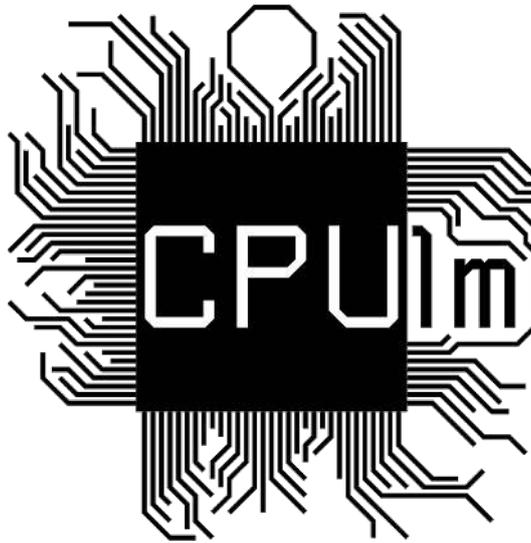


Winter Contest 2022

January 29th



Problems

- A Alohomora and Colloportus
- B Basic Brewing
- C Cellar Chase
- D Document Dimensions
- E Enchanted Exam
- F Forming Friendships
- G Going for Gold *(easy)*
- H Hidden Horcrux
- I Inconspicuous Identity
- J Joint Jinx
- K Kettle Kitten *(easy)*
- L Longbottom Leap *(easy)*
- M Magic Marbles

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Problem A: Alohomora and Colloportus

Time limit: 3 seconds

Colloportus is a charm that magically locks objects such that they cannot be opened manually. On the other hand, *Alohomora*, also known as *Thief's Friend*, is an unlocking charm that can open even magically locked objects. Both charms are taught in Hogwarts charms class in the first year and, by the end of the fifth year, every student should be able to cast them, as they are required in the *Theory of Charms* examination.



A messed up chain. Photo by Daniel Kirsch, Pixabay

In the exam, each student is given n interlocked chain links. To pass this part of the exam, you have to use the *Alohomora* charm to open some of the links and the *Colloportus* charm to interlock them again. By the end of the exam, the chain links should form a single closed chain. Ron messed up and is now left with a bunch of partially interlocked chain links and only enough time to cast both spells a single time.

More formally, Ron is able to open one chain link, change with which other chain links it is interlocked with, and then lock it again. After this, each chain link should be interlocked with exactly two other chain links to form a single closed chain. Is it still possible for Ron to pass the exam?

Input

The input consists of:

- One line with two integers n and m ($3 \leq n \leq 10^5, 0 \leq m \leq 2 \cdot 10^5$), the number of chain links and the number of interlocked pairs of chain links.
- m lines, each containing two integers a and b ($1 \leq a < b \leq n$), which means that the a -th and b -th chain link are interlocked.

Note that each pair of interlocked chain links is given at most once and that the initial chain may not be connected.

Output

If Ron can form a closed chain, output *yes*. Otherwise, output *no*.

Sample Input 1	Sample Output 1
4 3 1 2 2 3 2 4	yes

Sample Input 2

```
4 6
1 2
1 3
1 4
2 3
2 4
3 4
```

Sample Output 2

```
no
```

Problem B: Basic Brewing

Time limit: 1 second

In his first potion lesson Snape asked Harry: "Tell me, what would I get if I added *powdered root of asphodel* to an *infusion of wormwood*?" Back then, Harry had no idea what this meant and Snape had to explain to him that this would make a sleeping potion, so powerful that it is known as *Draught of Living Death*.



The classroom. Photo by Rob Young, [Wikimedia](#)

Now is Harry's sixth-year and his new professor, Slughorn, wants him and everyone else to brew exactly this potion. To no surprise, Harry is the one to brew it best, as he is the only one who knew that the final potion should contain exactly p percent of powdered root of asphodel.

After the class is over, professor Slughorn decides to mix some of his students potions together to brew a perfect Draught of Living Death himself. His class consists of n students, including Harry, and each of them attempted to brew the potion. Therefore, Professor Slughorn has access to n potions, each in a different cauldron. The i th cauldron contains c_i liters of potion in total and it contains p_i percent of powdered root of asphodel. How many liters of the Draught of Living Death can Slughorn brew?

