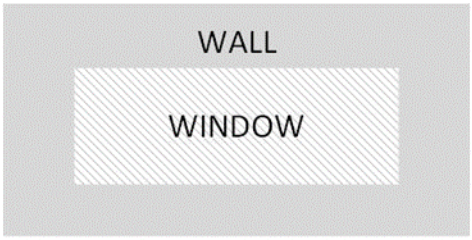
UCF Local Contest — September 1, 2018

Window on the Wall

filename: `window`
(*Difficulty Level:* `Easy`)

Anya (Arup's daughter) would like to add a window on the wall in her room. She asks Travis (the mathematician) to figure out the largest window she can have on her wall. Travis consults Chris (the engineer) to see if there are any structural constraints. Chris explains that there must be a minimum distance between the wall perimeter and the window perimeter for the wall to hold the window; otherwise the entire structure collapses.



NOT WINDOW OR WALL

The Problem:

Given the width and height of a rectangular wall and the window-border gap (minimum distance required between the perimeter of the wall and the perimeter of the window), determine the area of the largest rectangular window that can be installed on the wall.

The Input:

The input contains one line with three space-separated positive integers, w, h, and d (w, h < 1000, d < 100), representing, respectively, the wall's width, wall's height, and the minimum window-border gap amount needed.

The Output:

The output should be an integer on one line by itself, which represents the area of the largest rectangular window that can be installed. If it is not possible to install a window, output 0 (zero).

Sample Input	Sample Output
40 25 5	450
30 20 12	0
30 20 50	0
999 888 7	860890

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Parity of Strings

filename: `parity`
(*Difficulty Level:* `Easy`)

The historical battle between *numbers* and *strings* has taken a new twist: *numbers* are bragging on their categorization of being "even" or "odd" and *strings* lacking such feature. But don't count *strings* out yet!

A string is considered "even" if *every* letter in the string appears an even number of times; the string is "odd" if *every* letter in the string appears an odd number of times.

The Problem:

Given a string, determine whether the string is even, odd, or neither.

The Input:

The input consists of a single line, starting in column 1, not exceeding column 70, and containing only the lowercase letters (at least one letter).

The Output:

The output consists of a single integer: print 0 (zero) if the string is even, 1 (one) if the string is odd, or 2 if the string is not even and is not odd (i.e., it is neither).

Sample Input	**Sample Output**
`coachessoaehwwwwww`	`0`
`coachesarefun`	`2`
`coachesc`	`1`

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Historical TV Remote Control

filename: `remote`
(*Difficulty Level:* `Easy/Medium`)

As Dr. Orooji is getting older, he is becoming more attached to older items and has difficulty letting go of them (he claims they have historical value). For example, he still has the first table he got for the programming team! The situation is the same at home, e.g., there is a broken TV remote control but Dr. O still uses it, because he considers it an old item with historical value!

The Problem:

The old remote control has 12 buttons: digits 0-9, channel down, and channel up. There are no other buttons on the remote control. Some digits on the remote don't work but channel up/down always works. So, to get to a particular channel, Dr. O sometimes has to use the channel up/down. For example, let's assume digits 0 and 5 on the remote don't work:
If Dr. O wants to watch channel 102, he would select 99 and then "channel up" 3 times.
If he wants to watch channel 597, he would select 611 and then "channel down" 14 times.

Given the digits that do not work and a target channel, determine how many times Dr. O needs to hit channel up or down. Dr. O, of course, wants to exert the least energy, hence he wants to hit the channel up/down the minimum number of times. Assume that Dr. O will enter a channel between 0 and 999 (inclusive) to start and that channel down has no effect at 0 and channel up has no effect at 999.

The Input:

The first input line contains an integer, n ($1 \leq n \leq 9$), indicating how many digits on the remote do not work. These broken digits are listed (in increasing order) on the same input line. The second input line provides the target channel (an integer between 1 and 999, inclusive).

The Output:

The output consists of a single integer, indicating how many times Dr. O needs to hit channel up/down. Note that, since one or more digits work, it is always possible to reach the target channel.

