Problem A. XOR

Input file:	*standard input*
Output file:	*standard output*
Time limit:	6 seconds
Memory limit:	512 mebibytes

Every good problemset needs a problem that can be summarized in a single doge meme. Today's problemset is no different.

Given a multiset S of non-negative integers, divide it into two multisets A and B in a way that minimizes $|\mathrm{xor}(A) - \mathrm{xor}(B)|$. Here $\mathrm{xor}(X)$ denotes the bitwise XOR of all elements of X.

Note that one of the multisets A and B can be empty, and XOR of an empty multiset is 0.

It is enough to output the minimum possible value of $|\mathrm{xor}(A) - \mathrm{xor}(B)|$.

Input

The first line of input contains the number of test cases z ($1 \le z \le 50$). The descriptions of the test cases follow, two lines per test case.

The first line of every test case contains an integer n ($1 \le n \le 10^5$) – the size of the multiset.

The second line contains n integers x_i ($0 \le x_i \le 10^{18}$) – elements of the multiset.

Output

For each test case output one integer: the smallest possible difference of XORs.

Example

standard input	standard output
2 4 1 2 3 4 5 3 7 3 9 5	4 5

Problem B. Tribute

Input file:	*standard input*
Output file:	*standard output*
Time limit:	15 seconds
Memory limit:	512 mebibytes

The Son of Heaven, our beloved emperor, has commanded you, his First Minister, to extort tribute from n neighbouring kingdoms. Each of the tributaries has been assigned a number of silver coins to pay – for the i-th kingdom, the number is a_i. To show His infinite grace, the emperor decided to only take money from some of the countries, sparing the rest. Your overzealous finance minister, after writing down all a_i's, has already produced all possible $2^n - 1$ income values – the sums of the non-empty subsets of tributaries. Unfortunately, the minister lost the paper sheet with original tribute values in the process. For this infraction, as well as improper calligraphy, he was promptly executed.

Now you only have $2^n - 1$ sums, written rather badly. Can you recover the tribute values from them?

Input

The first line of input contains the number of test cases z ($1 \le z \le 200$). The descriptions of the test cases follow.

Every test case consists of two lines: the first contains a number n ($1 \le n \le 20$), the second – $2^n - 1$ integers not exceeding $2 \cdot 10^9$, denoting all the possible sums of tributes. Assume that the tribute values were all positive integers. The total number of sums in all test cases does not exceed 10^7.

Output

For each test case output the recovered values of a_i for $i = 1, 2, \ldots, n$, in increasing order. If there are no values that fit the input, or if there are multiple possibilities, simply write "NO" instead – you cannot execute anyone twice.

Example

standard input	standard output
1 3 1 2 3 3 4 5 6	1 2 3

Problem C. Boardroom Meeting

Input file:	*standard input*
Output file:	*standard output*
Time limit:	7 seconds
Memory limit:	512 mebibytes

Recently, you have been hired by an investment fund. You quickly developed a feeling, though, that something here was amiss, especially when a client's money has been invested in two companies carefully selected by their best astrologist.

Unfortunately, for the last n days the stock prices were (mostly) falling. The boss called an urgent meeting.

– "Ladies and gentlemen, you all know the situation. Any ideas?" – the boss had a nice habit of getting straight to the point (even when this point apparently lied in another dimension of reality).

– "We can choose a good subset of days, so that the prices are only increasing, then show the client only that company's prices for these days!" – volunteered Billy, the last Employee of the Month.

– "We can do better! Select the days such that *both* companies' prices form an increasing sequence!" – Anna, the senior manager, wouldn't allow herself to stay behind.

– "How about ditching the astrologist and doing some serious research?" – the words came from you almost involuntarily, as if your brain and vocal cords had fired without your consent.

The boss looked at you. It wasn't exactly a look of earnest approval...

Now you have some bruises, a lot of stairs to climb, and much work to do. Given the stock prices of the two companies for n consecutive days, find the maximum subset of days so that both price subsequences are (strictly) increasing. It is enough to output the maximum number of days.

Input

The first line of input contains the number of test cases z. The descriptions of the test cases follow.

The first line of every test case contains the number of days n ($1 \le n \le 200\,000$). Then two lines follow. The first one contains n positive integers not exceeding 10^9 – the stock prices of the first company for all n days. The second line contains the second company's prices, in the same format.

The total number of days in all test cases does not exceed $2\,000\,000$.

Output

For each test case output in a separate line a single integer – the maximum possible number of days.

Example

standard input	standard output
1 6 1 2 6 3 4 6 4 1 3 5 7 7	3

Problem D. Secret Santa

Input file:	*standard input*
Output file:	*standard output*
Time limit:	8 seconds
Memory limit:	512 mebibytes

Every Christmas, members of the Community of Algorithms Enthusiasts send gifts to each other. This tradition is a bit problematic and leads to conflicts, because some members always get more gifts than others. This year the community decided to introduce a coordinated and fair system, known as Secret Santa.