Input

The input consists of:

- One line with an integer n and a real value p ($1 \leq n \leq 1000, 0 \leq p \leq 1$), the number of cauldrons and the percentage of powdered root of asphodel the potion should contain.
- n lines, each containing an integer c and a real value p ($1 \leq c \leq 1000, 0 \leq p \leq 1$), the amount of potion in the i th cauldron in liters and the percentage of powdered root of asphodel in that potion.

All real values are given with at most three decimal places.

Output

Print a single real value, the maximal amount of Draught of Living Death that Slughorn can brew. Your solution is considered correct if the relative or absolute error is less than 10^{-4} .

Sample Input 1

```
3 0.5
5 0.3
1 0.4
10 0.9
```

Sample Output 1

```
8.75
```

Sample Input 2

```
3 0.5
5 0.3
1 0.4
1 0.9
```

Sample Output 2

```
3.5
```

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Problem C: Cellar Chase

Time limit: 1 second

On Halloween, Quirrell suddenly enters the Great Hall and claims to have seen a troll in the dungeons. The evacuation of the students into their dormitories is started immediately. At the same time, a group of teachers prepares to search the dungeons for the troll.

The dungeons were constructed over a long period of time and are a system of connected corridors. They originally consisted of just one long corridor with an entrance and an exit. Over time, new corridors were added. Each new corridor had its entrance placed on the right-hand wall of an already existing corridor and ended in the same corridor where it started, but further towards the exit. Furthermore, a newly built corridor did only intersect with the corridor containing its entrance and exit. To ensure that nobody gets lost, each corridor contains markers pointing to the corridor's exit.

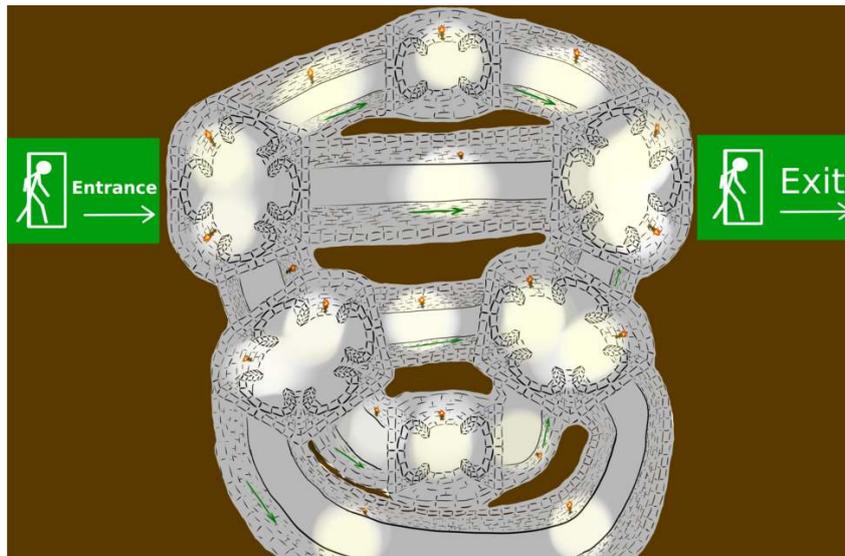


Figure C.1: Illustration of the second sample.

The teachers have a map of the dungeons and want to use the fact that there is only one exit to their advantage. They lock the exit and start all together at the entrance to the system. To ensure that all of them actually reach the exit, they agree that each of them only moves towards the exit of the current corridor or enters another corridor through its entrance. Of course, they want to avoid that the troll can leave through the entrance or even attack them from behind. Hence, they want to move in such a way that there is never a path between the entrance of the dungeons and the troll which is not blocked by some teacher. Fortunately, each teacher is capable enough to deal with the troll, that is, it is sufficient if it can be guaranteed that at least one teacher encounters the troll. How many teachers have to go to the dungeons?

