# Problem A. Contact Tracing

| | |
|---|---|
| Input file: | `standard input` |
| Output file: | `standard output` |
| Time limit: | 1 second |
| Memory limit: | 256 megabytes |

Covid-19 is a contagious virus. If a person has the virus and meets another person today, then the other person will also have the virus starting tomorrow. We assume that once a person has the virus, they continue to have it forever.

On day zero, some people had the virus because they had travelled to other countries. Since that day, however, the borders have been closed, so the only way that a new person can catch the virus is by meeting with a person who is already infected.

On one day called T-day, people stop meeting each other and some people get tested. The test reveals whether the person has the virus on T-day.

## Input

The first line of input contains three space-separated numbers: $N$, the number of people, $M$, the number of meetings, and $T$, the number of Covid-19 tests performed on T-day, with $0 \leq T \leq N \leq 100$ and $0 \leq M \leq N^2$.

The subsequent $M$ lines each contain three space-separated numbers describing a meeting: $D$, the day on which the meeting takes place, and $A$ and $B$, the identities of the two people who meet. The identity of each person is a number between 1 and $N$. Days are numbered sequentially using numbers between 1 and 100, inclusive. T-day is day 101.

The subsequent $T$ lines each contain an integer $R$ describing a test result. If $R$ is positive, then person $R$ has the virus on T-day. If $R$ is negative, then person $-R$ does not have the virus on T-day. Each positive $R$ is preceded by a unary $+$. Each negative $R$ starts with -.

## Output

Output $N$ lines. The $i$th line contains the character `-` if person $i$ cannot have the virus on T-day, the character `+` if person $i$ must have the virus on T-day, and the character `?` if it cannot be determined whether person $i$ has the virus on T-day.

## Example

| standard input | standard output |
|---|---|
| 5 2 2<br>1 1 2<br>1 3 4<br>+2<br>-3 | +<br>+<br>-<br>-<br>? |

# Problem B. Coronavirus Testing

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|---|---|
| Input file: | standard input |
| Output file: | standard output |
| Time limit: | 1 second |
| Memory limit: | 256 megabytes |

With the coronavirus raging, many scientists are looking for ways to make testing more efficient. One idea that was previously used for HIV testing - combine samples of several patients, and test those together first. If the result is negative, no further testing is required, otherwise, additional samples can be tested individually. For low-probability disease tests, such as HIV, this speeds up the process and reduces the cost.

Coronavirus put the town of Loowater into a grave danger after a series of in-person ICPC events were held. Unfortunately, the town of Loowater only has one testing machine, so they would like to utilize the idea of testing multiple samples at once. Formally, we have $N$ people, each of whom provided two samples that can be used for testing. We know that the probability of one patient being sick is $P$. To perform one test, up to $K$ samples from different people can be combined and sent to the machine, which would detect the presence of the disease in the input material. The testing machine is always correct. Each sample can only be used for one test and is discarded after the test. The local regulations also require that for patients testing positive, at least one test must be carried out with a sample of that patient alone (in other words, without combining multiple samples). Determine the smallest expected number of tests that must be carried out to test all of $N$ patients correctly.

## Input

The only line of input contains three numbers - $N$, $K$, $P$. $1 \le N \le 10^9$, $1 \le K \le 10^3$, $0.01 \le P \le 0.99$.

## Output

Output a single number - the expected number of tests. Your answer will be considered correct if the absolute or relative error to the jury's answer is within $10^{-4}$.

## Examples

| standard input | standard output |
|---|---|
| 2 2 0.1 | 1.380000000 |
| 2 2 0.9 | 2.000000000 |
| 5 3 0.2 | 4.184000000 |

## Note

This is based on a true story:
https://cnn.it/3miLiCI In the first case, we should test both patients together. With probability 0.81, the result would be negative and we're done. Otherwise, we should test each patient's other sample individually, meaning that with probability 0.19 we would need 3 tests in total. The answer is thus 1.38, which is better than 2 if the testing were done individually. In the second sample test, it's optimal to do testing individually.

# Problem C. Quarantine Math

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|---|---|
| Input file: | `standard input` |
| Output file: | `standard output` |
| Time limit: | 1.25 seconds |
| Memory limit: | 256 megabytes |

It's quarantine and you're so bored that you decided to dedicate some time to level up your math skills. Unfortunately, yesterday you bumped into a problem you couldn't solve. However, you've dreamt of this problem for the entire night, so maybe today the luck will be on your side?