The idea behind Secret Santa is very simple: each member of the community is assigned a person to whom they send a gift. This way each member prepares one gift and gets one gift. It is possible that some member is assigned themselves, then they simply send a gift to themselves.

The community is very enthusiastic about the idea, and now they want to assign who sends a gift to whom. However, they need to keep in mind how the postal system works – whether a package can be delivered from one town to another depends on how strong the wind is that day.

There are n members of the community. Each member lives in a different town, and the towns are numbered from 1 to n. If the wind speed is a, then a package with a gift can be sent from town k to town l if and only if $k - n + a < l < k + a$.

Your task is to find the number of ways to assign community members so that all can send their gifts the same day, given the wind speed that day. As the number can be very large, you only need to find the value modulo $10^9 + 7$.

Input

The first line of input contains the number of test cases z ($1 \le z \le 10$). The descriptions of the test cases follow.

Each test case consists of a single line containing two integers n and a ($1 \le a \le 200$, $1 \le n \le 10^6$, $a < n$), the number of community members and the strength of the wind, respectively.

Output

For each test case output one integer: the number of ways community members can be assigned to each other, modulo $10^9 + 7$.

Example

standard input	standard output
3 4 2 5 2 16 5	5 13 418144253

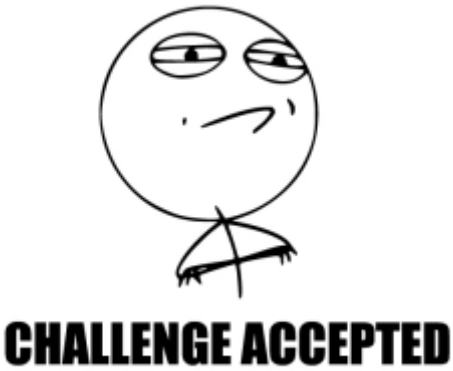
Problem E. Guessing Game

Input file:	*standard input*
Output file:	*standard output*
Time limit:	8 seconds
Memory limit:	512 mebibytes

Guessing Game is Alice's favorite game for two players. This game is played with a deck containing a number of cards, each having a sequence of zeroes and ones written on it. The lengths of all sequences on the cards are equal.

In Guessing Game Alice picks at random a card from the deck, and the other player attempts to determine what sequence is written on the card, by asking Alice a series of questions of the form "What is the i-th digit of the sequence?". After each such question Alice answers (truthfully) to the question, and the second player may ask another question, or try to guess the sequence on the card. The second player can only guess once, so if his guess is correct, he wins, otherwise he loses.

Alice challenged you to play the game and win by asking as few questions as possible.



Given all the sequences that appear on the cards, find the minimal number of questions needed to uniquely determine the sequence, no matter what card is picked by Alice.

Input

The first line of input contains the number of test cases z ($1 \le z \le 20$). The descriptions of the test cases follow.

The first line of every test case contains two integers n, k ($1 \le n \le 2^k; 1 \le k \le 13$), denoting the number of cards and the length of all sequences appearing on the cards respectively. Each of the following n lines contains a string of length k consisting of zeroes and ones, describing the sequence on one card. No two sequences in a test case are equal.

Output

For each test case output one integer: the minimal number of questions the second player has to ask to win the game.

Example

standard input	standard output
1 4 3 000 100 010 011	2

Problem F. Flat Earth

Input file:	*standard input*
Output file:	*standard output*
Time limit:	2 seconds
Memory limit:	512 mebibytes

The education system has let you down once again – your proposal to include the Flat Earth model into the high school program has been rejected for the sixth time in a row. The corrupt Round-Earth scientists refuse to listen to your arguments, and ignore the piles of data that support your claims.

It is time to settle this conflict once and for all. You have traveled all around the globe, and met with top Flat Earth scientists. Together, you devised a brilliant plan.

For the sake of contradiction, suppose that Earth is a sphere in the three-dimensional space. Then, assuming the sky is an infinite plane in the space, such an Earth would clearly cast a shadow on it! This shadow would be an orthogonal projection of Earth onto the sky. Since in reality there is no visible shadow on the sky, we reach a contradiction.

All that is left is to perform the calculations. Given the center and radius of Earth, as well as the equation of the sky-plane in the form $ax + by + cz + d = 0$, determine the area of an orthogonal projection of Earth onto the sky. Note that in some of your experiments Earth may intersect the sky – you wouldn't like to introduce too many unnecessary assumptions, would you?