Sample Input	**Sample Output**
3 0 8 9 35	0
4 1 2 5 9 250	50

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Circle Meets Square

filename: `circlesquare`
(*Difficulty Level:* `Medium`)

We all know that you can't put a round peg in a square hole. Asking you to do so in this contest would be cruel and unusual punishment, which is banned by the Eighth Amendment to the United States Constitution. But, perhaps a more reasonable problem that the Framers of the Constitution never thought about is determining if a given circle and square have an intersection of positive area (overlap), or touch (share a point in common), or don't touch at all.

The Framers of the US Constitution and the UCF Programming Team coaches would like to know, given a circle and a square, do the two overlap in some positive area, touch, or don't touch at all. Help them out by writing a program to solve the problem!

The Problem:

Given the description of a square and circle in the Cartesian plane, determine if the intersection between the two has positive area (overlap), is a single point (touches) or doesn't exist.

The Input:

The first line of input contains three integers: x ($-1{,}000 \leq x \leq 1{,}000$), y ($-1{,}000 \leq x \leq 1{,}000$), and r ($0 < r \leq 1{,}000$), representing the x and y coordinates and radius, respectively of the circle.

The second line of input contains three integers: t_x ($-1{,}000 \leq t_x < 1{,}000$), t_y ($-1{,}000 \leq t_y < 1{,}000$), and s ($0 < s \leq 1{,}000$), where (t_x, t_y) represents the coordinates of the bottom left corner of the square and s represents the side length of the square. The square's top right corner is (t_x+s, t_y+s), so that its sides are parallel to the x and y axes.

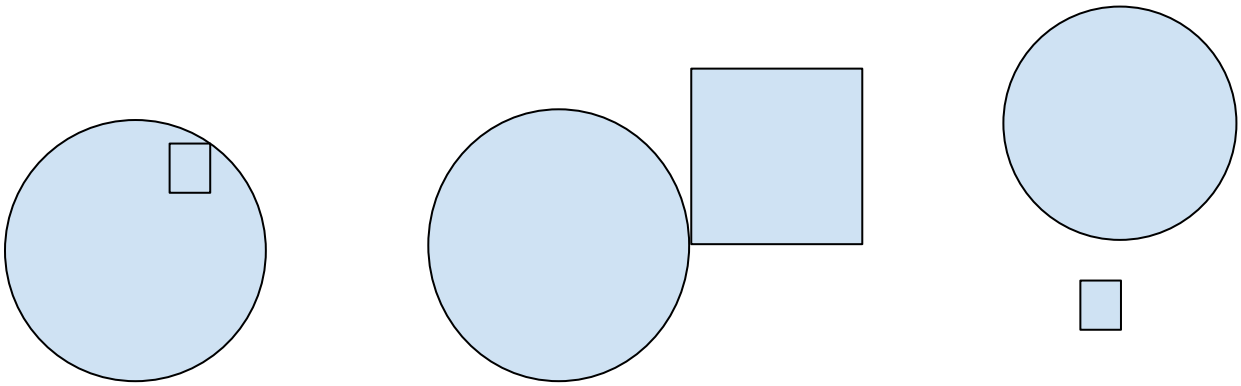
The Output:

If the circle and square ***don't touch***, output 0 (zero). If they ***touch*** at a single point, output 1 (one). If they ***overlap*** in positive area, output 2 (two).

Sample Input **Sample Output**

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

Pictures of the Sample Input:



First Sample Second Sample Third Sample

UCF Local Contest — September 1, 2018

SGA President

filename: `sga`
(*Difficulty Level:* `Medium`)

After an amazing performance at World Finals, Timothy and Alex, who are no longer eligible for ICPC, have decided to look for a new challenge. They'd like to run for SGA President and Vice President. Unfortunately, they have realized that with tickets from the previous election such as Josh/Jad and Brad/Breon, they have no hope of winning because all winning tickets must have two distinct names that start with the same first letter, so Timothy and Alex just won't do.

Naturally, Timothy was despondent about this revelation and to make himself feel better came up with a problem for locals. Given the names of each student at UCF, Timothy wondered how many potential winning pairs for SGA President and Vice-President there might be. In order for a pair to have the potential to win, their names must be different but start with the same first letter. Since President and Vice President are different roles, we count the ticket of Josh and Jad differently than the ticket of Jad and Josh. (The first name listed is the candidate for President while the second name listed is the corresponding candidate for Vice President.) Note that UCF has many students that share a first name, so there might be several potential winning pairs of Josh and Jad. For example, if there are 10 Joshes and 3 Jads on campus, there are 30 Josh/Jad pairs with a Josh running for President and a Jad running for Vice President (and these should all be counted).

