

FSU ACM Programming Contest

Spring 2009

Welcome to the FSU ACM Programming contest for Spring 2009. There are 8 questions in this programming contest. Your program should read from the standard input and write to standard output. Programming languages allowed are

- C/C++
- Java
- Python
- Perl

A problem is solved when it is accepted by the judges. The judges are solely responsible for accepting or rejecting submitted runs. Your program should terminate within 40 seconds, for any reasonable size input.

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Problem 1: In mathematics, the Fibonacci numbers are the following sequence of numbers:

$$0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, \dots$$

The first two Fibonacci numbers are 0 and 1, and each remaining number is the sum of the previous two:

$$0 + 1 = 1 \tag{1}$$

$$1 + 1 = 2 \tag{2}$$

$$1 + 2 = 3 \tag{3}$$

$$2 + 3 = 5 \tag{4}$$

$$3 + 5 = 8 \tag{5}$$

$$5 + 8 = 13 \tag{6}$$

$$\vdots \tag{7}$$

In mathematical terms, the sequence F_n of Fibonacci numbers is defined by the recurrence relation

$$F_n = F_{n-1} + F_{n-2},$$

with seed values $F_0 = 0$ and $F_1 = 1$.

Given a number n , its easy to calculate sum of all odd terms of the Fibonacci sequence upto the n -th term: $F_1 + F_3 + \dots + F_n$ (Assume that n is always odd). In this problem you are given an input of numbers ending with -1 . The input should be read from `stdin`. You need to output the sum of all odd terms of the fibonacci sequence for each input n . Assume $n \leq 30$.

Example Input:

3
5
-1

Output:

3
8
-1

Problem 2: Your task is to write a program which determines if word pairs given in an input are anagrams of one another. Anagrams are words which contain exactly the same letters in the same frequency, but in a different order. Example: the word *read* and the word *dare* are anagrams.

The input data will contain one line of data for each pair of words to be analyzed, with a single blank between the two words. For example, if the input contained 5 word pairs, it might look like

```
read dare
stake takes
tofu tofu
pumpkin pear
one two
```

The first two word-pairs are anagrams, the last three pairs are not. You may assume that: the input contains at least one word-pair, that each line contains two valid English words consisting of only lower case letters and that a word will contain no more than 20 characters. You may assume all data provided is valid and that you do not have to do any bad data checking on this problem.

Your output for the example output would look like:

```
YES!
YES!
no!
no!
no!
```

Problem 3: In the kingdom of Apes, a caveman with an initial capital investment of 100 bananas decides to start a monkey business venture. He begins with one adult monkey worker. Each adult monkey worker he owns can earn him 10 bananas a year. To expand his business, the caveman can spend 50 bananas to acquire a baby monkey, subject to the following constraints: (1) Due to child labor laws, a baby monkey acquired at year X cannot start to work until year $X + 4$. In other words, a baby monkey does not begin to earn income arrive until year $X + 5$. (2) If a baby monkey is acquired at year X , the caveman cannot acquire another baby monkey until year $X + 5$. (The caveman can only take care of one baby monkey at a time and needs one year of recuperation before he acquires another baby monkey.) Assume that the business starts at year zero and that the first chance for the caveman to acquire a baby monkey and collect income is at year one. Meanwhile, the caveman is trying to plan for his retirement in uncertain economic times. Write a program that takes an input containing only one line, which is an integer ($0 < N < 40$), indicating the number of years the caveman plans to run his business before he retires.

The output contains one line and indicates the maximum profit possible at the end of the monkey business venture, taking into account all possible expansion plans that the caveman can follow over the years. For a given expansion plan, the profit is computed by the number of bananas at the end of the plan minus the expenses over the years to acquire new monkeys and the initial 100 bananas. The monkey owned by the caveman at the beginning of this venture is free. Also, the caveman will keep his monkeys in his retirement, presuming they are self-sufficient and dont steal his bananas.

Example:

Input

6

Output

maximum profit: 60

Problem 4: Gustavo knows how to count, but he is now learning how to write numbers. As he is a very good student, he already learned 1, 2, 3 and 4. But he didn't realize yet that 4 is different than 1, so he thinks that 4 is another way to write 1. Besides that, he is having fun with a little game he created himself: he makes numbers (with those four digits) and sum their values. For instance:

$$132 = 1 + 3 + 2 = 6$$

$$112314 = 1 + 1 + 2 + 3 + 1 + 1 = 9$$

(remember that Gustavo thinks that $4 = 1$)

After making a lot of numbers in this way, Gustavo now wants to know how many numbers he can create such that their sum is a number n . For instance, for $n = 2$ he noticed that he can make 5 numbers: 11, 14, 41, 44 and 2 (he knows how to count them up, but he doesn't know how to write five). However, he can't figure it out for n greater than 2. So, he asked you to help him.

The Input: Input will consist on an arbitrary number of sets. Each set will consist on an integer n such that $1 \leq n \leq 1000$. You must read until you reach the end of the input.

The Output: For each number read, you must output another number (on a line alone) stating how many numbers Gustavo can make such that the sum of their digits is equal to the given number.

Sample Input

2
3

Sample Output

5
13

Problem 5: A person steps through integer points of the straight line. The length of a step must be nonnegative and can be by one bigger than, equal to, or by one smaller than the length of the previous step.

