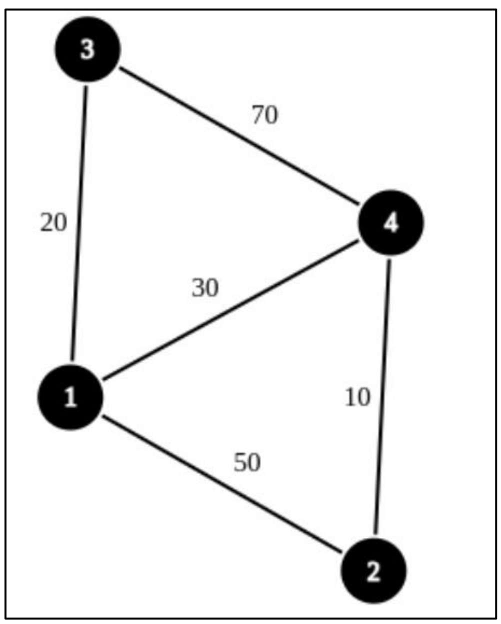
Problem A: DUT Cloud System

Time limit: 2s; Memory limit: 512 MB

Last week, we helped HCMUS to calculate their data transfer rate among their N servers. Their system works so well and become a model for other universities to follow. The Danang University of Technology (DUT) wants to build the same system.

DUT already have N servers, they want to connect them using bi-directional cables. Each pair of servers is connected by at most 1 cable (possibly 0).

The cable connecting server u and server v has the transmission capacity of $C_{u,v}$ megabits per nanosecond. Let us define $F_{u,v}$ as the data transfer rate between server u and server v. To transfer data from server u to server v, data can be split into multi parts and transferred via multiple routes.



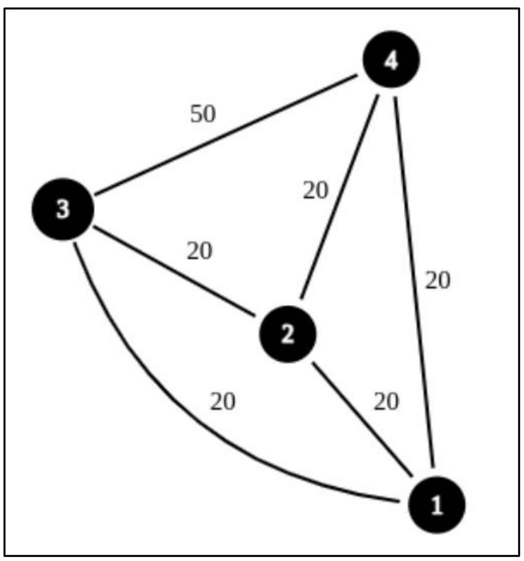
For example, to transfer data from server 1 to server 4, data can be split into 3 parts and transferred via 3 routes as follows:

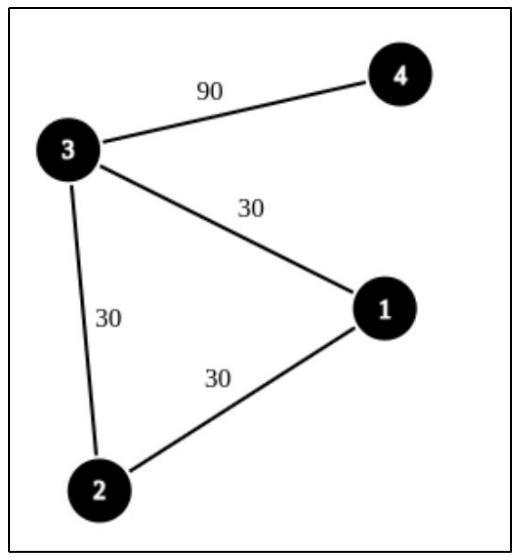
- 1 - 4 (30 Mb per nanosecond)
- 1 - 3 - 4 (20 Mb per nanosecond)
- 1 - 2 - 4 (10 Mb per nanosecond)

so the transfer rate from 1 to 4 is 60 Mb per nanosecond or $F_{1,4} = 60$. In this example, the full data transfer rate F is followed:

F	1	2	3	4
1	0	60	60	60
2	60	0	60	60
3	60	60	0	90
4	60	60	90	0

DUT has their expected data transfer rate F, your task is to help them select the cables and how to connect the N servers to achieve that expected transfer rate F. There might be multiple configurations to achieve that, for example:





Input

The first line is T the number of test cases. Then T test cases follow.