For given natural numbers $n$, $m$ let $S(n, m)$ be a set of positive integer numbers, such that for every elememt $k$ from this set, $(n \mod k) + (m \mod k) \geq k$, where $a \mod b$ – is the remainder of $a$ divided by $b$.

The problem asks to compute the value of the next function:

$$F(n, m) = \sum_{k \in S(n,m)} D(k)$$

,

where $D(x)$ - is the number of positive divisors of the number $x$.

## Input

Two natural numbers $n, m$. $1 \leq n, m \leq 10^9$.

## Output

One number - value of a function $F(n, m)$.

## Example

| standard input | standard output |
|---|---|
| 4 7 | 15 |

## Note

$S(4, 7) = 5, 8, 9, 10, 11$, $D(5) = 2, D(8) = 4, D(9) = 3, D(10) = 4, D(11) = 2$

# Problem D. Border Restrictions

| | |
|---|---|
| Input file: | `standard input` |
| Output file: | `standard output` |
| Time limit: | 1 second |
| Memory limit: | 256 megabytes |

To prevent the spread of the virus, many countries have closed their borders to travellers arriving from certain other countries. Over time, different people travel to different countries and it is still possible for the virus to spread from country to country. If the virus starts in one country, how long will it be before it has spread to other countries? We will assume that if the virus is in one country in week $i$ and a second country allows travellers from the first country, the virus will reach the second country in week $i+1$. Once the virus reaches a country, it is there forever, until a vaccine is found.

## Input

The first line of input contains $N$, the number of countries in the world, with $1 \leq N \leq 300$. $N$ lines of input follow, each describing a country. Each line has the form `DESTINATION allows travellers from ORIGIN1 ORIGIN2 ORIGIN3`, where `DESTINATION`, `ORIGIN1`, `ORIGIN2`, `ORIGIN3` are names of countries consisting of at most 30 uppercase letters from `A` to `Z`. Every country has a unique name. Note that there may be as few as 0 and as many as N-1 origin countries on a line, not always three. Also, the origin countries on each line are distinct and do not include the destination country. In week one, the virus is only in the first country listed in the input.

## Output

Output $N$ lines, one for each country, sorted in alphabetical order. On each line, output the country name followed by the number of the week in which the virus reaches that country. If the virus can never reach some country, output 0 instead of the number of the week in which the virus reaches that country.

## Example

| standard input | standard output |
|---|---|
| 3<br>CANADA allows travellers from USA<br>MEXICO allows travellers from USA<br>USA allows travellers from CANADA MEXICO | 1<br>3<br>2 |

# Problem E. One-way Sidewalks

| | |
|---|---|
| Input file: | `standard input` |
| Output file: | `standard output` |
| Time limit: | 5 seconds |
| Memory limit: | 256 megabytes |

A typical sidewalk in Waterloo is 1.5 metres wide. Two people walking in opposite directions cannot pass each other while maintaining 2 metres of physical separation. Many cities have designated one-way sidewalks to be used in only one direction. Usually, there is another sidewalk that makes it possible to walk in the opposite direction. Sometimes this is not possible because there is only a single route connecting a pair of places in the city. In these cases, some cities close part of the roadway to cars to allow for a wider walking area. Doing so is expensive and makes car drivers angry, so the city does this only in places where it is absolutely necessary.

## Input

The first line of input contains two integers $N$, $M$, the number of places and the number of sidewalks in the city, with $0 \leq N, M \leq 200,000$. There is a path from every place to every other place. The next $M$ lines each describe a sidewalk using two integers $A$, $B$, with $1 \leq A, B \leq N$, which identify the two places connected by the sidewalk.

## Output

Generate $M$ lines of output, one for each sidewalk, in the same order as the sidewalks are listed in the input. Each line should contain the character `>` if the sidewalk should be made one-way in the direction from place $A$ to $B$, the character `<` if it should be made one-way in the opposite direction, or `=` if the sidewalk must be widened to remain two-way. Your solution must minimize the number of sidewalks that need to be widened. If there are multiple solutions that minimize the number of sidewalks that need to be widened, you may output any one of those solutions.

## Example

| standard input | standard output |
|---|---|
| 4 4<br>1 2<br>2 3<br>3 1<br>1 4 | ><br>><br>><br>= |