Problem Set for The 1st Imos Contest

Osaka University Competitive Programming Club

Contest Held on 13 Dec 2008

OBJECTIVE

This local contest is held by Osaka University Competitive Programming Club ("OUCPC") for the purpose of training the members of OUCPC and the students interested in competitive programming.

This contest is supported by and the judge server is rented from Large-Scale Computational Science Division at Cybermedia Center, Osaka University, for the educational purpose in informatics.

STATUS OF PROBLEMS

All problems were newly created by imos for this contest.

The problem set was typeset by pLaTeX 2_ε with a style file so that the statement looks like those used in ACM-ICPC Regional Contest held in Japan.

TERMS OF USE

WARRANTY DISCLAIMER

Problem A
Extended RSA
Input: A.in

RSA is a well-known algorithm for public-key encryption. It uses a number which is the product of two primes as a public-key. Usually the two primes are selected randomly, but Dr. Imo found that the number can contain more information by choosing particular primes. Of course, Dr. Imo is intelligent enough to demonstrate that the public-key of the new method is as marvelously strong as that of the older method.

The Imo method is simple. Seek the pair of primes if you are given one prime and two number. The two primes and the two number meet the following requirements.

- There are two primes a, b and two number c, d ($c < 2^d$).
- $ab \equiv c \pmod{2^d}$. `((a * b) mod (2 ** d) = c)`

Thus, you can generate an RSA public-key ab which has information about c. For example, if a is 2, b is 13, c is 10 and d is 4, the remainder of division of a key $26(= ab)$ by $2^4(= 2^d)$ includes information $10(= c)$.

One prime b and two numbers c, d are given. You need to find the minimum prime a to assist him.

Input

The input is a sequence of datasets followed by a line containing three zeroes separated by a space. A dataset is a line containing three integers b, c and d separated by a space. You may assume that b is a prime, $2 \leq b < 2^{21},\ 0 < c < 2^d \leq 2^{20}$.

The input must be read from the file `A.in`.

CAUTION!
Although the sample input contains only small datasets, note that $a \times b$ is larger than 2^{31}.

Output

The output should be composed of lines, each corresponding to an input dataset. An output line should contain an integer indicating a prime a that meets $ab \equiv c \pmod{2^d}$. You may assume that it is less than 2^{21}.

The output must be written to standard output.

Sample Input

```
13 10 4
19 7 5
0 0 0
```

Sample Output

```
2
29
```

Problem B
Product-Sum
Input: B.in

Recently Dr. Imo is doing some research on integral numbers. Studies of splitting numbers is especially all the zeal for him. Now, he wants you to solve one problem and to sympathize with him that they are interesting.

The problem is what is the minimum number that meets the following requirements.

- It is an even-digit number, and it has no leading zeroes.
- On splitting the number into two numbers which have same digits, the product of them minus the sum of them equals N.

If you are given $N = 10$, the answer is not 0212 (this contains leading zeroes, so it does not meet the above requirements), but 1202 ($(12 \times 02) - (12 + 02) = 10$) is correct.

Input

The input is a sequence of lines each of which contains one integer N. This satisfies the following conditions.

$$0 < N < 1,000,000,000$$

The end of the input is indicated by a line containing a zero.

The input must be read from the file `B.in`.

Output

The output should be comprised of lines each of which contains a single integer, that is the minimum number which meets all the requirements.

The output must be written to standard output.

Sample Input

```
1
10
1000
0
```

Sample Output

```
23
1202
1292
```

Problem C
Apple Trees
Input: C.in

There are many apple trees in Farmer Imo's farm. He is always busy in raising cattle. To make matters worse, however, those apple trees have a hot temper and get angry unless they are well cared for. Once they get angry, annoyingly, they make their apples explode, and no one can stop them. For all that, he is working to the full right now, so he decided to employ two workers to care for these apple trees.

Upon employment, he tried to assign apple trees to two workers equally, but apple trees are distributed unequally. Additionally he hopes that the boundary of the assignments must be a straight line and intersect with his house to keep watch.

Although he knows the positions of all apple trees, he has no time to search the good boundary. It is also known that you can always assign equal number of the apple trees if the number of the apple trees is even.

His house is at $(0, 0)$, and no apple tree is at $(0, 0)$. No two apple trees have the same coordinates, and no two apple trees and his house are on a straight line.