Input

The first line of input contains the number of test cases z ($1 \le z \le 10$). The descriptions of the test cases follow.

Every test case is described with a line containing eight integers x, y, z, r, a, b, c, d. They denote the coordinates of Earth's center, it's radius, and the sky's equation, respectively. All numbers are between 1 and 1000 inclusive.

Output

For each test case output one number: the area of the projection. Your answer will be considered correct if the absolute or relative error does not exceed 10^{-6}.

Example

standard input	standard output
1 2 3 5 7 1 2 4 8	153.938040026

Problem G. We Need More Managers!

Input file:	*standard input*
Output file:	*standard output*
Time limit:	25 seconds
Memory limit:	512 mebibytes

The media company you are working at intends to replace its flat organizational structure (no bosses) with a hierarchical one. A CEO will be chosen, to whom everyone else, directly or indirectly, is going to report. Every other employee is going to have exactly one direct supervisor. As such a reform is bound to introduce friction between workers, your company's goal is to choose a hierarchy that minimizes social costs for the firm.

The amount of friction between two coworkers forced into a superior-subordinate relationship is proportional to the number of political issues they disagree on. In your company, every employee has very resolute views on each of the n most common political topics: in each of the n categories, an employee's opinions can be either leftist or rightist. To make matters worse, no two employees have identical beliefs. The cost of having one employee directly report to another is equal to the number of topics they disagree on. The cost of the new organizational structure is the sum of the costs of friction between every two employees such that one is (directly) managed by the other. You are asked to compute the minimum possible cost of the new structure.

Input

The first line of input contains the number of test cases z ($1 \le z \le 10$). The descriptions of the test cases follow.

Every test case consists of two integers n and m ($1 \le n \le 20$, $1 \le m \le 2^n$) – the number of topics the workers have an opinion on and the number of employees, respectively. Next, m lines follow, each describing the political opinions of one worker. The description of worker's views is a string consisting of n letters. If the i-th character is '`L`' ('`R`'), the worker has leftist (rightist) views on the i-th subject.

Output

For each test case output a line containing a single integer – the minimum cost of the management hierarchy.

Example

standard input	standard output
1 5 4 LLLLL LLLLR RRRRL RRRRR	6

Problem H. Masterpiece

Input file:	*standard input*
Output file:	*standard output*
Time limit:	2 seconds
Memory limit:	512 mebibytes

After the ingenious "Magenta Square", and the unconventional "Fuchsia Circle", the world-renowned artist Theodore Cadman Spencer is working on his next masterpiece. This time the great master has really outdone himself, as this work of art will be indescribable in terms of a single geometric shape, which is clearly a leap forward in Theodore's journey to completion.

The maestro has decided to use a huge canvas shaped like an n-by-n square, perfectly divided into 1-by-1 squares. The cloth starts entirely white, and the artist will use his brush to paint some of the squares maroon.

Theodore's idea is to place his paintbrush in the upper-left corner of the canvas (i.e. in the first row and the first column), and gently slide it to the lower-right corner, always moving either one square to the right, or one square down. All squares touched by the brush will immediately turn maroon. But, as unbelievable as it is, this is not the end of the genius painter's plan! As soon as he gets to the lower-right corner he goes back, moving either left or up, to finally finish in the square where he started. He is free to choose his path as he pleases, and fields that get painted twice don't change the way they look in the slightest.

You are a passionate fan of Spencer's work, and a novice hacker – unable to resist the urge you broke into the artist's computer, and tried to download the plans for his masterpiece. However, the enormous size of the file made it impossible, so you quickly compressed it in the following way. For each of the n rows, you computed the number of maroon squares in that row, then you did the same thing for each of the n columns. Finally, you saved those values onto your local server, and took off before getting caught.

Now, you are unsatisfied – you'd like to know the exact process that will lead to the creation of the masterpiece, and you couldn't care less about the compressed form you got. But how much does it tell you anyway? Compute the number of the distinct paths for the paintbrush that are consistent with the information you have. Two paths are considered different if, at some moment, the artist chooses a different direction. Note that two distinct paths can potentially lead to the same painting, but you care about the process so much that you consider them as different.

As the answer might turn out to be large, output it modulo $10^9 + 7$.

Input

The first line of input contains the number of test cases z ($1 \le z \le 30$). The descriptions of the test cases follow.

The first line of every test case contains the size of the canvas n ($1 \le n \le 100\,000$). The second line of every test case contains n integers r_i ($0 \le r_i \le n$), the numbers of maroon squares in each row of the painting. In the next line, the descriptions of columns follows, in the same format.

Output

For each test case output one integer: the number of paths that result in a painting consistent with the given information modulo $10^9 + 7$.