The system of corridors in the dungeons can also be constructed by composition of systems of corridors. For each such system there are two positions that are defined as the entrance and the exit of the corridor, respectively.

- $()$ denotes just one corridor with an entrance and an exit.
- $(A+B)$ denotes that we append the system B to A, that is, the entrance of A is the new entrance of the system, the exit of B is the new exit and we merge the exit of A with the entrance of B.
- $(A*B)$ denotes that A and B are parallel to each other. This means that the entries of A and B are merged and form the new entrance and the exits of A and B are merged as well and form the new exit.

Input

The input consist of a single string of length at most 10^6 describing the dungeons as explained above.

Output

Print a single integer, the minimum number of teachers needed to examine the entire dungeons.

Sample Input 1

Sample Output 1

$((() + (() * ((() + ())))))$	2
-------------------------------	---

Sample Input 2

Sample Output 2

$(((((() + ())) * ())) * (((() + (((() + ())) * ())) * ())) + ()))$	5
---	---

Problem D: Document Dimensions

Time limit: 4 seconds

Hermione was really proud of her one million word text she wrote for her assignment. She was, until she realized that the text must be handed in on a single piece of paper with limited dimensions. Obviously, she could have just shortened her text, but Hermione decided to go another route. She decided to just copy her text to a new piece of paper, writing a little bit smaller. . . To make this easier, she decided to first change the line breaks in her text such that the sum of the *height* and *width* of the piece of paper is minimized. Given Hermione's text with n words and assuming that each character takes up one unit height and one unit width, what is the minimal *height* plus *width* that can be achieved by inserting line breaks? Note that two words which are on the same line need to be separated by a single space.



Hermione's text. Image by Chris Martin, [Wikimedia](#)

Input

The input consists of:

- One line with a single integer n ($1 \leq n \leq 10^6$), the number of words.
- One line with n space separated words w_i ($1 \leq |w_i| \leq 10^6$), consisting only of lowercase Latin letters.

It is guaranteed that the total length of the text, i.e. the sum of the lengths of the n words, is not greater than 10^6 .

Output

Output a single integer, the sum of the *height* and *width* of the smallest piece of paper the text could fit on.

Sample Input 1

```
4
i am lord voldemort
```

Sample Output 1

```
11
```

Sample Input 2

```
10
i solemnly swear that i am up to no good
```

Sample Output 2

```
14
```

Notes

These are visualizations of the optimal result.

First testcase: 2 + 9

```
i_am_lord  
voldemort
```

Second testcase: 4 + 10

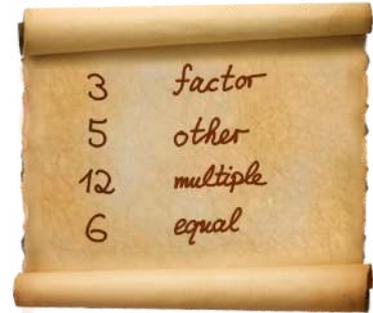
```
i_solemnly  
swear_that  
i_am_up_to  
no_good
```

Problem E: Enchanted Exam

Time limit: 1 second

In the Wizarding World, Arithmancy is the study of numbers and their magical properties, and it is also Hermione's favourite class at Hogwarts. She is currently studying for the final exams, the *Nastily Exhausting Wizarding Test (N.E.W.T.)*, using last year's exam questions.

To this day, students at Hogwarts still use parchments and quills as writing material. While these have some disadvantages compared to muggles' pen and paper, an advantage is that using magically enchanted parchment allows for more quirky exam questions such as the following:



Parchment from Wikimedia Commons, cc by-sa 3.0

You need to find a hidden integer number x between 1 and 100, inclusive. Up to 50 times you may write an integer number y on the provided piece of parchment. For each number you write, one of the following four words will appear next to it:

- `equal`, if you found the correct number;
- `factor`, if y is a divisor of x ;
- `multiple`, if y is a multiple of x ;
- `other`, if none of the above is true.

