A. The Play Never Ends

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

Let's introduce a two-player game, table tennis, where a winner is always decided and draws are impossible.

Three players, Sosai, Fofo, and Hohai, want to spend the rest of their lives playing table tennis. They decided to play forever in the following way:

- In each match, two players compete while the third spectates.
- To ensure fairness, no player can play three times in a row. The player who plays twice in a row must sit out as a spectator in the next match, which will be played by the other two players. Otherwise, the winner and the spectator will play in the next match, while the loser will spectate.

Now, the players, fully immersed in this infinite loop of matches, have tasked you with solving the following problem:

Given an integer k, determine whether the spectator of the first match can be the spectator in the k-th match.

Input

Each test contains multiple test cases. The first line contains the number of test cases t ($1 \le t \le 1000$). The description of the test cases follows.

The only line of each test case contains one integer k ($1 \le k \le 10^9$).

Output

For each test case, print `"YES"` (without quotes) if the spectator of the first match can be the spectator of the k-th match, and `"NO"` (without quotes) otherwise.

You can output the answer in any case (upper or lower). For example, the strings `"yEs"`, `"yes"`, `"Yes"`, and `"YES"` will be recognized as positive responses.

Standard Input	Standard Output
4 1 2 333 1000000000	YES NO NO YES

Note

In the first test case, the spectator of the first match is already a spectator in the 1st match.

In the second test case, the spectator of the first match will play in the 2nd match regardless of the result of the first match.

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B. Perfecto

```
Input file:    standard input
Output file:   standard output
Time limit:    1.5 seconds
Memory limit:  256 megabytes
```

A permutation p of length n^* is *perfect* if, for each index i ($1 \le i \le n$), it satisfies the following:

- The sum of the first i elements $p_1 + p_2 + \ldots + p_i$ is **not** a perfect square[†].

You would like things to be perfect. Given a positive integer n, find a *perfect* permutation of length n, or print -1 if none exists.

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[*] A permutation of length n is an array consisting of n distinct integers from 1 to n in arbitrary order. For example, $[2, 3, 1, 5, 4]$ is a permutation, but $[1, 2, 2]$ is not a permutation (2 appears twice in the array), and $[1, 3, 4]$ is also not a permutation ($n = 3$ but there is 4 in the array).

[†] A perfect square is an integer that is the square of an integer, e.g., $9 = 3^2$ is a perfect square, but 8 and 14 are not.

Input

Each test contains multiple test cases. The first line contains the number of test cases t ($1 \le t \le 10^4$). The description of the test cases follows.

The first and only line of each test case contains a single integer n ($1 \le n \le 5 \cdot 10^5$).

It is guaranteed that the sum of n over all test cases does not exceed 10^6.

Output

For each test case:

- If no solution exists, print a single integer -1.
- Otherwise, print n integers $p_1, p_2, \ldots, p_n$ — the *perfect* permutation you find.

If there are multiple solutions, print any of them.

Standard Input	Standard Output
3 1 4 5	-1 2 4 1 3 5 1 4 3 2

Note

In the first test case, there is only one permutation with length $n = 1$ that is $p = [1]$, which is not *perfect*:

- $p_1 = 1 = x^2$ for $x = 1$.

In the second test case, one possible *perfect* permutation with length $n = 4$ is $p = [2, 4, 1, 3]$:

- $p_1 = 2 \neq x^2$;
- $p_1 + p_2 = 2 + 4 = 6 \neq x^2$;
- $p_1 + p_2 + p_3 = 2 + 4 + 1 = 7 \neq x^2$;
- $p_1 + p_2 + p_3 + p_4 = 2 + 4 + 1 + 3 = 10 \neq x^2$.