What is the minimum number of steps in order to get from x to y ? The length of the first and the last step must be 1.

Input and Output: Input consists of an arbitrary number of test cases, each on a separate line. Each test case (i.e., input line) contains two integers x and y : $0 \leq x \leq y < 2^{31}$. For each test case, print a line giving the minimum number of steps to get from x to y .

Sample Input

```
45 48
45 49
45 50
```

Sample Output

```
3
3
4
```

Problem 6 (Sum of Primes):

An integer greater than one is considered to be prime if it is only divisible by itself and one with a result that is still an integer. By definition the value (1) is not prime. Any number greater than one can be calculated as a sum of prime numbers. For instance, 6 can be represented as the sum (3+3). There are often multiple ways to represent a number as a sum of prime; 6 can also be represented as the sum (2+2+2). Write a program that determines the minimum number (c) of prime numbers that are required to represent the numbers between 2 and 199. There is no input to this problem. There are 198 output lines (one for each number 2 to 199 inclusive) as follows:

If the number (n) is prime, print

```
"(n) is prime"
```

If the number (n) is not prime with a single solution that is the sum of (c) prime numbers (and no solutions with less than (c) prime numbers) print

```
"(n) is the sum of (c) prime numbers. (1 solution)"
```

If the number (n) is not prime with multiple solutions (m) with (c) prime numbers (and no solutions with less than (c) primes), print

```
"(n) is the sum of (c) prime numbers. ((m) solutions)"
```

The first 30 lines of the correct solution are:

```
2 is prime
3 is prime
4 is the sum of 2 prime numbers (1 solution)
5 is prime
6 is the sum of 2 prime numbers (1 solution)
7 is prime
8 is the sum of 2 prime numbers (1 solution)
9 is the sum of 2 prime numbers (1 solution)
10 is the sum of 2 prime numbers (2 solutions)
11 is prime
12 is the sum of 2 prime numbers (1 solution)
13 is prime
```

14 is the sum of 2 prime numbers (2 solutions)
15 is the sum of 2 prime numbers (1 solution)
16 is the sum of 2 prime numbers (2 solutions)
17 is prime
18 is the sum of 2 prime numbers (2 solutions)
19 is prime
20 is the sum of 2 prime numbers (2 solutions)
21 is the sum of 2 prime numbers (1 solution)
22 is the sum of 2 prime numbers (3 solutions)
23 is prime
24 is the sum of 2 prime numbers (3 solutions)
25 is the sum of 2 prime numbers (1 solution)
26 is the sum of 2 prime numbers (3 solutions)
27 is the sum of 3 prime numbers (7 solutions)
28 is the sum of 2 prime numbers (2 solutions)
29 is prime
30 is the sum of 2 prime numbers (3 solutions)
31 is prime

To help in understanding the counting:

The single correct solution for 4 is $(2+2)$.

The two correct solutions for 10 are $(7+3)$ and $(5+5)$. $(3+7)$ is not counted since $(7+3)$ is equivalent. $(2+2+3+3)$ is not counted because it uses more than the minimum number of primes.

The seven correct solutions for 27 are: $(23+2+2)$, $(19+5+3)$, $(17+7+3)$, $(17+5+5)$, $(13+11+3)$, $(13+7+7)$, $(11+11+5)$ There is no way to represent 27 as the sum of two prime numbers.

Problem 7:

Assume that there is a city occupying an N miles by N miles square area, where 4 divides N . The people of the city divide the city area into N^2 unit squares blocks and gives indices to the blocks starting from 0. For example, if $N = 4$, the indices are:

0	1	2	3
4	5	6	7
8	9	10	11
12	13	14	15

The people enforce strange rules about traveling between the block.

Suppose the current block is x . 1. If $x \bmod N = 0$, you may move to either the north block or the south block 2. If $x \bmod N = 1$, you may move to either the northeast block or the southwest block. 3. If $x \bmod N = 2$, you may move to either the east block or the west block. 4. If $x \bmod N = 3$, you may move to either the northwest block or the southeast block.

For example, suppose $N=4$. If you are currently in block 8, you may move to block 4 and 12. If you are in block 5, you may move to block 2 and 8. If you are in block 10, you may move to block 7 and 13. If you are in block 11, you may move to block 6. Note that you may move to only one neighboring block if the other block does not exist.

Assume moving from one block to any neighboring block is at unit cost. You are asked to find and print out the shortest path given three numbers as (1) N (2) the index of the starting block and (3) the index of the destination block.

Examples:

Input: 16 99 5

Output: 99 116 100 84 68 52 36 20 5

Problem 8: In the plane, you are given positions of red and blue points. There exists a line that separates the red and blue points. (You can assume that this is always the case) Find the equation of this line.

The first line of the input tells you the number of red points and blue points that follow. The coordinates of the red points follow the first line, after which the blue point coordinates are given. For example in the following input there are 4 red and 3 blue points.

The output consists of the coefficients of the equation $Ax + By + C = 0$. All you have to do is print out the coefficients A, B, C in the output.

Example:

Input:

```
4 3
1 0
0 0
0 1
1 1
4 0
0 4
2 2
```

Output:

```
1 1 -3
```