The Problem:

Given the names of each UCF student, calculate the number of possible President/Vice-President pairs who have a potential to win the SGA election.

The Input:

The first line of input contains a single positive integer, n ($n \leq 66{,}183$[1]), representing the number of UCF students. The following n lines each contain a single first name of one UCF student. All names will consist of uppercase letters only and be between 1 and 20 letters long, inclusive. Each line represents a distinct student, but distinct students may have the same first name.

The Output:

On a line by itself, output the total number of President-Vice President pairs that have a chance to win the SGA election.

[1] This was the actual enrollment at UCF in the 2017 fall semester!

Sample Input **Sample Output**

10 JOSH JAD JENNIFER JENNIFER JALEN HASAAN ALI TIM ALEX TRAVIS	22
5 ALEX BRANDY CELINE DWAYNE ELIZABETH	0

UCF Local Contest — September 1, 2018

Rounding Many Ways

filename: `rounding`
(*Difficulty Level:* `Medium`)

Timothy and Alex's hopes and dreams of running for UCF's Student Government Association have been crushed by the realization that their campaign ticket would not be alliterative. So, they have decided to analyze statistics from many different polls given to students to determine what pair of programming team members would be best situated to win the election. However, there is a problem. All of the statistics have been rounded off. This would not be an issue apart from the fact that the pollsters forgot to mention how the number was rounded!
(Math Terminology Note: if we round, say, 198 to 200, then 198 is called the "true value" and 200 is called the "rounded value".)

For example, the rounded value 750 could have come from a true value rounded to the nearest 10 or maybe even the nearest 250. It may also have come from a true value rounded to the nearest 1 (thus not rounding it at all). Thus, the true value could have been something like 625 or maybe much closer like 748.

Luckily for Timothy and Alex, after some reconnaissance work, they have discovered the general rounding methods used:

- The original statistic was a positive integer **S**
- Then a positive integer **X** was chosen such that **X** is a divisor of some power of 10, i.e., there exist non-negative integers **Y** and **Z** such that $\mathbf{X} * \mathbf{Y} = 10^{\mathbf{Z}}$
- Finally the statistic **S** was rounded to the nearest positive multiple of **X** to get the rounded value **N**, i.e., there exists a positive integer **W** such that $\mathbf{X} * \mathbf{W} = \mathbf{N}$ and $|\mathbf{S} - \mathbf{N}|$ is minimized.

The Problem:

Given the rounded value, find all the different ways it could have been rounded (derived). In other words, given **N** and using the above constraints, you are to find all values of **X** that satisfy both of the following two equations:

- $\mathbf{X} * \mathbf{Y} = 10^{\mathbf{Z}}$
- $\mathbf{X} * \mathbf{W} = \mathbf{N}$

The Input:

The first and only line of input contains an integer, **N** ($1 \leq \mathbf{N} \leq 10^{18}$), representing the rounded value.

The Output:

First print out a single line containing an integer representing the number of different **X** values that the rounded value **N** could have been derived from. Then print out all of these values of **X**, in increasing order, on separate lines.

Sample Input **Sample Output**

30	4 1 2 5 10
120	8 1 2 4 5 8 10 20 40
8	4 1 2 4 8

Explanation for the first Sample Input/Output:

```
Output: 1
     X = 1, Y = 10, Z = 1, W = 30
     Rounded to nearest multiple of 1: 1*10=10, 1*30=30

Output: 2
     X = 2, Y = 5, Z = 1, W = 15
     Rounded to nearest multiple of 2: 2*5=10, 2*15=30

Output: 5
     X = 5, Y = 2, Z = 1, W = 6
     Rounded to nearest multiple of 5: 5*2=10, 5*6=30

Output: 10
     X = 10, Y = 1, Z = 1, W = 3
     Rounded to nearest multiple of 10: 10*1=10, 10*3=30
```

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World Cup Fever

filename: `soccer`
(*Difficulty Level:* `Medium/Hard`)

The 2018 World Cup was held recently in Russia. Some great soccer countries (e.g., Italy, Netherlands, Chile, USA) did not qualify for this World Cup. These countries have found out that they needed more effective passing.