We decided to reuse this N.E.W.T. question as a problem for Winter Contest 2022. Unfortunately we were not able to obtain enough magical interactive parchment in time for the contest, so that we had to convert the original question into an interactive programming problem instead.

Interaction

This is an interactive problem. Your submission will be run against an *interactor*, which reads the standard output of your submission and writes to the standard input of your submission. This interaction needs to follow a specific protocol:

Repeatedly output query numbers y ($1 \leq y \leq 100$). For each such number, the interactor replies with one of the strings `equal`, `factor`, `multiple` or `other`, as described above.

After every query you should *flush* the standard output to ensure that the query is sent to the interactor. For example, you can use `fflush(stdout)` in C++, `System.out.flush()` in Java, and `sys.stdout.flush()` in Python.

You may use at most 50 queries and your program must exit after you found the hidden number. The interaction will be run multiple times. The hidden number x is fixed in advance and will be different for each run.

A testing tool is provided to help you develop your solution. It can be downloaded from the [DOMjudge problems overview page](#).

Read

Sample Interaction 1

Write

3

factor

5

other

12

multiple

6

equal

Read

Sample Interaction 2

Write

100

multiple

99

multiple

1

equal

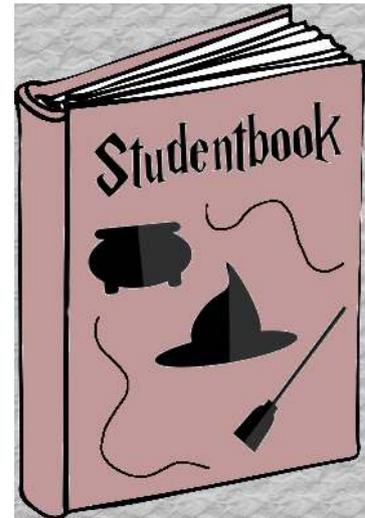
Problem F: Forming Friendships

Time limit: 3 seconds

Inspired by some ideas from the Muggle world, a bunch of Ravenclaw students recently founded *Studentbook*. This is actually a book (magically enhanced, of course), which has a page for each Hogwarts student showing their recent social activities.

Every interested student can buy their own small version of this book, which shows recent activities of their friends. Unfortunately, this is not very popular at the moment, because everybody already knows what their friends are up to anyways.

One of the Ravenclaw students behind *Studentbook*, Michael Corner, has a plan to fix this. He wants to perform the powerful spell *Amicitia*, also known as the friendship spell. This spell acts permanently and does the following: If student a and student b are friends and student b and student c are friends as well, then student a and c will be made friends by the spell.



The Studentbook. Wizard Icons by sonnycool, Vecteezy

Michael was immediately alerted to the potentially catastrophic consequences of his plan. Due to the spell, it might happen, that more and more friendships will be formed, completely disrupting the social balance in Hogwarts.

But he does not want to abandon his idea so easily. Instead, he first wants to find out how many friendships would be formed by the spell.

Input

The input consists of:

- One line with two integers n and m ($1 \leq n \leq 2 \cdot 10^5, 0 \leq m \leq 2 \cdot 10^5$), the number of students and friendships at Hogwarts.
- m lines, each containing two integers a and b ($1 \leq a, b \leq n, a \neq b$), indicating that the students a and b are friends.

Each friendship is given at most once.

Output

Output the number of new friendships due to the *Amicitia* spell.

Sample Input 1	Sample Output 1
3 3 1 2 2 3 1 3	0

Sample Input 2

4 3
1 2
3 2
3 4

Sample Output 2

3

Sample Input 3

5 3
1 2
2 3
4 5

Sample Output 3

1

Problem G: Going for Gold

Time limit: 1 second

The Triwizard Tournament is a contest between wizarding schools, with each school represented by a *champion*. At the start of the school year, students enter their names into the *Goblet of Fire*, which selects one champion for each of the n participating schools. The school champions then face off in three magical events spread throughout the year.