In the third test case, one possible *perfect* permutation with length $n = 5$ is $p = [5, 1, 4, 3, 2]$:

- $p_1 = 5 \neq x^2$;
- $p_1 + p_2 = 5 + 1 = 6 \neq x^2$;
- $p_1 + p_2 + p_3 = 5 + 1 + 4 = 10 \neq x^2$;
- $p_1 + p_2 + p_3 + p_4 = 5 + 1 + 4 + 3 = 13 \neq x^2$;
- $p_1 + p_2 + p_3 + p_4 + p_5 = 5 + 1 + 4 + 3 + 2 = 15 \neq x^2$.

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C. Trapmigiano Reggiano

```
Input file:     standard input
Output file:    standard output
Time limit:     2 seconds
Memory limit:   256 megabytes
```

In an Italian village, a hungry mouse starts at vertex st on a given tree* with n vertices.

Given a permutation p of length $n^\dagger$, there are n steps. For the i-th step:

- A tempting piece of Parmesan cheese appears at vertex p_i. If the mouse is currently at vertex p_i, it will stay there and enjoy the moment. Otherwise, it will move along the simple path to vertex p_i **by one edge**.

Your task is to find such a permutation so that, after all n steps, the mouse inevitably arrives at vertex en, where a trap awaits.

Note that the mouse must arrive at en after all n steps, though it may pass through en earlier during the process.

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*A tree is a connected graph without cycles.

†A permutation of length n is an array consisting of n distinct integers from 1 to n in arbitrary order. For example, $[2, 3, 1, 5, 4]$ is a permutation, but $[1, 2, 2]$ is not a permutation (2 appears twice in the array), and $[1, 3, 4]$ is also not a permutation ($n = 3$ but there is 4 in the array).

Input

Each test contains multiple test cases. The first line contains the number of test cases t ($1 \le t \le 10^4$). The description of the test cases follows.

The first line of each test case contains three integers n, st, and en ($1 \le n \le 10^5$; $1 \le \mathrm{st}, \mathrm{en} \le n$) — the number of vertices of the tree, the starting vertex, and the trap vertex.

Each of the next $n-1$ lines contains two integers u and v ($1 \le u, v \le n$, $u \ne v$) — the indices of the vertices connected by an edge.

It is guaranteed that the given edges form a tree.

It is guaranteed that the sum of n over all test cases does not exceed 10^5.

Output

For each test case:

- If no such permutation exists, output -1.
- Otherwise, output n integers $p_1, p_2, \ldots, p_n$, representing the order in which the cheese will appear at the vertices, ensuring the mouse will eventually be caught at vertex en.

If there are multiple solutions, print any of them.

Standard Input	Standard Output
4 1 1 1 2 1 2	1 1 2

1 2 3 2 2 1 2 2 3 6 1 4 1 2 1 3 4 5 5 6 1 4	3 1 2 1 4 3 2 6 5

Note

In the first test case, there is only one permutation with length $n = 1$ that is $p = [1]$, which successfully catches the mouse:

$$\mathrm{st} = 1 \xrightarrow{p_1=1} 1 = \mathrm{en}.$$

In the second test case, one possible permutation with length $n = 2$ is $p = [1, 2]$:

$$\mathrm{st} = 1 \xrightarrow{p_1=1} 1 \xrightarrow{p_2=2} 2 = \mathrm{en}.$$

In the third test case, one possible permutation with length $n = 3$ is $p = [3, 1, 2]$:

$$\mathrm{st} = 2 \xrightarrow{p_1=3} 3 \xrightarrow{p_2=1} 2 \xrightarrow{p_3=2} 2 = \mathrm{en}.$$

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D1. Infinite Sequence (Easy Version)

```
Input file:     standard input
Output file:    standard output
Time limit:     2 seconds
Memory limit:   256 megabytes
```

This is the easy version of the problem. The difference between the versions is that in this version, $l = r$. You can hack only if you solved all versions of this problem.

You are given a positive integer n and the first n terms of an infinite binary sequence a, which is defined as follows:

- For $m > n$, $a_m = a_1 \oplus a_2 \oplus \ldots \oplus a_{\lfloor \frac{m}{2} \rfloor}$*.

