

Problems - Beginning

B1 - Comparison of Areas

You are given three values:

- 1) the radius of a circle (r);
- 2) the height of a triangle (h); and
- 3) the base of that triangle (b).

You are to determine which shape is larger in area, the circle or the triangle. The area of a circle is determined by the following formula:

$$A = \pi r^2$$

(you may assume that $\pi = 3.1416$)

The area of a triangle is determined by the following formula:

$$A = h b / 2$$

You may assume that all values will be positive, and that the areas of the two shapes will be different.

Example 1:

Enter radius: 2.5

Enter height: 5.0

Enter base: 3.0

The circle is larger.

Example 2:

Enter radius: 2.0

Enter height: 5.6

Enter base: 7.8

The triangle is larger.

B2 - Roman Numerals

Given a string that correctly represents a Roman Numeral, print out the integer value. Assume that the string is less than 14 characters.

Example 1:

Enter Roman Numeral: MCMXCVIII

answer is 1998

Example 2:

Enter Roman Numeral: CDLIX

answer is 459

B3 - Double Arrow

This program will draw a double arrow using the '*' character. The left arrowhead should look like:

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

and the right arrowhead should look like:

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

The shaft should contain n '*'s, where n is given as input. You may assume that n is greater than 0 and less than 74.

Example 1:

Enter n: 1

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

Example 2:

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

B4 -- Difference in words

This program should count the number of differences between two words of the same length. Each difference is a position i such that the character at position i in one word is different from the character at position i in the other word. You may assume that the two words given as input are of the same length, are of length at most 15, and consist of only alphabetic characters.

Example:

Enter first word: computers

Enter second word: commuting

There are 4 differences.

B5 -- Reducing Fractions

The input for this program consists of two positive, non-zero integers, which represent the numerator and denominator of a fraction. The output is the fraction reduced to lowest terms.

Example:

Enter numerator: 18

Enter denominator: 12

The reduced fraction is: 3/2

B6 - Tic Tac Toe

Write a program that plays tic-tac-toe. The user moves first. Accept user moves as an integer from 1 to 9. The computer can play any open space. Do not allow the user to play in a space already occupied. Print the board after each computer move. Identify wins by either X or O.

Example:

Enter move: 1

X O

Enter move: 4

X O O

X

Enter move: 4

That space is already occupied, enter another move: 9

X O O

X O

X

X wins

Problems - Advanced

A1 -- Nim

You are to write a program that plays the version of Nim given by the following rules:

- The game is played with a certain number of stones (given as input).
- The computer and the player alternate taking 1-4 stones. The computer plays first
- The one who takes the last stone wins.

A winning strategy is to leave a number divisible by 5 (if possible). Your program should use this strategy whenever it is possible. If this strategy is impossible, the program should take 1 stone.

You may assume that the initial number of stones is positive and that the player cheats.

Example 1:

Enter initial number of stones: 21

I take 1 stones.

There are 20 stones.

How many will you take? (1-4) 3

That leaves 17 stones.

I take 2 stones.

There are 15 stones.

How many will you take? (1-4) 2

That leaves 13 stones.

I take 3 stones.

There are 10 stones.

How many will you take? (1-4) 1

That leaves 9 stones.

I take 4 stones.

There are 5 stones.

How many will you take? (1-4) 4

That leaves 1 stones.

I take 1 stones.

I win!

Example 2:

Enter initial number of stones: 10

I take 1 stones.

There are 9 stones.

How many will you take? (1-4) 4

That leaves 5 stones.

I take 1 stones.

There are 4 stones.

How many will you take? (1-4) 4

Congratulations -- you win!

A2 - Roman Numerals

Given two strings that correctly represent Roman Numerals, print out the Roman Numeral that represents the difference between the two numbers. Assume that the first number is the larger number. Assume that each string is less than 14 characters.

Example 1:

Enter first Roman Numeral: MCMXCVIII

Enter second Roman Numeral: ML

answer is CMXDVIII

Example 2:

Enter first Roman Numeral: CDLIX

Enter second Roman Numeral: CDLI

answer is VIII

A3 - Cross Word Puzzles

Given four, 2-character words, try to arrange them into a 2 by 2 cross word. If they fit, print out the solution. If there is not an arrange, print out an error message.

Example 1:

Enter first word: ab

Enter second word: ab

Enter third word: aa

Enter fourth word: bb

answer is

ab

ab

Example 2:

Enter first word: ab

Enter second word: ab

Enter third word: ab

Enter fourth word: aa

no solution

A4 - Trains

Train A leaves town X heading south and train B leaves town Y heading east. The two trains will both use a section of track 100 km south of town X and 150 km east of town Y. The two trains cannot be on the shared track at the same time. The two trains go opposite directions on the shared track. Train A is 1 km long, Train B is 2 km long.

Given the suggested departure times and speeds, determine which train should be delayed and by how many minutes to avoid meeting on the shared track. Minimize the amount of the delay. Enter start

times in hr:min. Assume a 24 hour clock. All times will be on the same day. Enter speeds in km/hr.

example 1:

enter start time of train A

13:59

enter start time of train B

14:02

enter speed of train A

100

enter speed of train B

150

no delay necessary

example 2:

enter start time of train A

10:12

enter start time of train B

10:08

enter speed of train A

50

enter speed of train B

75

delay train B by 8 minutes

A5 -- Polynomial multiplication

You are to write a program that multiplies two polynomials of one variable and prints the result. The polynomials are represented by a sequence of coefficients. The first coefficient represents the highest-order term, and successive coefficients represent successively lower-order terms. Thus, the sequence

4 -2 0 1

Represents the polynomial

$$4x^3 - 2x^2 + 0x + 1$$

You may assume that all coefficients are integers, and that the two given polynomials have degree at most 15. Be sure the coefficients are listed (in both input and output) in the order specified.

Example:

Enter coefficients of first polynomial:

4 -2 0 1

Enter coefficients of second polynomial:

1 2 3

Coefficients of result:

4 6 8 -5 2 3

The n th element is obtained from the $(n-1)$ st element by reading the $(n-1)$ st. For example, the first element contains, "One 1"; hence, the next element is 11. The fifth element is, "Three 1's, two 2's, one 1"; hence the sixth element is 312211.

You may assume that the number generated contains no more than 1000 digits.

Example 1:

Enter n: 1

1

Example 2:

Enter n: 6

312211

Example 3:

Enter n: 17

11131221131211132221232112111312212321123113112221121113122113111231133221121321

132132211331121321231231121113122113322113111221131221

A6 -- Conway's sequence

You are to write a program to determine the n th element in the following sequence:

1, 11, 21, 1211, 111221, ...

The n th element is obtained from the $(n-1)$ st element by reading the $(n-1)$ st. For example, the first element contains, "One 1"; hence, the next element is 11. The fifth element is, "Three 1's, two 2's, one 1"; hence the sixth element is 312211.

You may assume that the number generated contains no more than 1000 digits.

Example 1:

Enter n: 1

1

Example 2:

Enter n: 6

312211

Example 3:

Enter n: 17

11131221131211132221232112111312212321123113112221121113122113111231133221121321

132132211331121321231231121113122113322113111221131221