Triwizard Cup by Gallant's Photography via flickr, cc by-sa 2.0

For this most recent edition, the Triwizard Tournament is using the same scoring system that has been used in the sport climbing event of last year's Tokyo Summer Olympics (this is a sport where muggles compete to see who is able to climb vertical obstacle courses the fastest). After each of the three events, all n champions are ranked by their scores, each receiving a rank between 1 and n , inclusive. In the end, the three ranks of each champion are *multiplied* and the champion with the lowest score wins the cup for their school.

The first two events have already happened and the third is scheduled for tomorrow. Is it still possible for our favourite, the Hogwarts champion, to win? If yes, find a possible ranking for the third event so that this happens. As Hogwarts won the last edition of the tournament, the rules stipulate that in the event of a tie the Hogwarts champion will be declared the winner.

Input

The input consists of:

- One line with an integer n ($1 \leq n \leq 100$), the number of champions in the tournament.
- One line with n distinct integers a_1, \dots, a_n ($1 \leq a_i \leq n$ for each i), where a_i is the rank of the i th champion in the first event.
- One line with n distinct integers b_1, \dots, b_n ($1 \leq b_i \leq n$ for each i), where b_i is the rank of the i th champion in the second event.

The Hogwarts champion is the champion with number 1.

Output

If there is no way for the Hogwarts champion to win, output `impossible`. Otherwise, output n distinct integers c_1, \dots, c_n ($1 \leq c_i \leq n$ for each i), where c_i is the rank of the i th champion in the third event, so that Hogwarts wins the tournament.

Sample Input 1

```
7
1 6 5 3 2 4 7
7 1 4 2 3 6 5
```

Sample Output 1

```
4 5 3 7 6 2 1
```

Sample Input 2

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

Sample Output 2

```
impossible
```

Sample Input 3**Sample Output 3**

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

```
1 4 2 3
```

Problem H: Hidden Horcrux

Time limit: 1 second

Harry Potter just found out that there were not only 7 but 8 horcruxes. The vicious Voldemort stored the last one in the middle of a desert. To protect the 8th horcruxes, vicious Voldemort cursed the desert in a way that Harry Potter can only pass it by walking the entire distance which takes him d days in total. The amount of water that any person can carry while being in the desert is also limited to c units. As Harry Potter cannot carry enough water by himself, he takes some of his beloved friends with him that he lured into joining the secret club *Dumbledore's Army* which he founded a few years back during his school time in Hogwarts.



Photo by Jörg Peter, Pixabay

While Harry Potter and each of his friends can carry c units of water, they need to drink one unit of water per day. At the end of each day, Harry Potter can decide who of his friends will accompany him further to the middle of the desert and who has to return to the origin the next day. When travelling back, his friends use the exact same route as on their forward journey in order not to get lost. Thus, they need the same number of days they travelled so far to get back to the origin.

Harry Potter and any of his friends can pass on an integer amount of water units to any of their peers. However, if any person is sent home, he must be given enough water to reach the origin safely.

Harry Potter does not want to put his friends at danger. Therefore, it is sufficient for him if he reaches the middle of the desert alone to destroy the 8th horcrux by himself. Once the horcrux is destroyed, it magically changes to a portkey that takes Harry Potter safely back to Hogwarts.

What is the minimum number of friends that Harry Potter needs to take with him in order to reach the middle of the desert?

Input

The input consists of:

- One line with two integers d and c where
 - d ($1 \leq d \leq 10^9$) is the number of days it takes to reach the middle of the desert.
 - c ($1 \leq c \leq 10^6$) is the maximum number of daily water rations that Harry Potter and each of his friends can carry at most.

Output

If it is possible to reach the middle of the desert, output one integer indicating the minimum number of friends needed. Otherwise, output `impossible`.

Sample Input 1

4 3

Sample Output 1

1

Sample Input 2

5 3

Sample Output 2

`impossible`

Explanation Sample Input 1

Harry Potter takes 1 friend with him. Both start out with 3 units of water. After the first day, both have only 2 units of water left. Harry Potter takes away one unit of water from his friend so that Harry Potter now has 3 units of water and his friend only 1 unit of water. On the second day, the friend travels back to the origin. Harry Potter continues walking to the middle of the desert and uses up all his water until he reaches the desert's center at the end of day 4.