Your task is to compute the sum of elements in a given range $[l, r]$: $a_l + a_{l+1} + \ldots + a_r$.

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* $\oplus$ denotes the bitwise XOR operation.

Input

Each test contains multiple test cases. The first line contains the number of test cases t ($1 \le t \le 10^4$). The description of the test cases follows.

The first line of each test case contains three integers n, l, and r ($1 \le n \le 2 \cdot 10^5$, $1 \le l = r \le 10^{18}$).

The second line contains n integers $a_1, a_2, \ldots, a_n$ ($a_i \in \{0, 1\}$) — the first n terms of the sequence a.

It is guaranteed that the sum of n over all test cases does not exceed $2 \cdot 10^5$.

Output

For each test case, output a single integer — the sum of elements in the given range.

Standard Input	Standard Output

9 1 1 1 1 2 3 3 1 0 3 5 5 1 1 1 1 234 234 0 5 1111 1111 1 0 1 0 1 1 1000000000000000000 1000000000000000000 1 10 87 87 0 1 1 1 1 1 1 1 0 0 12 69 69 1 0 0 0 0 1 0 1 0 1 1 0 13 46 46 0 1 0 1 1 1 1 1 1 0 1 1 1	1 1 0 0 1 0 1 0 0

Note

In the first test case, the sequence a is equal to

$$[\underline{1}, 1, 1, 0, 0, 1, 1, 1, 1, 1, \ldots]$$

where $l = 1$, and $r = 1$. The sum of elements in the range $[1, 1]$ is equal to

$$a_1 = 1.$$

In the second test case, the sequence a is equal to

$$[1, 0, \underline{1}, 1, 1, 0, 0, 1, 1, 0, \ldots]$$

where $l = 3$, and $r = 3$. The sum of elements in the range $[3, 3]$ is equal to

$$a_3 = 1.$$

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D2. Infinite Sequence (Hard Version)

```
Input file:     standard input
Output file:    standard output
Time limit:     2 seconds
Memory limit:   256 megabytes
```

This is the hard version of the problem. The difference between the versions is that in this version, $l \le r$. You can hack only if you solved all versions of this problem.

You are given a positive integer n and the first n terms of an infinite binary sequence a, which is defined as follows:

- For $m > n$, $a_m = a_1 \oplus a_2 \oplus \ldots \oplus a_{\lfloor \frac{m}{2} \rfloor}$*.

Your task is to compute the sum of elements in a given range $[l, r]$: $a_l + a_{l+1} + \ldots + a_r$.

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* $\oplus$ denotes the bitwise XOR operation.

Input

Each test contains multiple test cases. The first line contains the number of test cases t ($1 \le t \le 10^4$). The description of the test cases follows.

The first line of each test case contains three integers n, l, and r ($1 \le n \le 2 \cdot 10^5$, $1 \le l \le r \le 10^{18}$).

The second line contains n integers $a_1, a_2, \ldots, a_n$ ($a_i \in \{0, 1\}$) — the first n terms of the sequence a.

It is guaranteed that the sum of n over all test cases does not exceed $2 \cdot 10^5$.

Output

For each test case, output a single integer — the sum of elements in the given range.

Standard Input	Standard Output

9 1 1 1 1 2 3 10 1 0 3 5 25 1 1 1 1 234 567 0 5 1111 10000000000 1 0 1 0 1 1 1000000000000000000 1000000000000000000 1 10 41 87 0 1 1 1 1 1 1 1 0 0 12 65 69 1 0 0 0 0 1 0 1 0 1 1 0 13 46 54 0 1 0 1 1 1 1 1 1 0 1 1 1	1 5 14 0 6666665925 0 32 3 2