The Problem:

Given the player positions for two teams, determine the minimum number of passes needed to get the ball from one player to another player. For the purposes of this problem, players do not change position, i.e., they do not move.

Player P_1 can pass the ball directly to P_2 if they are on the same team and no other player is in between the two players.

Let's assume:

- P_1 and P_2 are on the same team
- P_1, P_2, P_3 form a line with P_3 between P_1 and P_2
- There are no other players on the line formed by P_1, P_2, P_3

Then,

- If P_3 is on the other team, P_1 cannot pass the ball directly to P_2.
- If P_3 is on the same team, P_1 can pass the ball to P_3 to pass it to P_2.

The Input:

The first input line contains an integer, n ($2 \le n \le 11$), indicating the number of players on each team. The second input line contains $2n$ integers, providing the (x,y) coordinates for the n players on Team 1; the first integer on this input line is the x coordinate for Player 1, the second integer is the y coordinate for Player 1, the third integer is the x coordinate for Player 2, etc. The third input line provides (in a similar fashion) the (x,y) coordinates for the n players on Team 2. Assume that all coordinates are integers between 1 and 999 (inclusive) and that all players are on distinct locations, i.e., no two players occupy the same spot (point).

Assume Player 1 on Team 1 has the ball and wants to pass the ball to Player n on Team 1. Assume that any player can pass the ball any distance.

The Output:

The output consists of a single integer, indicating the minimum number of passes needed to get the ball from Player 1 on Team 1 to Player n on Team 1. If it is not possible to get the ball from Player 1 to Player n, print -1.

Sample Input	Sample Output
3 10 15 13 17 10 19 10 17 16 17 13 19	2
5 1 1 3 1 5 1 7 1 9 1 2 1 4 1 6 1 8 1 10 1	-1
3 1 1 5 5 2 2 10 10 50 50 20 20	1

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First Last Sorting

filename: `firstlast`
(*Difficulty Level:* `Medium/Hard`)

Arup has just created a data structure that makes the two following list transformations in constant O(1) time:

a. Take any element in the list and move it to the front.
b. Take any element in the list and move it to the back.

You've realized that sorting speed can be improved using these transformations. For example, consider the input list:

8, 3, 6, 7, 4, 1, 5, 2

We can do the following sequence of transformations to sort this list:

8,	3,	7,	4,	1,	5,	2,	6	(move 6 to end)
8,	3,	4,	1,	5,	2,	6,	7	(move 7 to end)
2,	8,	3,	4,	1,	5,	6,	7	(move 2 to front)
1,	2,	8,	3,	4,	5,	6,	7	(move 1 to front)
1,	2,	3,	4,	5,	6,	7,	8	(move 8 to end)

You are now curious. Given an input array of distinct values, what is the fewest number of these first/last operations necessary to sort the array?

The Problem:

Given an initial permutation of the integers 1, 2, ..., n, determine the fewest number of first/last operations necessary to get the list of values sorted in increasing order.

The Input:

The first line of input will contain a single positive integer, n ($n \leq 10^5$), representing the number of values to be sorted. The next n lines contain one integer each. All of these integers will be distinct values in between 1 and n (inclusive), representing the original order of the data to sort for the input case.

The Output:

On a line by itself, output the fewest number of first/last operations necessary to sort the input list.

Sample Input	Sample Output
8 8 3 6 7 4 1 5 2	5
5 1 2 5 3 4	1

UCF Local Contest — September 1, 2018

Team Shirts/Jerseys

filename: `shirts`
(*Difficulty Level:* `Medium/Hard`)

The Legendary Mathematician Travis and his friends are in a recreational (rec) league for competitive programming. Travis has *n* friends and his friends want to show a sense of unity for this competitive programming league, so they splurged on team shirts/jerseys each of which has an integer between 1 and 99 (inclusive) on the back. Each of Travis's friends have already selected their own (not necessarily distinct) jersey number so we have a list of *n* integers. Travis now needs to choose his jersey number to complete a list of *n+1* integers. Travis will also choose an integer between 1 and 99 (inclusive) and he does not have to pick a number different from what his friends have picked (i.e., he can choose to duplicate a jersey number).