Problem I: Inconspicuous Identity

Time limit: 1 second

Last night, Rubeus Hagrid once again visited his giant half-brother Grawp in the forbidden forest. Unfortunately, when Grawp saw Hagrid's pink umbrella, he used it to chase barbaric bowtruckles in the trees. In this chaotic chase, Grawp unfortunately broke Hagrid's umbrella into pieces. Back in his homey hood, Ruben Hagrid wants to assemble a new umbrella. In the past, he only stored the broken pieces of his wand in it. However, he recently realized that members of the non-magic community mostly use umbrellas to protect them against the rain. In order to blend in and hide his true identity whenever he goes shopping to London, Hagrid wants his new umbrella to look exactly like any other umbrella.



Photo by Pascal Robert, Pixabay

The umbrella should consist of a straight wooden handle with 8 metal ribs of length x meters connected symmetrically to its top. Hagrid wants to attach the remaining non-stretchable, rainproof, pink fabric he found in his hood along the full length of the metal ribs, i.e. from the top of the umbrella where all ribs meet down to the very end of each metal rib. If the umbrella is opened all the way, the fabric between two metal ribs forms an isosceles triangle. Depending on the amount of fabric that is used, the umbrella can be opened more or less wide.

Hagrid has up to a square meters of non-stretchable, rainproof, pink fabric available for the umbrella. Since he is quite a corpulent man, he wonders what the maximum area is that the umbrella can keep dry if the rain falls perpendicular to the ground and there is absolutely no wind?

Input

The input consists of:

- One line with two real numbers a and x where
 - a ($0 < a \leq 10$) is the amount (in square meters) of non-stretchable, rainproof fabric that is available for the production of a single umbrella.
 - x ($0 < x \leq 5$) is the length (in meters) of a metal stick.

All real values are given with at most three decimal places.

Output

Print a single real value, the maximum area (in square meters) that can be kept dry. Your solution is considered correct if the relative and absolute error is less than 10^{-4} .

Sample Input 1

10.000 0.500

Sample Output 1

0.7071067812

Sample Input 2

10.000 5.000

Sample Output 2

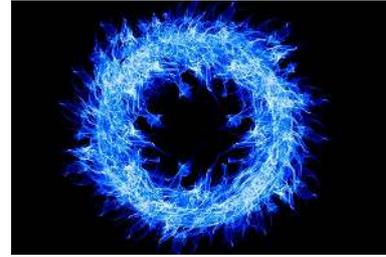
1.2101397319

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Problem J: Joint Jinx

Time limit: 1 second

On their quest to destroy the horcruxes, Harry, Ron and Hermione have returned to Hogwarts to search for the Lost Diadem of Ravenclaw, which they suspect has been turned into one of these dark artifacts. It does not take long before their presence is noticed, and now the Hogwarts professors and the members of the Order of the Phoenix are shielding the castle with various protective jinxes and charms to prepare for the arrival of Voldemort and the Death Eaters.



Ring of Fire by Fruity-Paws on Pixabay

One of the most powerful charms in their repertoire is *Repello Inimicum*, which creates a near impenetrable barrier that will disintegrate anything that tries to pass through it. The charm needs to be performed by n wizards and witches working together. Each of them uses their wand to draw a large circle in the sky while chanting the incantation. The potency of the charm depends on the number of points where two or more of these circles touch or intersect.

For simplicity we assume that the n circles that make up the charm are all drawn in the same plane. Given k , the number of intersections that is needed for the charm to be the most potent, find a possible arrangement of the n circles so that there are exactly k intersection points. Two circles touching in a point counts as a single intersection. If more than two circles intersect in some point, then that point is only counted once.

