Computer Olympiad

First Round

P.O. Box 13287
Mowbray
7705
Ph: +27 21 448 7864
Fax: +27 21 447 8410
Email: Olympiad@cssa.org.za

Q1. Wondrous

By Donald Cook (IOI Coach)

Description

Consider the following process:
Begin with a number:

- If it is odd, we triple it, and add one (1).
- If it is even we take half of it.

Take that result and repeat the process.
A number whose value is one (1) after repeatedly applying the rules is called wondrous, those that do not become 1 are unwondrous.

Task

You are required to write a program to report if a number is wondrous or unwondrous.
If a number is wondrous your program should print:
<value> becomes wondrous after <N> repetitions.

Example:

```
Enter number to start with: 10
10 becomes wondrous after 6 repetitions.
```

Test your program with:

a. 106 and b. 15

Q2. Tent

By Carl hultquist (Silver Medallist IOI 2000)

Description

A tent consists of an equilateral triangle of size N, on the center of the base of which another equilateral triangle is drawn with size (N + 2) / 3 (note that this means it is not always possible to draw the tent). In this way the door to the tent trisects the base of the tent (divides it into three equal parts).

Task

Given a size N, draw a tent as illustrated in the examples below.
Your program should report if a tent can not be drawn.

Examples:

```
Enter N: 6
Unable to draw tent of this size!
Size must a multiple of 3 plus 1.

Enter N: 10
          *
         * *
        *   *
       *     *
      *       *
     *         *
    *           *
   *     *     *
  *     * *     *
 *     *   *     *
* * * *     * * * *
```

Test your program with:

a. N=4 and b. N=16

Q3. Primes

By Bruce Merry (Gold medallist IOI 200)

A prime number is a number whose only factors are 1 and the number itself. For example, the first ten primes are 2, 3, 5, 7, 11, 13, 17, 19, 23 and 29. Note that 1 is not considered to be a prime.

Every number can be written as a product of primes. For example, 420 = 2 x 2 x 3 x 5 x 7. Write a program that accepts a number N, between 2 and 1000 inclusive and prints it as a product of primes. You must list the primes in increasing order.

Example:

Enter a number between 2 and 1000:
420 = 2 x 2 x 3 x 5 x 7

Test your program with:

a. 306 and b. 741

SACO First Round

Q4. Noughts and crosses

By Rainer Hoft (IOI Team 1999)

Description

This game of noughts and crosses is played on a rectangular grid with *r* rows and *c* columns where 1 ≤ r,c ≤ 9. There are two players who take turns. One player writes noughts and the other writes crosses on the grid. When the grid is filled up, the player with the longest line is the winner. If the longest lines of each player are equal, the game is a draw. Lines can be horizontal, vertical or diagonal. E.g. in the following game, the player using noughts is the winner, since (s)he has the longest line of 4 noughts:

O	X	X	O	O	X
O	**O**	X	X	O	O
X	X	**O**	X	X	X
O	O	X	**O**	O	O
X	X	O	O	X	X

Task

You are required to find the longest line of noughts or crosses to determine who is the winner after each game. If there is more than one longest line, then you need only find one of them, unless the game is a draw, when you must find a longest line for each player.

Input

Two numbers – the number of rows *r* and the number of columns *c*. An *r* by *c* grid, showing a completed game of noughts and crosses.

Output

The same grid with the longest line replaced by a line of 1's. If the game is a draw then a longest line for each player should be indicated. Use a line of 2's to indicate the longest line of the other player. In addition you should state the length of the longest line and which player is the winner or in the case of a draw, state that it is a draw.

Examples:

```
Enter number of rows – 5
Enter number of columns – 6
Enter noughts and crosses:
oxxoox
ooxxoo
xxoxxx
ooxooo
xxooxx

1xxoox
o1xxoo
xx1xxx
oox1oo
xxooxx

Longest line length = 4
Player using O is the winner
```

```
Enter number of rows – 7
Enter number of columns – 7
Enter noughts and crosses:
oxxooxx
ooxxoox
xxoxxxx
ooxooox
xxooxxx
oooooox
xooxoxo

oxxoox1
ooxxoo1
xxoxxx1
ooxooo1
xxooxx1
2222221
xooxoxo

Longest line length = 6
The game is a draw
```

Test your program with:

a.

```
oxoxoxox
xoxoxoxo
xooxoxox
oxxoxoxo
xoxooxox
oxoxooxo
xoxoxoox
```

b.

```
oxoxooox
xoxoxoxo
xooxooox
oxxoxoxo
xoxoooox
oxoxooxo
xxxxxooo
ooooooox
```

Q5. Alphametic

By Carl hultquist, Bruce Merry (Medallists IOI 2000)

Description

Cryptograms are puzzles in which letters or symbols are substituted for the digits in an arithmetical calculation. Such puzzles have existed for centauries, the form of the puzzles that used letters in place of the digits and these letters form sensible words or phases were termed an alphametic by J.A.H. Hunter in 1955.

Task

Given an alphametic (i.e. a simple sum in which letters have replaced the digits) write a program to find out what each letter represents.

Example:

```
  SEND
+ MORE
 MONEY
```

Output

S=9; E=5; N=6; D=7; M=1; O=0; R=8; Y=2

Test your program with:

```
a.
 THESE
 TEASE
PUPILS

b.
 BEST
 MADE
MASER
```