- Each test case starts with an integer N ($N \leq 200$).
- In the next N lines, each contains N integers to describe 2D array F.
- It is guarantee that $F_{u,v} = F_{v,u}$, $F_{u,u} = 0$, $0 \leq F_{u,v} \leq 1000000$.
- The sum of N in all test cases does not exceed 1000.

Output

Each test case should start with a line containing: “Case #t: YES” or “Case #t: NO” if it is possible/impossible to achieve the expected data transfer rate F. If it is possible, the next N lines should describe your configuration. The v^{th} number of the u^{th} row should represent $C_{u,v}$. You have to make sure that $C_{u,v} = C_{v,u}$, $C_{u,u} = 0$ and $0 \leq C_{u,v} \leq 1000000$.

Sample

Input	Output
2 3 0 1 2 1 0 4 2 4 0 4 0 60 60 60 60 0 60 60 60 60 0 90 60 60 90 0	Case #1: NO Case #2: YES 0 30 30 0 30 0 30 0 30 30 0 90 0 0 90 0

Problem B: Product of Array Elements

Time limit: 1s; Memory limit: 512 MB

Given array ***A*** consisting of n integers a_i. Tuan wants to remove at most 1 element in array A so that the product of all remaining elements in that array is the largest. Please help Tuan do it!

You task is to calculate the product of all remaining elements in that array after removed at most 1 element.

Input

- The first line contains a positive integer n ($2 \le n \le 1000$).
- Next line contains n integers a_i separated by a space ($-10^9 \le a_i \le 10^9$).

Output

- Print the result of the problem. Since it may be too big, print it after taking modulo 10^9+7.

Sample

Input	Output
4 4 2 3 5	120
5 -1 -2 -4 1 2	16

Explanation Example 1:

- Without dropping any elements, the product of 4 elements is 4 × 2 × 3 × 5 = 120.

Explanation Example 2:

- Remove -1, the product of the remaining 4 elements is -2 × (-4) × 1 × 2 = 16

Problem C: Copper Hydroxide

Time limit: 2s; Memory limit: 512 MB

Copper Hydroxide (chemical formula $Cu(OH)_2$) is a pale greenish blue or bluish green solid. It is a beautiful strong base, as this problem is for strong and beautiful coders. Let's prove it!

Given a vector $a = (a_1, a_2, \dots, a_n)$ in $\mathbb{R}^n$. A vector $b = (b_1, b_2, \dots, b_n)$ is non-increasing if and only if $b_1 \le b_2 \le \dots \le b_n$.

The Euclide distance between two vectors a, b is calculated as

$$d(a,b) = \sqrt{(a_1 - b_1)^2 + (a_2 - b_2)^2 + \dots + (a_n - b_n)^2}$$

Find a non-decreasing vector b in $\mathbb{R}^n$ such that $d(a,b)$ is minimized.

Input

The first line contains a natural number, n $(1 \le n \le 10^6)$

The second line contains n real numbers $a_1, a_2, \dots, a_n$ $(|a_i| \le 10^5)$. Each of them has at most 3 decimal digits in the input.

Output

Print one real number, which is the min $d(a,b)$, for all non-increasing vector b. The answer is accepted if the absolute error or relative error does not exceed 10^{-6}.

Sample

Input	Output
3 1 1 2	0
4 3.368 97.561 80 353	12.41750218

Explanation

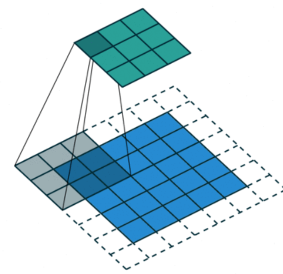
In sample 1, $a = (1,1,2)$, which is already non-decreasing. We choose $b = (1,1,2)$ then $d(a,b) = 0$.

In sample 2, we choose $b = (3.368, 88.7805, 88.7805, 353)$. Then, $d(a,b) = \sqrt{0 + (97.561 - 88.7805)^2 + (80 - 88.7805)^2 + 0} = 12.41750218\dots$

Bonus: Find out what $Cu(OH)_2$ facts that correspond to numbers in sample 2.
Good luck!

