S.A. Computer Olympiad
Second Round Start Div. 2006
For all grades up to and including Grade 10

Q1. Squares

Prepared by Donald Cook

Description

Squares can be made up by printing an equal number of rows and columns of characters.

Task

Your task is to write a program that prints out a 'square' of N x N characters. The program must accept a single integer that specifies the size of the square to be printed out. Your program must use the # as the character to print.

Constraints

The largest integer will be 20.

Sample run

Assume you run a test program with the integer 5.

Input

Enter size of square: 5

Output

```
#####
#####
#####
#####
#####
```

Test your program with

a. 3
b. 7
c. 11

Q2. Fibonacci

Prepared by Marco Gallotta

Description

The Fibonacci numbers are very well known. The numbers are defined as follows:
$F_1 = 1$
$F_2 = 1$
$F_3 = F_1 + F_2$
$F_4 = F_2 + F_3$
and so on giving
$F_n = F_{n-2} + F_{n-1}$ for $n \geq 3$
If you do all the calculations, you will see that the first few Fibonacci numbers are 1, 1, 2, 3, 5, 8, 13, ...

Task

Usually we set the values $F_1 = 1$ and $F_2 = 1$, giving the sequence 1, 1, 2, 3, 5, 8, 13, ...
Your program must read in alternative starting values for F_1 and F_2. You must also read in N. Your task is to calculate F_N.

Constraints

- $0 \leq F_1, F_2 \leq 20$
- $1 \leq N \leq 15$

Sample run

If $F_1 = 2$ and $F_2 = 3$ and $N = 4$
$F_3 = F_1+F_2 = 2+3 = 5$
$F_4 = F_2+F_3 = 3+5 = 8$

Input

Enter F1: 2
Enter F2: 3
Enter N: 4

Output

F4 = 8

Test your program with

a. $F_1 = 3, F_2 = 0, N = 5$
b. $F_1 = 4, F_2 = 6, N = 9$
c. $F_1 = 9, F_2 = 20, N = 15$

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Standard Bank

Q3. Decompression

Prepared by Donald Cook

Description

To save time in the transmission of data, it is often compressed. One simple way of doing this is to encode lengthy sequences of the same value by using a single instance of that value followed by the number of times it is repeated.
For example if you have a sequence 2222227777 it would be represented as 2 6 7 4.

Task

Your task is to write a program that will receive as input a sequence of numbers representing encoded data and decompress it. That is, print out the original sequence in its long form.

Constraints

The input will be terminated by -1.
An expanded sequence will only contain the digits from 0 to 9 and will not be longer than 50 digits.

Sample run

Note the input is terminated by -1.

Input

Enter the string to decompress:
0 14 1 7 2 18 -1

Output

00000000000000011111112222222222222222222

Test your program with

a. 0 5 1 10 2 15 3 10 -1
b. 1 3 3 5 2 7 5 9 8 11 -1
c. 2 5 4 5 8 15 4 5 2 5 -1

Q4. Sets

Prepared by Marco Gallotta

Description

A set in mathematics is a collection of distinct elements. The union of two sets A and B consists of all unique elements which are either in set A, or set B, or both set A and set B. The intersection of two sets A and B consists of all elements which are in both set A and set B.

Task

Write a program that reads in two sets of integers, A and B, and calculates both the union and intersection of A and B. The new sets must be output in ascending order, i.e. smallest integers first.

Constraints

- Size of set A and B ≤ 20
- An element will not be repeated in a set.

Sample run

Suppose A = {1, 2, 4} and B = {2, 4, 6, 8}. The union of A and B is the set {1, 2, 4, 6, 8}, since all the numbers appear in *at least one of* A or B. The intersection of A and B is the set {2, 4}, since they are the only numbers that appear in *both* A and B.

Input

Enter the size of set A: 3
Enter element 1 of set A: 1
Enter element 2 of set A: 2
Enter element 3 of set A: 4

Enter the size of set B: 4
Enter element 1 of set B: 2
Enter element 2 of set B: 4
Enter element 3 of set B: 6
Enter element 4 of set B: 8

Output

A union B: 1 2 4 6 8
A intersect B: 2 4

Test your program with

a. A = {1, 2, 3, 4, 5, 6, 7, 8}
   B = {1, 4, 9, 16, 25}
b. A = {7, 3, 16, 11, 8, 5, 19, 20, 1, 25, 15, 30}
   B = {18, 4, 26, 3, 16, 21, 5, 19, 2, 9, 27, 32, 14, 6}
c. A = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20}
   B = {2, 4, 6, 8, 10, 12, 14, 16, 18, 20}

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Q5. Reduce

Prepared by Marco Gallotta

Description

Every letter in the English language can be represented as a number. Consider the numeric representation of a lower case letter to be equal to its position in the alphabet with 'a' being represented as 1 and 'z' being represented as 26.

Task

Given a word, your task is to create a new word by splitting the original word into pairs of adjacent letters and then combining these as follows. You split the original word into pairs by starting at the beginning of the word, and grouping each successive pair of letters as you read from left to right.
If the numeric representations of a pair are A and B, then:

1. If $A + B \leq 26$, then add the letter whose numeric representation is $A + B$ to the new word
2. If $A + B > 26$: if $A < B$, add the letter whose numeric representation is $(B - A) + 1$ to the new word; otherwise add the letter whose numeric representation is $(A - B) + 1$ to the new word.

If your original word has an odd number of letters, then at the end you will have one spare letter which is not in a pair: add this letter to the end of the new word.

You should then repeat the above process until you are left with a word that is a single letter. You must also print out the word at each cycle in this process.

Constraints

- The length of the word ≤ 12.
- The word will consist of lower case letters only.

Sample run

Consider the word "hello", which can be represented by the numerical values {8,5,12,12,15}. After one iteration you should get a numerical representation of {[8+5], [12+12],15} = {13,24,15} = "mxo".
A second iteration and you get {[(24-13) +1],15} = {12,15} = "lo", followed by a third giving you {(15-12)+1} = {4} = "d".
Now that we are left with only a single letter, we are done.

Input

Enter word: hello

Output

hello
mxo
lo
d

Test your program with

a. reduce
b. computer
c. shuttleworth