Program 4 - Sheep, Functions, and Ancient Numerals

1 Introduction

Having invented a way to track sheep, Reg and Stan have become fabulously wealthy. (Really it wasn't the sheep that did it. They won a massive patent infringement suit against the Romans for "Roman Numerals"). They, of course, had a problem. They had more sestersii than they knew what to do with.

"Did you ever see so much silver?" Stan said, his eyes gaping wide at the large budget of coins brought by the centurion.

"No." Reg replied. Reg looked very introspective, as shepherds are want to do. "I suppose we'd better expand our fields!"

"Brilliant idea!," Stan replied. They then set about buying all of the adjoining land to theirs. This, in turn, produced a runaway recursive problem. "You know, Reg. If we keep buying all the land that touches our ever expanding borders, we'll end up trying to buy the whole continent?!" Reg replied "Oh yeah. Maybe we should start buying some more sheep then." And that is precisely what they did. Unfortunately, they had bought so much land, that all the sheep in the Roman Empire would not fill their fields.

1.1 A Trip to India

"I guess we'll have to travel long and far looking for more sheep." Stan said one day. So the two set out into the world. They went to India first. They discovered that the Indian sheep were tagged with prices which were in some strange alphabet. "What is this?" Stan said pointing at the marks "123". The Indian merchant replied "That's One Hundred and Twenty Three Rupees." Stan quickly realized that there was more than one way to count numbers. This first number system they encountered was the Indian numeral system, which we incorrectly call "Arabic Numerals" thanks to a misunderstanding by an 11th century English cleric.

The reader should already be familiar with these numbers, as they are the number system used the whole world over in the modern era.

"Well, the Indian number system is very nice! I especially liked the 0." Reg said as they were leaving. "Eh, it will never catch on" replied Stan.

1.2 A Quick Stop in Judea

After buying all the sheep in India, and making broad swaths through Arabia, Reg and Stan encountered yet another way of printing prices. They found a Jewish shepherd named Jethro. Jethro had a very nice ram which was labeled with (transliterated) "DTs". "Stan, what do you suppose that strange mark is?" Jethro explained, "Those are Hebrew letters, but here they are showing a number. This ram is worth 94 Shekels." "94 Shekels, that's quite a deal!", exclaimed Stan. They handed over the appropriate amount of silver, and the ram was theirs. Not missing an opportunity to learn something new, Reg asked Jethro about the Hebrew number system. Jethro explained the Hebrew alphabet, and how they had a system where each letter represented a number. He went on to show them how Hebrew is read from right to left. Stan took notes, however, given that Stan was not adept at forming the Hebrew letters, he wrote down their names, inventing a Romanized transliteration for each, and also wrote down their numeric values. Stan's notes are as follows:

```
Name      Sound        Value
----      ---------    -----
Aleph     * (none)       1
Bet       B              2
Gimel     G              3
Dalet     D              4
Hei       H              5
```

```
Vav        V              6
Zayin      Z              7
Het        Ch             8
Tet        T              9
Yud        Y             10
Kaf        K             20
Lamed      L             30
Mem        M             40
Nun        N             50
Samech     S             60
Ayin       ^ (none)      70
Pei        P             80
Tsadi      Ts            90
Kuf        Q            100
Resh       R            200
Shin       Sh           300
Tav        Ta           400
```

NOTE: If you are interested in the shape of these letters, just google "Hebrew Alphabet" and you'll find it. There are some wonderful coincidences in the Hebrew number system. For instance, the word for father is "Ab", the word for mother is "Haim" and the word for child is "Yaled". If we use our transliterated Hebrew numbers, we have B*=3, M*=41, DLY = 44. Thus "Mother + Father = Child".

They thanked Jethro, and they departed from the land of Judea and made their way back to Latinum. They were a bit puzzled by the silent letters, but they decided they could distinguish between them in Roman characters by using * for aleph and ^ for ayin.

1.3 A Grecian Odyssey

Along the way back to their peninsula, they passed through Greece. While in Greece they encounter a beautiful ewe. The ram they bought in Judea agreed that the ewe was beautiful, and before they could stop him, the ram expressed his admiration for the ewe in the way which sheep generally do! "You have spoiled my purebred sheep!" Screamed Aristophanes the Shepherd. "I am terribly sorry, but he got out of our hands." Reg said, in his most placating tone. "Since she is ruined for pure breeding, I think it only fair that we buy her from you.", said Stan. Aristophanes ignored Reg, but Stan's offer made sense.

"How much?" asked Reg. Like all sheep, this ewe had a price tag. The price tag read "TA". "How much is that?" Stan asked. "301 Drachmas" replied Aristophanes. "301 Drachmas! That's almost 5 times what we paid for the ram." shouted Reg, kicking the beast. "She is of a very rare breed, a fine line of sheep." Replied Aristophanes. They both sighed and paid for the sheep. In exchange, Aristophanes showed them the Greek Number system. Once again, being not at all used to printing out the strange characters of Greece, Stan wrote out their names, sound, and value.

```
Name          Sound        Value
----          -----        -----
Alpha           A            1
Beta            B            2
Gamma           G            3
Delta           D            4
Epsilon         Eh           5
Vau             Va           6
Zeta            Zd           7
Eta             Ee           8
Theta           Th           9
```

```
Iota          Ey          10
Kappa         K           20
Lambda        L           30
Mu            M           40
Nu            N           50
Ksi           X           60
Omicron       O           70
Pi            P           80
Koppa         Ku          90
Rho           R           100
Sigma         S           200
Tau           T           300
Upsilon       Iy          400
Phi           F           500
Chi           Ch          600
Psi           Ps          700
Omega         Aw          800
Sampi         Sa          900
```

Note: The astute reader will note the presence of a few extra letters. These letters are Vau, Koppa, and Sampi. These letters are alternate forms of Greek letters, basically indicating a different kind of stop for the consonants they represent. These letters were considered obsolete by about 403BC when Athens adopted the Ionian local variant of Greek spelling. They were still used for numbering though, otherwise the decades wouldn't work out!