So, determine the boundary which satisfies him. The boundary must be indicated by the angle between the first apple tree (measuared counter-clockwise in radians).

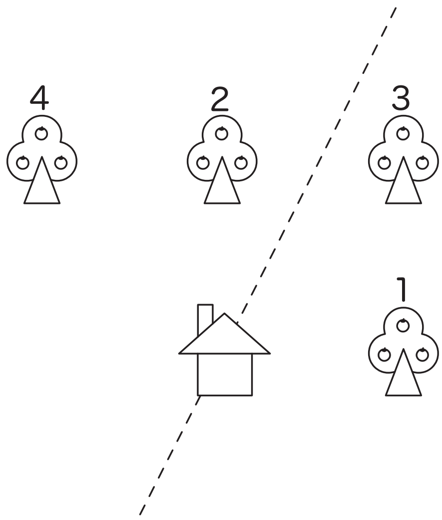

Figure 1: The number of trees is equally divided by the boundary between 2 and 3.

Input

The input is a sequence of datasets. A dataset is formatted as follows:

$$\begin{array}{cc} n & \\ x_1 & y_1 \\ \vdots & \vdots \\ x_n & y_n \end{array}$$

The first line is a positive even integer n less than 10,000. The following n lines, one for each apple tree, each containing two space-separated numbers x_i and y_i ($i = 1, \cdots, n$), indicating the coordinates of i-th apple tree. x_i and y_i are integers between -2,000 and 2,000 inclusive.

The end of the input is indicated by a line containing a single zero.

The input must be read from the file `C.in`.

Output

For each dataset, output a line containing the angle of the boundary which distributes apple trees equally. The boundary must be at a distance of at least 10^{-5} from any apple tree and every dataset should have at least one solution whose boundary is more than 10^{-4} away from any apple tree.

Each output value should be in a decimal fraction.

The output must be written to standard output.

CAUTION!
As this problem has many solutions, your solution will be evaluated by special judge system.

Sample Input

```
4
1 0
0 1
1 1
-1 1
2
1 10
-1 10
0
```

Sample Output

```
1.17809725
0.09966865
```

Problem D
Mountain Residence
Input: D.in

Imo Company has a piece of land on a rocky mountain and wants to sell it. And a rich person Mr. Uni wants to buy a certain square area of the land with a certain amount of fund and build his house on it. Of course the company hopes that the land will be sold at the highest profit.

Rocks in the rocky mountain are too hard to excavate, so the company has to bury the rocks in soil in order to level the ground. But the company has no skill to find the most suitable square area to be sold at the minimum expense.

The cost to cover the area with soil can be calculated by $t - a$ with the height of the tallest rocks t and the average height of the rocks a in the section for sale of the land that is in proportion to the amount of soil used to bury rocks with.

4	1	4	3	1
6	3	2	3	6
0	1	3	1	3
5	3	2	2	2
1	4	6	5	0

$\Rightarrow$

3	2	3
1	3	1
3	2	2

Figure 2: The left one is the land and the right one is the section.

The cost of the section in the above example is $\frac{7}{9}$ because the difference between 3 which is the height of the tallest rock and $2 + \frac{2}{9}$ which is the average height of the rocks is $\frac{7}{9}$. Additionally $\frac{7}{9} = 0.77777777\cdots$ is the lowest cost in any other 3×3 square sections of the land in this example.

Input

The input consists of multiple datasets, each in the following format.

$$
\begin{array}{ccc}
n & s & \\
a_{1,1} & \cdots & a_{n,1} \\
\vdots & \ddots & \vdots \\
a_{1,n} & \cdots & a_{n,n}
\end{array}
$$

The first line of a dataset contains two positive integers: n ($0 < n < 1000$), which is the size of the land, and s ($0 < s \leq n$), which is the size of the section that Mr. Uni wants to buy. Both the land and the section are regular squares.

Each of the following n line contains n integers separated by single spaces. Each number $a_{i,j}$ ($0 \leq a_{i,j} < 1000$) shows the height of the rock in the land. The number $a_{1,1}$, $a_{n,1}$, $a_{1,n}$ and $a_{n,n}$ correspond to the north-west corner, the north-east corner, the south-west corner and the south-east corner of the land respectively.

The end of the input is indicated by a line containing two zeroes separated by a space.