Even though Travis can choose any jersey number, he wants to show why he is considered to be a legendary mathematician. Travis has a favorite positive integer and he wants to select his jersey number such that he would be able to pick a set of numbers from the list of *n+1* integers, concatenate this set of numbers together, and reach his favorite integer without extra leading or trailing digits (since Travis wants his favorite integer and not some other integer, he is trying to do so without any extra trailing or leading digits).

Travis has the fortunate option to choose his jersey number last. Now he just needs to determine if he can select some number that guarantees he can form his favorite integer. For example, suppose Travis's friends have selected the jersey numbers 3, 10, 9, and 86. Then, by selecting the number 75, Travis could form his favorite positive integer 8,675,310. Note that Travis didn't need to use the jersey number 9.

Note that if Travis chooses to use a jersey number, he must use the number completely, i.e., he cannot use just some of the digits in the number. For example, if he decides to use 75 in the above example, he must use "75"; he cannot just use "7" or use just "5". Note also that if he wants to use a particular jersey number multiple times, he must have multiple friends with that jersey number. For example, if he wants to use 75 multiple times, he must have multiple friends with the number 75 (he can, of course, pick 75 for himself as well to increase the number of occurrences of 75 in the list of *n+1* numbers).

We now have to break the secret that Travis is very temperamental! He tends to gain and lose friends very easily (so much for that whole unity thing); he also changes his favorite integer more often than the lights change at a busy intersection. For these reasons, Travis needs your help to write a program to solve this problem for a general set of friends and favorite numbers.

The Problem:

Given a set of positive integers representing friends' jersey numbers, and a favorite integer, determine if Travis can choose a jersey number (for himself) that can allow for the creation of his favorite integer via concatenation of zero or more friends' numbers and potentially his number. Additionally, since this is a rec league, the list of friends may contain duplicate jersey numbers, and Travis can choose an already chosen number for his shirt.

The Input:

The first line of input contains exactly one positive integer, t ($t < 1{,}000{,}000{,}000$), representing Travis's favorite integer. The second line of input contains exactly one positive integer, n ($n \leq 25$), representing how many friends Travis has today. The next input line contains n space separated integers which denote the jersey number chosen by each of Travis's friends. The jersey numbers will be between 1 and 99 (inclusive) and will have no leading zeroes, e.g., the input would have jersey number 7 but not 07.

The Output:

If Travis is capable of reaching his favorite integer with (or without) his set of friends, print 1 (one); otherwise output 0 (zero).

Sample Input	**Sample Output**
707 2 7 24	1
70707 2 7 7	0
1122 3 21 1 23	0
715 1 75	0

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Alex is Right

filename: `alex`
(*Difficulty Level:* `Hard`)

While on the first leg of their journey to Beijing (China) for the 2018 ACM ICPC World Finals, Alex and Timothy (two of the team members) were in a vigorous debate. The discussion was about their upcoming 13-hour flight from Washington, DC to Beijing. More specifically, whether the airplane would travel (a) west over the Pacific, or (b) east over the Atlantic, or (c) North then South passing by the North Pole. Alex argued that their flight would obviously fly them relatively close to the North Pole but Timothy, the self-proclaimed "Geometry Master", contested this as nonsense saying that there's no way the pilots would choose such a suboptimal route.

To Timothy's disappointment, once they landed in Washington, DC, Alex pulled up a flight map and proved that he was right by showing Timothy as well as Arup and Eric (who both supported Timothy's viewpoint) that their upcoming flight would indeed fly a route close to the North Pole.

The Problem:

Given the locations of two distinct points (cities) on the earth, calculate the minimum Euclidean distance between the airplane and the North Pole that will be achieved during the shortest possible flight around the surface of the earth between these two cities, and determine if Alex's claim is correct. Assume that the airplane is a point on the surface of the earth at all time, i.e., the airplane does not have an altitude.

Alex's claim can be formally defined as follows:

> The minimum Euclidean distance from the airplane to the North Pole, while traveling along an optimal (shortest) flight around the earth, is strictly less than that of the distance from the North Pole to both the starting and ending points.