Note

In the first test case, the sequence a is equal to

$$[\underline{1}, 1, 1, 0, 0, 1, 1, 1, 1, 1, \ldots]$$

where $l = 1$, and $r = 1$. The sum of elements in the range $[1, 1]$ is equal to

$$a_1 = 1.$$

In the second test case, the sequence a is equal to

$$[1, 0, \underline{1, 1, 1, 0, 0, 1, 1, 0}, \ldots]$$

where $l = 3$, and $r = 10$. The sum of elements in the range $[3, 10]$ is equal to

$$a_3 + a_4 + \ldots + a_{10} = 1 + 1 + 1 + 0 + 0 + 1 + 1 + 0 = 5.$$

E. LeaFall

Input file: standard input
Output file: standard output
Time limit: 3 seconds
Memory limit: 512 megabytes

You are given a tree* with n vertices. Over time, each vertex i ($1 \le i \le n$) has a probability of $\frac{p_i}{q_i}$ of falling. Determine the expected value of the number of unordered pairs† of **distinct** vertices that become leaves‡ in the resulting forest§, modulo $998\,244\,353$.

Note that when vertex v falls, it is removed along with all edges connected to it. However, adjacent vertices remain unaffected by the fall of v.

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*A tree is a connected graph without cycles.

†An unordered pair is a collection of two elements where the order in which the elements appear does not matter. For example, the unordered pair $(1, 2)$ is considered the same as $(2, 1)$.

‡A leaf is a vertex that is connected to exactly one edge.

§A forest is a graph without cycles

Input

Each test contains multiple test cases. The first line contains the number of test cases t ($1 \le t \le 10^4$). The description of the test cases follows.

The first line of each test case contains a single integer n ($1 \le n \le 10^5$).

The i-th line of the following n lines contains two integers p_i and q_i ($1 \le p_i < q_i < 998\,244\,353$).

Each of the following $n-1$ lines contains two integers u and v ($1 \le u, v \le n$, $u \ne v$) — the indices of the vertices connected by an edge.

It is guaranteed that the given edges form a tree.

It is guaranteed that the sum of n over all test cases does not exceed 10^5.

Output

For each test case, output a single integer — the expected value of the number of unordered pairs of distinct vertices that become leaves in the resulting forest modulo $998\,244\,353$.

Formally, let $M = 998\,244\,353$. It can be shown that the exact answer can be expressed as an irreducible fraction $\frac{p}{q}$, where p and q are integers and $q \not\equiv 0 \pmod{M}$. Output the integer equal to $p \cdot q^{-1} \bmod M$. In other words, output such an integer x that $0 \le x < M$ and $x \cdot q \equiv p \pmod{M}$.

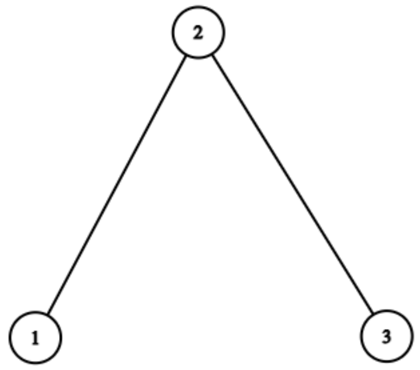
Standard Input	Standard Output
5 1 1 2 3 1 2 1 2 1 2	0 623902721 244015287 0 799215919

1 2 2 3 3 1 3 1 5 1 3 1 2 2 3 1 998244351 998244352 6 10 17 7 13 6 11 2 10 10 19 5 13 4 3 3 6 1 4 3 5 3 2	
1 10 282508078 551568452 894311255 989959022 893400641 913415297 460925436 801908985 94460427 171411253 997964895 998217862 770266391 885105593 591419316 976424827 606447024 863339056 940224886 994244553 9 5 9 6 9 8 8 7 3 6 1 5 7 4 8 10 4 2	486341067

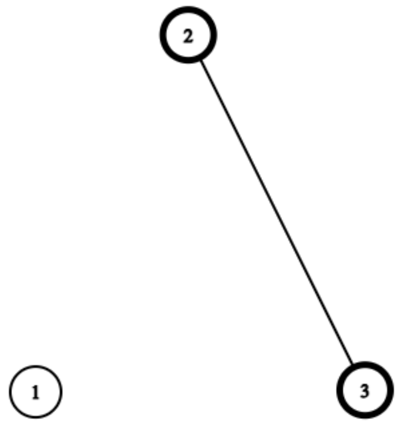
Note

In the first test case, only one vertex is in the tree, which is not a leaf, so the answer is 0.