Also, I have taken a few liberties. Originally, Greek was written right to left, as was Phoenician (from which it descends.) I have opted to use left to right, however, so that only the Hebrew section will be truly difficult. However, given the apparent time frame of our story, Greece would still have been writing from right to left. Sorry for the anachronism!

Now armed with a Judean ram, a Greecean ewe, and several soon to be Greco-Jewish lambs, Reg and Stan returned to the land of Tuscany where they put their new herds to pasture and passed on knowledge of the foreign number systems to their countrymen.

2   The Group Project

The task that is now before us is to help Reg and Stan carry out international commerce in the ancient world. We will suppose that they have a computer, one which can print only Latin characters, and they wish to trade with their neighboring countries. We want to be able to readily convert from any number system to any other number system. For Hebrew and Greek, we will use Stan's phonetic representations for our characters. That is, anytime you want an "Aleph" your program is going to print "*" and anytime you want a "Beta" your program will print "B". For the Greek letters this will almost work correctly anyway. The Romans, being ever jealous of the Greeks, stole a significant portion of the Latin alphabet from the Greek alphabet. (Even the name "alphabet" derives from the first two letters in Greek.)

An example run of this system can be found below:

```
Welcome to Reg and Stan's Number Writer 500(BC)

What number system would you like to start with?
   1.)   Roman/Etruscan
   2.)   Indian
   3.)   Hebrew
   4.)   Greek
Choice?  1
```

```
Roman Number: CCXII


What number system would you like to convert to?
   1.)   Roman/Etruscan
   2.)   Indian
   3.)   Hebrew
   4.)   Greek
Choice?  4

Greek Number: SEyB
```

Additionally, your program should provide error checking for the menus. Extra credit will be awarded for programs which perform error checking on the number entry screens.

2.1   Group and Decomposition Details

You will be working in groups of 3-4. If you can't find a group to join, let me know and I will assign you to one. You will need to create a set of files to work together. Each group member will be responsible for some set of functions. The breakdown of files in my sample version of the program are as follows:

- roman.h

- roman.cpp

- hebrew.h

- hebrew.cpp

- greek.h

- greek.cpp

- menu.h

- menu.cpp

- main.cpp

Each of the files representing different number systems have functions which have this type of signature:

```
string indianToRoman(int n);
int romanToIndian(string s);
```

Additionally, I wrote unit test files for each of the sub systems, so I had "romanTest.cpp", "hebrewTest.cpp", "greekTest.cpp", "menuTest.cpp". I would recommend that each person in the group be assigned one of the subsystems and that they develop their files and their test files.

Because compilation will be a pain, given the large number of files, you will want to create a makefile for this project.

3   Submission Requirements

One member of your group should create a script file. This script file should include the following:

- A listing of everyone's names. To do this, type a `#` followed by the group names. For instance, Reg and Stan would type:

  ```
  #Group Members: Reg, Stan
  ```

- A listing of all source files, including your makefile.

- Test runs for your program. Use the following numbers:

  - 425
  - 5
  - 321
  - 1984

  For each number, run it through all the conversions. Start with converting Indian to Greek, Roman, and Hebrew. Next, do Greek to Indian, Roman, and Hebrew. And so on. (Each number will result in 12 sample runs).

- Use the `turnin` program to submit your script file.

As this is a group effort, only one program will be submitted per group. The top of each file, however, should indicate who worked on the file. The format that I want to see is:

```
//File: filename
//Purpose: What the file does
//Authors: List of people who worked on the file
```

If your name does not appear at the top of one of the files, you won't get any credit for the program, so make sure to label the stuff that you work on!

4   Major Extra Credit Opportunity! (5 points on the Midterm Exam)

Reg and Stan are merchants, really. They would be very interested in being able to convert currency as well as numbers. The currency in the ancient world was based on weights of precious metals. The currencies mentioned in the story are:

- Roman: Sestersii

- Greek: Drachma

- Indian: Rupee

- Hebrew: Shekel

Note that some of these coins exist now, but they are no longer made of silver or gold. Instead, they are now "fiat money". If you do a little bit of research, you can establish a base price in ounces of silver for all of the ancient values. Then you can convert money from one denomination to another. If you alter your program so it also shows the money conversion, I will reward you richly. Not with silver or gold, but something far rarer and more sought after. Points on your exam!

4.1 Example

Suppose I choose Greek in the first menu. The number I enter will be assumed to be in Drachmas. Then suppose I choose roman in the second menu. This will still change the number, but it will also show me the value in Sestertii, but the value will be printed in Roman numerals.