The input must be read from the file `D.in`.

Output

For each dataset, the minimum cost should be printed. The cost should be in a decimal fraction with an error less than 0.0000001 ($= 1.0 \times 10^{-7}$).

The output must be written to standard output.

Sample Input

```
5 3
4 1 4 3 1
6 3 2 3 6
0 1 3 1 3
5 3 2 2 2
1 4 6 5 0
3 2
1 2 1
3 1 4
0 4 2
0 0
```

Sample Output

```
0.77777778
1.25000000
```

Problem E
Pie Party
Input: E.in

A party is held every year on the anniversary of the founding of Imo Creative Production Company. The number of the participants of the party is increasing year by year.

Traditionally pies are served in the party. And it is also known that each pie is divided equally into N parts and N is a unique integer to each year. The number of the participants, however, is not predictable and may not be exactly a multiple of N, so some pieces may be left after each participant received a piece of the pies.

But this year the chief cook carelessly has forgotten the number N, and regrettably there is no record but the amount R of the pieces of pies which are eaten by them and the upper limit of the unique integer L.

Your mission is to write a program to estimate two coprime integer, the number P of participants and the unique integer N, that minimize $\left| R - \frac{P}{N} \right|$ $(1 \leq N \leq L)$.

Input

The input consists of multiple datasets, each of which contains one decimal fraction R and one integer L. R is the amount of pieces of the pies which are eaten, and L is the upper limit of the unique integer.

You may assume the following.

$$0 < R < 5$$

$$0 < L < 10,000,000$$

The end of the input is indicated by a line containing two zeroes.

The input must be read from the file `E.in`.

Output

For each dataset, output a line containing the number P of participants and a unique integer N whose greatest common divisor is 1.

The output must be written to standard output.

Sample Input

```
3.14159265358979 10
0.12500000000000 100
0.00000000000000 0
```

Sample Output

```
22 7
1 8
```

Problem F
Gear Factory
Input: F.in

Imo Company has a gear factory. As the factory has some ratio gears, various ratio gears are provided by the combination of those gears. Having 2:1 and 3:1 gears, it may provide 4:9 gear with two 2:1 ones and two 3:1 ones. The provision is very reasonable for lower costs because it is easy to produce the certain ratio gears. Of course, some ratio gears cannot be produced for its combination of gears in possession.

Recently the factory is receiving many orders. But some of the orders are not excutable for the lack of available gears. For lower expenditure, you must make a program to judge whether the factory can produce and to tell how to satisfy the requests.

The gears which it has satisfy the following conditions.

- Each gear has a simple ratio and does not have a ratio of 1 to 1.
- Any ratio can be made by only one combination of the gears or cannot.
- The number of each ratio gear is limitless.

The set of gears – 3:2, 2:1, 3:1 – does not satisfy the second of the above conditions because 3:2 can be made by two ways. One 2:1 and one 3:1 (if you turn 2:1 and connect two gears, 3:2 can be made $1 : 2 \times 3 : 1 = 3 : 2$) produce 3:2, and of course 3:2 also produce 3:2 as is.

Input

The input consists of multiple datasets, each of which contains integers and describes the list of the gears that the factory has, in the following format.

$$\begin{array}{lll} n & x & y \\ a_1 & b_1 & \\ \vdots & \vdots & \\ a_n & b_n & \end{array}$$

n $(0 < n < 100)$ is the number of sorts of the gears that the factory has and x, y $(0 < x, y < 100,000)$ is an ordered gear whose ratio is $x : y$. And each of n lines following the first line contains a pair of integers a_i and b_i. Each set of a_i $(0 < a_i < 100,000)$ and b_i $(0 < b_i < 100,000)$ describes a gear whose ratio is $a_i : b_i$, that the factory has.

The input must be read from the file `F.in`.

Output

For each dataset, output a single line containing n integers delimited by single spaces or `impossible`. If the order can be produced, print n integers that represent the number of the gears to be used for the order. Otherwise print `impossible`. Output lines must not contain other characters.

The output must be written to standard output.

Sample Input

```
2 2 9
2 1
3 1
2 2 3
2 1
5 1
3 21 10
2 5
5 6
7 10
2 1 4
1 2
1 3
0 0 0
```

Sample Output

```
1 -2
impossible
-1 -1 1
2 0
```