The Euclidean distance between two points (x_0, y_0, z_0) and (x_1, y_1, z_1) is defined as $\sqrt{(x_0 - x_1)^2 + (y_0 - y_1)^2 + (z_0 - z_1)^2}$. Note that this is not the same as the arc distance that would need to be traveled along the surface of the earth.

To refresh your memory, below is the conversions from latitude and longitude to Cartesian coordinates on a sphere of radius R:

$$x = R * cos(latitude) * cos(longitude)$$
$$y = R * cos(latitude) * sin(longitude)$$
$$z = R * sin(latitude)$$

Notes:

- Use 6,371 km for the radius of the earth in your calculations.
- The North Pole is located at 90 degrees latitude and 0 degrees longitude.

The Input:

The first line of input consists of a single integer, T ($1 \leq T \leq 500$), representing the number of trips Alex and Timothy went on. Each trip consists of two input lines. The first line of each trip consists of two space-separated real numbers *latitude* and *longitude* ($-90 \leq latitude < 90$; $-180 < longitude \leq 180$) with exactly 6 digits after the decimal point, representing (respectively) the latitude and longitude of the departure city of this trip. The second input line of each trip contains the latitude and longitude of the destination city in the same format as the departure city. It is guaranteed that the departure and destination cities will be at distinct location (and not on the North Pole) and that there will be exactly one shortest possible flightpath between these two cities.

The Output:

For each trip, output two lines. For the first line, output either `Alex` or `Timothy` representing who was right for this trip. On the next line for each trip, output the minimum Euclidean distance between the North Pole and the plane that will be achieved while flying from the departure city to the destination city. Output your answer with exactly 6 digits after the decimal point. Answers will be judged correct if the absolute or relative error is at most $1e^{-6}$ km. Output a blank line after each trip.

Note #1: Use the value of PI (π) provided by the library of your chosen language.

Note #2: It is guaranteed that in cases where Alex is right, the absolute value of the difference between the minimum distance along the flightpath to the North Pole and the minimum distance to the destination is no less than 1 km.

Sample Input	**Sample Output**
2 38.946474 -77.437568 39.918620 116.443983 16.000000 175.000000 -45.000000 -93.000000	Alex 928.608923 Timothy 7668.327025

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Chocolate Gifts

filename: `chocolate`
(*Difficulty Level:* `Hard`)

This is Timothy's last semester here at UCF, and he is determined to finish college as the most favorite Knight ever! With his "extensive" friendship knowledge, he has determined that chocolate brings smile to any face and that is the key to becoming the most favorite Knight. So, Timothy has decided to send a chocolate bar to each and every UCF student. Specifically, Timothy will send a rectangular chocolate bar (made of smaller rectangular chocolate pieces assembled together) to as many UCF students as he can.

However, Timothy realizes that if two students see that they both received the same chocolate gifts, they would be repulsed and find this otherwise kind act suddenly creepy. To combat this, Timothy has decided that each gift he sends must be different. Thus, no pair of chocolate bars can have the same dimensions. But, because the smaller pieces have designs on them, a 5-by-3 chocolate bar is considered different than a 3-by-5 bar. Note, however, that a 5-by-5 (i.e., square) bar is the same as another 5-by-5 bar even though the smaller pieces have designs on them.

Timothy realized that he could of course send as many students unique chocolate bars as he wants because there are obviously an infinite number of sizes of chocolate bars he could make. However, because Timothy is no longer on the programming team, he is not that rich anymore! A chocolate bar with width *a* and height *b* will cost Timothy *a*b* and he has limited savings in his bank account. Thus, he can only afford a certain number of chocolate bars. More specifically, the total cost for the bars cannot exceed his savings. He thus needs your help to determine, given his limited budget, the maximum number of students he could send chocolate bars to such that no pair of students receive chocolate bars with the same dimensions.

In addition to all of this, Timothy must send the chocolate bars in nicely wrapped boxes, each bar in a separate box (i.e., not all bars in one box). But, all the boxes have the same size, i.e., there are not several boxes with varying sizes to choose from. Thus, every chocolate bar he makes must fit into one box. Furthermore, when putting a bar in a box, the bar cannot be rotated as this would cause the pattern on the chocolate to not match the pattern on the box. For example, let's assume the box has width 3 and height 5, then a 3-by-5 bar would fit in the box but a 5-by-3 bar will not fit in the box (again, the bar cannot be rotated).