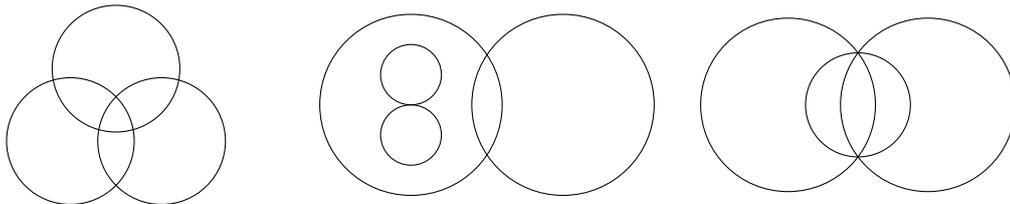


Figure J.1: Illustrations of the first, third and fourth sample cases.

Input

The input consists of:

- One line with two integers n and k ($1 \leq n \leq 10, 0 \leq k \leq 100$).

Output

If there is no solution, output `impossible`. Otherwise, output n lines, each with three integers x, y and r ($-1\,000 \leq x, y \leq 1\,000, 1 \leq r \leq 1\,000$) giving the center (x, y) and radius r of one of the circles. The circles must be distinct. If there is more than one solution, any one of them will be accepted.

Sample Input 1

3 6

Sample Output 1

0 0 7
10 0 7
5 8 7

Sample Input 2

5 100

Sample Output 2

impossible

Sample Input 3

4 3

Sample Output 30 1 1
0 -1 1
0 0 3
5 0 3**Sample Input 4**

3 2

Sample Output 40 0 5
4 0 3
8 0 5

Problem K: Kettle Kitten

Time limit: 6 seconds

Hermione is training the *Liquefacio* spell which allows her to liquefy objects and living creatures. She is already quite good at liquefying books, plants, and rats, so she decided to go one step further and try to do it with her cat Crookshanks. Of course she wants Crookshanks to get back her original shape and so it is important that she does not lose one single drop of the liquid she will transform Crookshanks into.



Figure K.1: Illustration of the first sample. The first two kettles are large enough for the cat. Since the second has less volume than the first, it is the only solution.

She therefore decided to put Crookshanks in a kettle before performing the spell, and, to stay inconspicuous, she wants the kettle to be as small in volume as possible. She asked Dobby to help her find a suitable kettle. He showed her a large selection of *cylindrical* kettles from the Hogwarts kitchen, and now she has to decide which one she wants to take.

Input

The input consists of:

- One line with two integers n and v ($1 \leq n, v \leq 10^6$), the number of available kettles and the volume of Crookshanks. The kettles are numbered from 1 to n .
- n lines, each with two integers h_i and r_i ($1 \leq h_i, r_i \leq 1000$), the height h_i and the radius r_i of the i -th kettle.

Output

Output the number of the smallest kettle which is large enough for Crookshanks. If there are several optimal solutions you can output any of them. If there is no such kettle, output impossible.

Sample Input 1

```
3 19
2 3
4 2
6 1
```

Sample Output 1

```
2
```

Sample Input 2

```
2 199
1 2
2 3
```

Sample Output 2

```
impossible
```

Sample Input 3

```
3 100
2 4
8 2
32 1
```

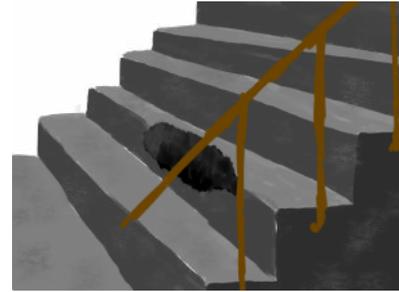
Sample Output 3

```
3
```

Problem L: Longbottom Leap

Time limit: 1 second

During his seventh year in Hogwarts, Neville Longbottom reactivated Dumbledore's Army with Ginny and Luna, and replaced Harry as their leader in order to fight against Voldemort's takeover. As he did so often lately, this night Neville sneaked into the restricted section of the library to find new ways to inconvenience Snape and his fellow Death Eaters and Slytherins.



Among the books he discovered during his previous visit, one in particular caught his attention. It contains a spell which supposedly fixes the vanishing steps in certain staircases that had plagued Neville during his entire time in Hogwarts and are now used as an opportunity to ridicule and belittle the poor first-years more than ever. Willing to try this spell and put an end to this, he decided to take the book this time.