Problem D: Image Filtering

Time limit: 3s; Memory limit: 512 MB



In computer vision, image filtering a technique used to change the appearance of an image by altering the colors of the pixels. Hung is a student of data science and artificial intelligence course of DUT. He is very interesting with following filtering method:

Given an image **A** of size $h \times w$. Each pixel of **A** has a brightness level of $a_{i,j}$ ($1 \leq i \leq h$ and $1 \leq j \leq w$). Hung uses a filter **L** which is a matrix of intergers $l_{x,y}$ of size X × Y ($1 \leq x \leq$ X, $1 \leq y \leq$ Y) and X, Y are odd numbers. The output of the method is a image **B** of the same size as **A** and whose pixels' brightness level b_{ij} are calculated by the following formula:

$$b_{ij} = \sum_{x=1}^{X}\sum_{y=1}^{Y} l_{x,y} \times a_{i+x-\left\lceil\frac{X+1}{2}\right\rceil, j+y-\left\lceil\frac{Y+1}{2}\right\rceil}$$

Note, if i or j do not satisfy the condition $1 \leq i \leq h$ and $1 \leq j \leq w$ then $a_{i,j}$ is considered equal to 0. $\lceil * \rceil$ represents the formula to round up. Please help Hung to implement the program using the above method.

Input

- The first line contains 4 natural numbers h, w, X and Y ($1 \leq h \times w \leq 5\times10^5$, $1 \leq$ X $\leq h$, $1 \leq$ Y $\leq$ w and X, Y are odd numbers).
- Next h lines are brightness level $a_{i.j}$ of image **A** ($0 \leq a_{i.j} \leq 5\times10^5$).
- Next X lines are matrix of intergers $l_{x,y}$ of filter **L** ($0 \leq l_{i.j} \leq 5\times10^5$).

Output

- Print brightness level $b_{i.j}$ of image **B**.

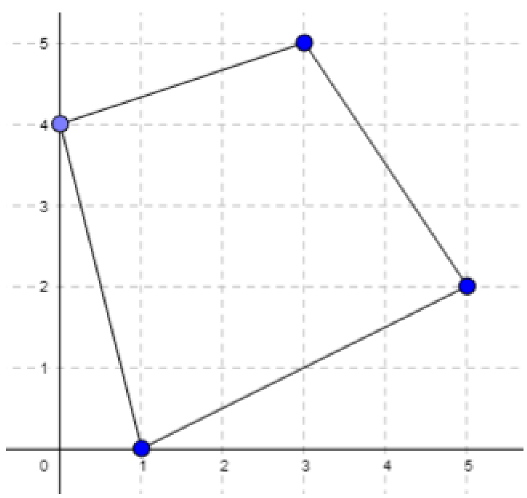
Sample

Input	Output
3 3 3 3 1 2 3 4 5 6 7 8 9 1 1 1 1 1 1 1 1 1	12 21 16 27 45 33 24 39 28
3 3 1 3 1 2 3 4 5 6 7 8 9 1 2 1	4 8 8 13 20 17 22 32 26

Problem E: Convex Quadrilateral

Time limit: 1s; Memory limit: 512 MB

A quadrilateral is a polygon in Euclidean plane geometry with four edges and four vertices. Quadrilaterals are either simple (not self-intersecting), or complex (self-intersecting, or crossed). Simple quadrilaterals are either convex or concave. This problem focuses on convex quadrilateral. A convex quadrilateral is a quadrilateral which has all interior angles less than 180 degrees and all the diagonals lie within the quadrilateral.



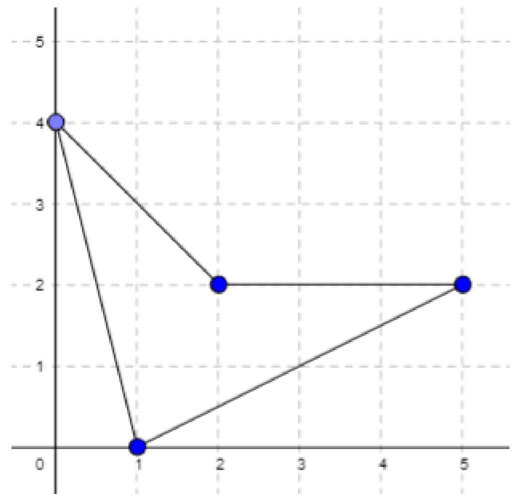


Figure 1. Left quadrilateral is a convex quadrilateral and right quadrilateral is not a convex quadrilateral

Given 4 points in 2D space, can they be the 4 vertices of a convex quadrilateral?