The Problem:

Given Timothy's savings balance, determine the maximum number of rectangular chocolate bars he could make, such that no two bars have the same dimensions. Note that Timothy does not need to use up all of his money, but he cannot (of course) exceed his savings balance. Note also that each bar must fit into the given box size, i.e., the box size also restricts the bars he can make.

The Input:

The input consists of a single line containing three positive integers, w, h, and x ($1 \leq w, h, x \leq 10^{18}$) representing (respectively) the width and height of each box and Timothy's savings balance.

The Output:

Output a single line containing an integer representing the maximum number of students Timothy can send chocolate bars to given his constraints.

Sample Input	**Sample Output**
2 1 2	1
3 2 11	4
8 3 64	13

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Cupcake Bonuses

filename: `bonuses`
(*Difficulty Level:* `Hard`)

The Unsweet Cupcake Factory (UCF) has recently seen a sudden increase in sales and business has been booming. Thus, the company has been rapidly expanding and is hiring new people nearly every day. Furthermore, to increase company morale (because the sugarless cupcakes don't seem to be helping), UCF has been paying out bonuses to employees belonging to certain departments according to each individual's performance.

The company is structured as follows:

- Each employee has exactly one direct supervisor (except for the CEO who has no supervisor).
- An employee can have zero or more direct subordinates (employees who have him/her as their supervisor).
- Each employee heads their own department.
- Every employee is a part of their own department and all of the departments that their supervisor is a part of (thus, the CEO is a part of only one department and all employees are a part of that department).

When UCF decides that a certain department is doing well, it pays out bonuses to all the employees that are a part of that department. Bonuses are calculated by multiplying the bonus amount B with the employee's bonus multiplier M. All employees begin with the same bonus multiplier, but depending on performance, an employee's bonus multiplier can change thus potentially changing the amount of money that employee gets for future bonuses.

UCF has found it to be quite a nuisance to handle the sudden increase in staff size. Thus, they have enlisted you to create a program which can help keep track of the amount of money paid out to employees in bonuses.

The Problem:

Given different queries, keep track of the amount of money paid to the different employees in bonuses. Queries will be one of four types:

1. Hire a new employee and assign him/her their supervisor.
2. Update an employee's bonus multiplier.
3. Pay out bonuses to all employees in the department headed by a given employee.
4. Retrieve (Display) the total amount of money paid to a given employee.

Employees are numbered starting at 1 (the CEO) and all new employees are given the next integer employee identification (id) number in the order they were hired into the company. Initially, the company has only the CEO, i.e., only one employee.

The Input:

The input will begin with a line containing two integers, n and S ($1 \leq n \leq 10^5$; $0 \leq S \leq 10^6$), representing (respectively) the number of queries to follow and the starting bonus multiplier for all new hires (including the CEO). The next n lines describe the queries and each is in one of the following four formats:

- "1 i" meaning that a new employee is hired and has the supervisor with employee id i.
- "2 i M" meaning that the bonus multiplier of the employee with the id i is now equal to M ($0 \leq M \leq 10^6$).
- "3 i B" meaning that a bonus with the base amount, B ($0 \leq B \leq 10^6$), is paid out to all employees in the department headed by i. Note that the bonus for an employee is calculated by multiplying the bonus amount B with the employee's bonus multiplier M.
- "4 i" representing a query asking for the amount of money paid in bonuses so far to the employee with the id i.

Assume that all the input values are valid, e.g., when referring to a supervisor (or an employee), assume that the supervisor (or the employee) exists.

Note that there will not be a query of Type-1 to indicate the hiring of CEO, i.e., assume the company starts with one employee (CEO).

The Output:

For each Type-4 query, print out a single line containing an integer representing the amount of money paid in bonuses to the employee in question thus far.

Sample Input	Sample Output
7 1 3 1 10 4 1 2 1 2 1 1 3 1 5 4 1 4 2	10 20 5
13 10 1 1 1 1 2 2 20 3 1 5 4 1 4 2 4 3 1 2 3 2 7 4 1 4 2 4 3 4 4	50 100 50 50 240 50 70