Luckily, the spell allows fixing all the vanishing steps in an arbitrarily long sequence of consecutive steps at once. However, the spell gets longer and longer the more consecutive steps are considered. For the spell's shortest possible form, this sequence can contain up to 32 consecutive steps. In order to increase this number, the word `long` can be appended an arbitrary number of times to the front of the spell, doubling the maximum number of consecutive steps every time. For instance, `long long` and `long long long long` can be applied to sequences of consecutive steps of length 64 and 128, respectively.

Unfortunately, the new regime under Snape greatly strengthened the safety measures, so Neville should return the book as soon as possible so that they won't notice that someone sneaks into the restricted section and close the last remaining loopholes in their security system. Because the spell requires the casting wizard to stand close to the first step of the considered sequence, it would take too long to apply it multiple times. Furthermore, he of course wants to keep the spell itself as short as possible.

Neville already knows the sequence of consecutive steps he wants to fix using the spell and also knows which of these steps need fixing, but is not sure what the shortest sufficient form of the spell is. Can you help him?

Input

The input consists of:

- One line containing a single string s describing the sequence of steps Neville wants to apply the spell to. Each character in s is either 0 or 1, where a 1 indicates that the respective step is a vanishing step. s contains at most 10^6 characters and no leading or trailing zeroes.

Output

Output the shortest sufficient form of the spell.

Sample Input 1

1

Sample Output 1

long

Sample Input 2**Sample Output 2**

1000111010101011110100011010101111

long

Sample Input 3**Sample Output 3**

1000000000000000000000000000000001

long long

Problem M: Magic Marbles

Time limit: 4 seconds

You may know *Wizard's Chess*, which is a magical version of chess, but there are more magical games in the wizarding world. Another one you may recognize is *Magic Marbles*, which is similar to the muggle game *Marble Temple*. In this game, you are given a chain of differently coloured marbles m , which you need to destroy. To do this, you can add additional marbles to the chain. This may sound counterproductive, but if there ever is a *run* of at least k consecutive marbles that are of the same colour, then all of these marbles magically disappear instantly. The resulting gap is closed by moving the remaining marbles closer together, which can lead to new runs that then again disappear.



A frozen marble on ice. Image by rihaij, Pixabay



Figure M.1: The initial state of the first sample. The first marble will be added between the second yellow marble and the first blue marble. Since this results in a run of three blue marbles, all of them instantly disappear.

This year there is a great Magic Marbles tournament in Hogwarts. However, you fear that some magicians are not as sincere as you and may try to cheat in this magic tournament. Therefore, you decided to simulate the game without magic.

Input

The input consists of:

- One line with three integers n, k, q ($1 \leq n, q \leq 2 \cdot 10^5, 2 \leq k \leq 4 \cdot 10^5$), the initial length of the marble chain m , the minimal run length where marbles disappear, and the number of marbles that will be added during the game.
- One line with n space-separated integers m_i ($1 \leq m_i \leq 10^6$), where m_i is the colour of the i -th marble of the initial chain m . It is guaranteed that each run of marbles of the same colour has length less than k .
- q lines, each containing two integers p_x and m_x ($0 \leq p_x \leq |m|, 1 \leq m_x \leq 10^6$), the position where the next marble will be inserted and the colour of the marble that is inserted. $|m|$ denotes the current length of the marble chain. If the position p_x is 0, the marble will be added in front of the currently first marble. Otherwise, the marble will be added after the p_x -th marble.

Output

For each of the q insertions of a new marble, output a single integer $|m|$, the length of the marble chain after that insertion and any deletions that were caused by it.

Sample Input 1

```
7 3 2
1 2 2 1 3 3 1
4 3
3 2
```

Sample Output 1

```
5
0
```

Sample Input 2

```
5 2 3
1 2 1 2 3
0 1
1 1
0 3
```

Sample Output 2

```
4
1
0
```