Input

- Each test contains several test cases. The first line contains one integer number t ($1 \leq t \leq 100$) — the number of test cases..

- The first line of each case contains 8 integers $x_1,y_1,x_2,y_2,x_3,y_3,x_4,y_4$ ($-10^9 \leq x_i$, $y_i \leq 10^9$) – coordinates of 4 points.

Output

- For each test case, print “YES” if these point are the 4 vertices of a convex quadrilateral and “NO” otherwise.

Sample

Input	Output
2 1 0 0 4 3 5 5 2 1 0 0 4 2 2 5 2	YES NO

Problem F: Number of Unique Characters

Time limit: 2s; Memory limit: 512 MB

Define the $f(X)$ is the number of unique characters in the string (X). For example: $f(a) = 1,\ f(abde) = 4, f(abded) = 3, f(abba) = 0$.

Given a string S. Calculate the value of following expression:

$$G(S) = \sum_{i=1}^{|S|} \sum_{j=i}^{|S|} f(S[i..j])$$

with $S[i..j]$ is the consecutive substring from i to j of S (1-based indexing).

Input

- Each test contains multiple test cases. The first line contains the number of test cases $\boldsymbol{T}$ $(\mathbf{1} \leq \boldsymbol{T} \leq \mathbf{10})$.
- Each test case contains only 1 line, string S $(1 \leq |S| \leq 10^5)$ which only contains lowercase alphabetical characters $(a..z)$.

Output

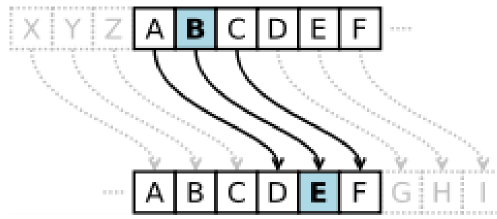
- For each test case, print the value of $G(S)$.

Sample

Input	Output
4 z icpccentral abcde uuuu	1 212 35 4

Problem G: Caesar cipher

Time limit: 2s; Memory limit: 512 MB



Today, in a course on Cryptography, Associate Professor Khoi Nguyen Tan, Head of IT Department - University of Science and Technology - UD, talked about Caesar cipher. a Caesar cipher, also known as Caesar's cipher, the shift cipher, Caesar's code or Caesar shift, is one of the simplest and most widely known encryption techniques. It is a type of substitution cipher in which each letter in the plaintext is replaced by a letter some fixed number of positions down the alphabet. For example, with a right shift of 3, A would be replaced by D, B would become E, and so on. The method is named after Julius Caesar, who used it in his private correspondence.

Tien is a student of IT department, he is very interested in this type of cipher and has come up with an idea to create a new cryptogram by performing the following steps:

- Given a letter consisting of a string S containing uppercase Latin characters.
- Repeat the Caesar cipher for k times. Each time i ($1 \le i \le k$), Tien uses a right shift of n_i and replaces all characters indexing from the x_i to y_i in string S.

What will be the result after encrypting?

Input

- The first line is string S ($1 \le |S| \le 5\times10^5$).
- The second line is number k ($1 \le k \le 2\times10^5$).
- Next k lines contain the triples n_i, x_i and y_i ($0 \le n_i \le 25$; $1 \le x_i \le y_i \le |S|$).

Output

- Print one string after encrypting.