Example

standard input	standard output
3 2 2 2 2 2 2 1 1 1 1 3 2 2 1 1 2 2	2 0 1

Problem I. Don't Split The Atom!

Input file:	*standard input*
Output file:	*standard output*
Time limit:	2 seconds
Memory limit:	512 mebibytes

Two mad (and evil) scientists, Professor Zoom and Doctor Horrible, have just obtained n atoms of a very rare element, which they want to share between themselves. They have decided to play the following game:

First, Professor divides the atoms into two non-empty groups. Next, Doctor takes one group and uses it for his evil purposes, and splits the other into two non-empty parts. Then, Professor takes one of the parts, and divides the other one again into two, returning it to Doctor. The game goes on – with every turn, a scientist taking one of the parts, and splitting the other – until one of the players is forced to split a single atom. This results in an explosion, and the unlucky splitter loses the game (probably with his life).

Knowing the number of atoms n determine which one of the villains survives the game.

Input

The first line of input contains the number of test cases z ($1 \le z \le 50$). The descriptions of the test cases follow.

Every test case consists of one integer n ($1 \le n \le 1\,000\,000$) – the initial number of atoms.

Output

For each test case output a line containing a single character: '`A`' if Professor wins the game, '`B`' if Doctor wins.

Example

standard input	standard output
2 2 17	A B

Problem J. Bobby Tables

Input file:	*standard input*
Output file:	*standard output*
Time limit:	2 seconds
Memory limit:	512 mebibytes

Little Bobby Tables stores his favorite big numbers in his database. Those numbers take a lot of memory, so he is trying to figure out a way to store them more efficiently. He noticed that in the database there is a number X which has no large prime factors, and he suspects that it is of the form $\binom{n}{k}$, for some relatively small numbers n, k.

Help Bobby and check if it is really the case. Given an integer m and the prime factorization of X, determine whether there exist integers n, k such that $0 \le k \le n \le m$ and $X = \binom{n}{k}$.

Input

The first line of input contains the number of test cases z ($1 \le z \le 10\,000$). The descriptions of the test cases follow.

The first line of every test case contains two integers t, m ($1 \le t, m \le 150\,000$), the number of primes in the factorization of X and the upper bound for output values, respectively. The second line contains t primes p_i ($2 \le p_i \le m$), such that product of all p_i is X.

The sum of the numbers t in all the test cases does not exceed $200\,000$. The sum of the numbers m in all the test cases does not exceed $2\,000\,000$.

Output

For each test case, if there exist appropriate n and k, output "YES" in the first line, and the values of n and k in the second line. Otherwise output only one line containing "NO".

Example

standard input	standard output
2 2 5 3 2 3 7 2 2 2	YES 4 2 NO

Problem K. Triples

Input file:	*standard input*
Output file:	*standard output*
Time limit:	12 seconds
Memory limit:	512 mebibytes

You are given a tree, i.e. a connected undirected graph with no cycles. For every two vertices x, y let $d(x, y)$ denote the length (i.e. the number of edges) of the unique simple path between x and y. Count all the (unordered) triples $\{x, y, z\}$ such that $d(x, y) = d(y, z) = d(z, x) > 0$.

Input

The first line of input contains the number of test cases z ($1 \le z \le 20$). The descriptions of the test cases follow.

The first line of every test case contains the number of vertices n ($3 \le n \le 100\,000$). Each of the next $n - 1$ lines contains two integers a, b ($1 \le a, b \le n$), denoting that there is an edge between vertices a and b.

Output

For each test case output one integer: the number of triples in question.

Example

standard input	standard output
2 4 1 2 1 3 1 4 8 1 2 1 3 1 4 2 5 2 6 3 7 4 8	1 4

Problem L. Related Languages

Input file:	*standard input*
Output file:	*standard output*
Time limit:	12 seconds
Memory limit:	512 mebibytes

You are studying two ancient languages, aiming to prove that they are closely related. You suspect that the words for "push-relabel flow algorithm" in both languages stem from a single ancestor. If so, they contain similar cores, i.e. subwords that do not differ much from each other.

Given two words A and B, determine the maximum possible s, for which there are connected subwords A' in A and B' in B such that A' and B' have length s, and differ on at most k positions.

Input

The first line of input contains the number of test cases z ($1 \le z \le 2000$). The descriptions of the test cases follow.

Every test case consists of three lines. The first line contains three numbers n, m, k ($1 \le n, m \le 4000$; $0 \le k \le \min(m, n)$). In the next two lines there are two strings A and B, of lengths n and m, respectively, each consisting of lowercase English letters.

The total length of all the words in the input does not exceed 200 000.

Output

For each test case output a single integer – the maximum possible length of subwords that differ on at most k positions.

Example

standard input	standard output
1 12 13 2 hakunamatata hienakulameta	9