 PRACTICE: Functions**: Next char in string

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LAB ACTIVITY | 10.60.1: PRACTICE: Functions**: Next char in string 0 / 8

Write a function that, given a string, index, and character, returns the index of the first occurrence of the character starting the search at the index. If not found, return -1. If the inputs are "Hello-friends", 3, and 'e', the function returns 9 (indexing the 'e' in friends).

Hints:

- Various approaches exist to solve this problem. We prefer an approach that uses a for loop along with a boolean variables to indicate the character was found (which should end the for loop immediately).

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```
#include <iostream>
#include <string>
using namespace std;

// Type your code here

int main() {
   string inputString;
   int startIndex;
   char searchChar;

   cin >> inputString;
   cin >> startIndex;
   cin >> searchChar;

   cout << FindNextCharInString(inputString, startIndex, searchChar) << endl;

   return 0;
}
```

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10.61 PRACTICE: Functions***: Find next substring

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LAB ACTIVITY | 10.61.1: PRACTICE: Functions***: Find next substring 0 / 5

Write a function that returns the index of the next occurrence of a substring in a string. Inputs are the string, start index, and substring. If not found, return -1. Do not use built-in string functions. If the input is "heyhey-friend", 1, "hey", the output is 3 (where the second "hey" starts).

Hints:

- This is fairly difficult. You might start by writing a program that looks for a next single character rather than substring. Once that program is working and tested, then you're ready to look for a substring rather than a character.
- To look for a substring, consider writing a loop to do your own string comparison. Other approaches are possible.
- While you iterate through the string, realize that you can stop if you are near enough to the end that the substring can't possibly fit. So don't iterate all the way to i < string.size(); stop sooner than that.

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```
#include <iostream>
#include <string>
using namespace std;

// Type your code here


int main() {
   string inputString;
   int startIndex;
   string searchStr;

   cin >> inputString;
   cin >> startIndex;
   cin >> searchStr;

   cout << FindNextSubstr(inputString, startIndex, searchStr) << endl;

   return 0;
}
```

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10.62 PRACTICE: Functions***: Output guitar tabs

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LAB ACTIVITY | 10.62.1: PRACTICE: Functions***: Output guitar tabs 0 / 2

An earlier problem introduced guitar tabs. In this problem, the user can enter a sequence of chords, and the program should output the tabs in sequence. The first input is the number of chords to follow. If the input is 4 G C G D, the output should be:

```
e|-3-0-3-2-
B|-0-1-0-3-
G|-0-0-0-2-
D|-0-2-0-0-
A|-2-3-2---
E|-3---3---
```

Hints:

- Use 6 C++ strings, one for each guitar string ("string" below will mean C++ string unless otherwise noted).
- Start by the e string with "e|-", the B string with "B|-", etc.
- For each user chord, append (using append()) to each string the appropriate item (a number or -) plus -, like "2-".
- When done, print the 6 strings one at a time separated by newlines.

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```
#include <iostream>
#include <string>
using namespace std;

int main() {

   /* Type your code here. */

   return 0;
}
```

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10.63 PRACTICE: Functions*: Rotate three values

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LAB ACTIVITY | 10.63.1: PRACTICE: Functions*: Rotate three values 0 / 2

Given three function parameters p1, p2, p3, rotate the values to the right. Rotate means to shift each item to the item on the right, with the rightmost item rotating around to become the leftmost item. If initial values are 2 4 6, final values are 6 2 4.

Hints:

- Declare the function's three parameters as reference type. Function return type is void.
- Use a tmp variable in the function (similar to when swapping two variables). Your first assignment statement in the function should be assigning tmp with one of the three parameter's value.
- Be careful not to overwrite a value that you expect to use. The order in which you do the assignments matters.

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```
#include <iostream>
using namespace std;

// Type your code here



int main() {
   int n1, n2, n3;

   cin >> n1;
   cin >> n2;
   cin >> n3;

   RotateRight3(n1, n2, n3);

   cout << n1 << " " << n2 << " " << n3 << endl;

   return 0;
}
```

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