Sample

Input	Output
TIEN 1 1 1 4	UJFO
TIEN 3 5 1 2 2 3 4 3 1 3	BQJP

Problem H: Cut Cake

Time limit: 1s; Memory limit: 512 MB

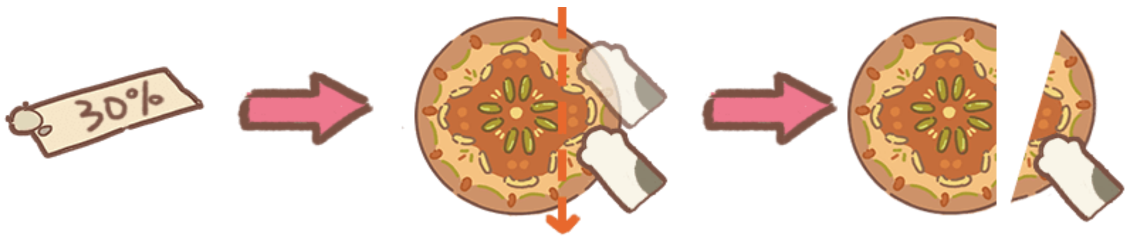


*Image from Animal Restaurant game

Chef Gumi is the Chef of Animal Restaurant. Recently, he is interested in the mini-game Cut Cake. He is given a cake and he has to cut according to the customer's request – the customer wants a part of the cake which is smaller than 50%. Please help Gumi check if he satisfies the request.

In the two-dimensional Cartesian coordinate system, the cake is a circle with its center point C and its radius while the cut is illustrated by a straight line from 2 different points – point A and point B.

Input

The input consists of 8 float numbers. The first six numbers represent the *x*- and *y*-coordinates of points A, B, and C, respectively, ($-10^5 \leq x_A, y_A, x_B, y_B, x_C, y_C \leq 10^5$). Next is the radius of the cake ($0 < R \leq 10^3$) and last is the percentage of cake the customer wants ($0 < P < 50$)

Output

Print YES if Gumi satisfies his customer's request, which means his cut is through the cake and the difference between the smaller part of the cake and the request is within 5%. If not or his cut is outside or only touches the cake, print NO.

Sample

Input	Output
-1 0 0 1 0 0 1 10	YES
-1 0 0 1 0 0 1 15	NO

Problem I: Hanging Certificates of Merit

Time limit: 2s; Memory limit: 512 MB

The Informatics Olympiad Club of University of Science and Technology - University of Danang over the years participating in Vietnam The Informatics Olympiad and ICPC has received many certificates of merit. Captain Khai of the club came up with an idea to set up a display area for these certificates. Khai prepared n rectangular frames to hang them. The i^{th} frame of size (w_i, h_i) is hung on the wall using a nail nailed to the center of the frame at coordinates (x_i, y_i) on the wall. However, after doing this, Khai noticed that some frames were overlapping. Khai decided to adjust by selecting some frames and rotating them around these center 90 degrees so that the frames no longer overlap. Because the work is quite difficult, please help Khai.

Input

- The first line contains a positive integer n $(1 \leq n \leq 2500)$.

- The next n lines, each line contains 4 interger x_i, y_i, w_i, h_i ($-10^9 \leq x_i, y_i \leq 10^9$, $1 \leq w_i, h_i \leq 10^9$).

Output

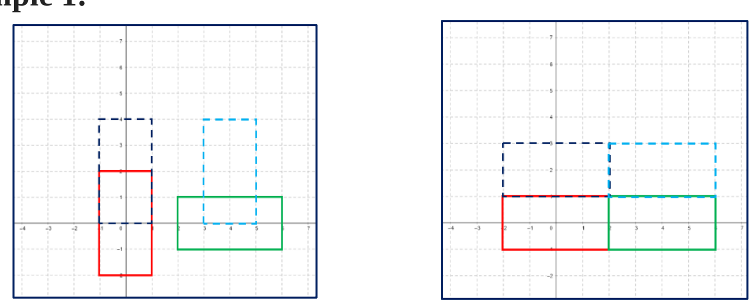
- If there is no way to rotate, print “No”.

- Otherwise: the first line prints “Yes”, the second line prints the rotation way by a string containing the characters “Q” or “K”. The i-th character represents whether the i^{th} frame rotates or not. “Q” represents **rotation** and “K” represents **no rotation**. If there are multiple ways, print the way with the smallest one in lexicographic order.

Sample

Input	**Output**
4 0 2 2 4 0 0 2 4 4 0 4 2 4 2 2 4	Yes QQKQ
2 0 0 2 2 1 1 2 2	No

Explanation Example 1:



Problem J: Manganese Dioxide

Time limit: 5s; Memory limit: 512 MB

Manganese Dioxide (chemical formula MnO_2) is a blackish or brown solid. Although looking harsh, its properties are wonderful and popularly used in batteries. Similarly, this problem may look difficult, but its solution contains beautiful insights. Let's see if it's true!

Given an array of integers $a_1, a_2, \dots, a_n$, and an integer k. For every $i = 1, 2, \dots, k$, calculate the sum of their i-th powers: $f(i) = a_1^i + a_2^i + \cdots + a_n^i$.

Input:

The first line contains two natural numbers, n, k $(1 \le n \le 10^5, 1 \le k \le 10^5)$

The second line contains n real numbers $a_1, a_2, \dots, a_n$ $(0 \le a_i < 998244353)$.

Output:

Print k lines, containing $f(1), f(2), \dots, f(k)$, each on one line. Since they may be too big, print them after taking modulo 998244353.

Sample:

Input	Output
3 3 1 2 3	6 14 36
4 5 87 535 808 5026	6456 26207334 864427735 110742109 992865564

Explanation:

In sample 1, $1 + 2 + 3 = 6, 1^2 + 2^2 + 3^2 = 14, 1^3 + 2^3 + 3^3 = 36$

Bonus: Find out what MnO_2 facts that correspond to numbers in sample 2. Good luck!

Problem K: Racing in maze

Time limit: 1s; Memory limit: 512 MB

Anyone has studied the subject of Artificial Intelligence taught by leacture Pham Minh Tuan at the Faculty of Information Technology - University of Science and Technology - UD a few years ago, knows that programming racing in the maze is a mandatory activity if you want to pass the subject with a high score. Participants will be given a maze which is a map of size $h \times w$, which contain cells denoted by one of the following symbols:

- '#': Obstacle cell.
- '+': From this cell, the car can move to the adjacent square (Left, Right, Up, Down).
- 'L': From this cell, the car can only move left.
- 'R': From this cell, the car can only move right.
- 'U': From this cell, the car can only move up.
- 'D': From this cell, the car can only move down.

The participants must program the car control so that from any position the car moves to a secret location in a given time t. However, because the secret location is a secret, no one knows how to program properly, the participant's car runs wildly until the time is up, then stops. Mr. Tuan wants to know how many valid ways to move in all the time t allows. Knowing that each time unit, the car moves 1 cell according to the symbol of the map. Note that, car hitting an obstacle or leaving the map are considered illegal and do not count as a valid way.

Input

- The first line contains 3 natural numbers h, w and t ($1 \le h \times w \le 100$, $1 \le t \le 10^9$).

- Next h lines contains the symbols of maze.

Output

- Print the number of valid way. Since result may be too big, print it after taking modulo 10^9+7.

Sample

Input	Output

`2 2 10`
`RD`
`UL`
	`4`

`3 3 2`
`RD#`
`U+#`
`#LR`
	`7`

Explanation Example 1: From any coordinate, there is one valid move. So there are 4 ways in total.

Explanation Example 2: From coordinates (1,1) there is one valid way to move, RD. From coordinates (1,2) there are 3 valid ways to move: DU, DL, DR. From coordinates (2,1) there is 1 way UR. From coordinates (2,2) there are 2 ways: UD, LU. The other coordinates with no valid way of moving. So there are 7 ways in total.

Problem L: Watermelon park

Time limit: 4s; Memory limit: 512 MB

As the Graw city is in need of financial support, they decided to put their watermelon park on sale. Fortunately, Mr. Schuyler, the only one that can afford the park, is willing to buy it.

Schuyler was informed that the park has n watermelons of multifarious sizes, and for any pair of watermelons, there exists only one route between them. In other words, when viewing the map of the park, we can see that it has the structure of a Tree.

Schuyler is satisfied with the park's infrastructure. However, he finds the idea of a "Watermelon park" quite peculiar, therefore, he wants the park to be as astonishing as possible. He decided to try to take his friends on a tour around the park through different paths that connect two watermelons. A tour is made by a pair of watermelons **(**s, t**)**, meaning that this tour starts from **watermelon** s and ends at **watermelon** t.

Schuyler notices that his friends get surprised everytime they see a watermelon bigger than all the ones they saw before. With a blueprint already in hand, he gave the President of Graw, Keanu, some questions in order to decide whether he will buy the park or not.

Schuyler gives Keanu the blueprint, showing how he wants the park to be structured. Then, he lists several pairs of watermelons, demonstrating the tours he wants to take his friends on, and asks Keanu: for each pair, how many times will Schuyler's friends get surprised?

Your mission is to assist Keanu in answering these questions to help his city.

Input

- The first line consists of two numbers n and q, meaning the number of watermelons in the park and the number of questions. $(1 \le n, q \le 2 \cdot 10^5)$
- The second line consists of n numbers a_i showing the sizes of n watermelons. $(1 \le a_i \le 10^9)$
- The next $n - 1$ lines, each of which consisting of two numbers u and v $(1 \le u, v \le n$, $u \ne v)$ demonstrates that watermelons u and v have a path between them.
- For the next q lines, you are given the encoded tours in the form of two numbers x_i and y_i $(0 \le x_i, y_i \le n)$. In order to decode these questions, you will need to find s_i and t_i, the original tour.
    - $s_i = (x_i + p) \bmod n + 1$
    - $t_i = (y_i + p) \bmod n + 1$
    - p is the answer to the question before. For the first question, $p = 0$

Output

Print each answer to the questions in one single line.

Sample

Input	Output
6 3 2 4 2 1 3 1 1 3 2 3 3 4 5 3 6 5 5 1 0 3 5 1	2 3 1

Problem M: Student Clubs

Time limit: 2s; Memory limit: 512 MB

Mai's university has many student clubs and each has its power. This power is calculated by the factorial of the number of club' members. What is the total power of all clubs?

It is easy problem if she knows how many members are in each group, however, she doesn't have them. One thing she can do is interview students and that student tells her about another student in the same club.

Suppose she collected enough student statistics, each student join only one club and a valid club has more than 2 members (> 2 members), please help her get the total power of all club in her university.

Input

- First-line contains 2 integers N and M $(1 \leq N, M \leq 10^5)$, where N is the number of students and M is the number of interviewed students.
- Next M lines contain 2 integers which are the student who is interviewed and his club's friend.

Output

Print an integer which is the total power of student clubs in the university modulus $10^9 + 7$

Sample

Input	Output
9 5 1 2 2 3 0 4 4 5 8 7	12

Explain

There are only 2 valid clubs:
One has 3 members 1, 2, and 3. => power1 is 3! = 6
Another valid club has 3 members 0, 4 and 5 => power2 is 3! = 6

⇨ Total power is 12

Problem N: Subsequence and Permutation of String

Time limit: 2s; Memory limit: 512 MB

Given 2 strings S and T, find the lexicographically smallest string X satisfying following conditions:

- X is a subsequence of S.
- X is a permutation of T.

Input

- Each test contains 2 lines.
- The first line is string S $(1 \le |S| \le 10^5)$.
- The second line is string T $(1 \le |T| \le 10^3)$.
- Both strings only contain lowercase alphabetical characters $(a \dots z)$.

Output

Print string X which satisfies the given conditions. Otherwise print -1.

Sample

Input	Output
bcadca dacb	badc
icpccentral nccai	iccna
uuuuuu uzt	-1

Problem O: Wood Game

Time limit: 2s; Memory limit: 512 MB

Quang and Tung are now working at a wood factory. The factory's electrical power system has N single outlets, each of them is either negative (-) or positive (+) type. In the factory there is a cut-and-union machine C with two electrical jacks A and B. Inside the machine, a wood panel of size $X \times Y$ are waiting to be solved (X and Y are **odd numbers**). If A and B are in the different types of outlet (.i.e - + or + -), C will work as a cut machine: In one step, it can cut a panel into two panels such that they are both rectangles with integer sides' length (the positions and directions of panels are kept). If A and B are in the same type of outlet (.i.e + + or - -), C will work as an union machine: In one step, it can union two neighbor panels into a panel such that the panel is a rectangle (the positions and directions of panels are kept).

As world finalists, Quang and Tung usually have different views about a unique problem. They can't reach an agreement on how to use the machine. There are K steps that applied to the panel, but now Quang and Tung stop working because of disagreement. Instead of hit/kick the others, they decided to play a game to avoid the conflict:

- They draw m directed edges, each of them connects two outlets such that there is no cycle (.i.e outlets and edges form a **D**irected **A**cyclic **G**raph)
- Initialize, jack A is in a-th outlet, jack B is in b-th outlet, the panel was applied by K steps before starting the game.
- They play in alternate turns. Quang plays first.
- In one turn, player can choose one of three action:
    - Move jack A down to a new outlet (.i.e they can move jack A from u-th outlet to v-th outlet if (u, v) is an edge)
    - Move jack B up to a new outlet (.i.e they can move jack B from v-th outlet to u-th outlet if (u, v) is an edge)
    - Use machine C to apply a legal step to the panel
- The one who can't make a legal turn loses the game.
- Quang wonders if he can win the game or not, if they are both intelligent. Please help him.

Input

- First line contains an integer T is the number of test cases. Each test case is described in some lines.
- First line contains 4 integers N, M, a, b $(1 \leq a, b \leq N \leq 10^5; 0 \leq M \leq 10^5)$.
- The second line contains a string of length N, the i-th character is either + or - describe the type of i-th outlet.
- Each of next M lines contains 2 integers u, v means they draw an edge from u to v $(1 \leq u, v \leq N)$. It is guaranteed that there are no cycles.
- The next line contains 3 integers X, Y, K $(0 \leq K \leq 10^5; 1 \leq X, Y \leq 10^5; X\ Y$ are odd numbers)
- The i-th line of next K lines contains 5 integers t, u, v, p, q describes the i-step that applied to the panel:
  - If $t = 0$ then this is a cut step, if $t = 1$ then this is an union step
  - Numbered all integer points on the panel from (0,0) to (x, y). The machine cut/union from point (u, v) to point (p, q)
  - It is guaranteed that interval from (u, v) to (p, q) is parallel with at least one panel's side, and this is a legal step

The sum of N, the sum of M and the sum of K over all test cases are at most 10^5

Output

Print T lines, the i-th one is YES or NO corresponding Quang can win the game in the i-th test case or not.

Sample:

Input	Output
1 5 4 2 2 +-+-+ 1 2 2 3 3 4 4 5 1 2 3 0 0 1 1 1 1 0 1 1 1 0 0 1 1 1	YES

Problem P: Jerry and Jelly

Time limit: 2s; Memory limit: 512 MB

Jerry's 24th birthday is coming! Like all other mice, the age of 24 is a very important milestone in his life. On this occasion, he invites lots of his friends to his house for a very special party. After having waited for Tom to fall asleep, Jerry silently broke into a fridge and found a very big piece of grass jelly there! He silently brought the jelly piece away and... it's time for joy!

The piece of jelly Jerry stole is a rectangular whose dimensions are x, y and z, respectively. Jerry wants to split it into several smaller pieces by making several cuts. So as to make the jelly pieces look tasty, every Jerry's cut must split some piece into exactly two smaller pieces which are also rectangulars with integer dimensions. Moreover, a cut must be parallel to at least one faces of the piece being cut as well.

After cutting the jelly, Jerry will put jelly pieces into a plate. While placing a piece, Jerry always rotate the piece so that its largest face lies on the plate. Formally, suppose that the dimensions of a piece are a, b and c where $a \geq b \geq c$, its surface area should always be $a \times b$ and its height should always equal to c.

Jerry only considers a piece of jelly cute when its height is at least u. He will only put cute pieces of jelly onto the plate while throwing away all non-cute pieces. For a beautiful plate of jelly, he wants the total surface area of jelly pieces on the plate to be as large as possible.

Jerry would like to know the maximum value of total surface area of all cute jelly pieces on the plate, before making any cuts to his delicious jelly. He is very good at hiding, running and stealing; but not programming. So please help him!

Input

The first line of the input contains one integer τ $(1 \leq \tau \leq 10^5)$ denoting the number of test cases. In the rest τlines, each presents a test case with 4 positive integers x, y, z and $u (1 \leq x, y, z, u^2 \leq 100)$ where x,y,z are dimensions of the stolen jelly peace and u is the minimum height of a cute jelly piece.

Output

For each test case, print a single integer on a line, representing the maximum possible value of total surface area of all jelly pieces on the plate.

Sample

input	output
2 5 4 3 2 4 3 2 1	30 24

Explanation

In the first test case, Jerry got a rectangular piece of jelly with dimensions $(5, 4, 3)$. He should cut it into two rectangular pieces with dimensions $(5, 2, 3)$ and put these two pieces onto the plate. Both pieces' surface areas equal to $5 \times 3 = 15$ and both pieces' heights equal to 2. Hence the total surface area is $15 + 15 = 30$.

In the second test case, since every piece's height is at least 1, the piece is always cute. Hence, Jerry can cut the initial jelly piece with dimensions $(4, 3, 2)$ into $4 \times 3 \times 2 = 24$ cubes of side 1. Each cube's surface area is 1.