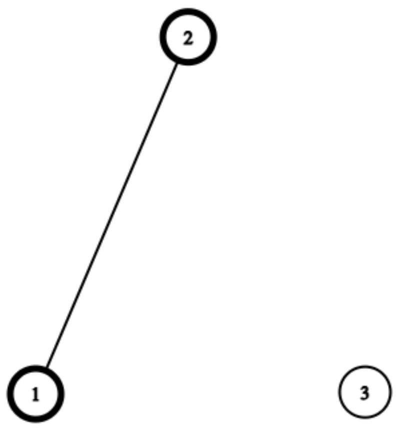
In the second test case, the tree is shown below.



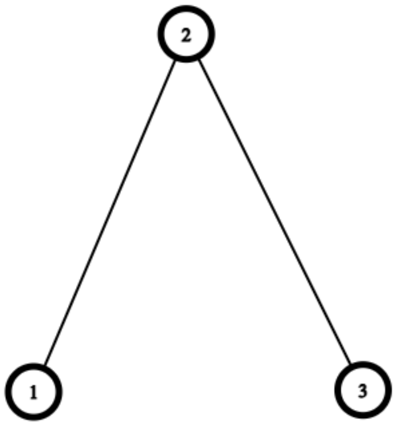
Vertices that have not fallen are denoted in bold. Let us examine the following three cases:



We arrive at this configuration with a probability of $\left(\frac{1}{2}\right)^3$, where the only unordered pair of distinct leaf vertices is $(2, 3)$.



We arrive at this configuration with a probability of $\left(\frac{1}{2}\right)^3$, where the only unordered pair of distinct leaf vertices is $(2, 1)$.



We arrive at this configuration with a probability of $\left(\frac{1}{2}\right)^3$, where the only unordered pair of distinct leaf vertices is $(1, 3)$. All remaining cases contain no unordered pairs of distinct leaf vertices. Hence, the answer is $\frac{1+1+1}{8} = \frac{3}{8}$, which is equal to $623\,902\,721$ modulo $998\,244\,353$.

F. Towering Arrays

Input file: standard input
Output file: standard output
Time limit: 6 seconds
Memory limit: 1024 megabytes

An array $b = [b_1, b_2, \ldots, b_m]$ of length m is called p-*towering* if there exists an index i ($1 \le i \le m$) such that for every index j ($1 \le j \le m$), the following condition holds:

$$b_j \ge p - |i - j|.$$

Given an array $a = [a_1, a_2, \ldots, a_n]$ of length n, you can remove at most k elements from it. Determine the maximum value of p for which the remaining array can be made p-*towering*.

Input

Each test contains multiple test cases. The first line contains the number of test cases t ($1 \le t \le 10^4$). The description of the test cases follows.

The first line of each test case contains two integers n and k ($0 \le k < n \le 2 \cdot 10^5$).

The second line contains n integers $a_1, a_2, \ldots, a_n$ ($1 \le a_i \le 10^9$).

It is guaranteed that the sum of n over all test cases does not exceed $2 \cdot 10^5$.

Output

For each test case, output a single integer — the maximum value of p for which the remaining array can be made p-*towering*.

Standard Input	Standard Output
6 5 0 2 1 4 5 2 5 3 2 1 4 5 2 6 1 1 2 3 4 5 1 11 6 6 3 8 5 8 3 2 1 2 7 1 14 3 3 2 3 5 5 2 6 7 4 8 10 1 8 9 2 0 1 1	3 5 5 7 9 1

Note

In the first test case, you cannot delete any element. The array remains $[2, 1, 4, 5, 2]$ and is p-*towering* for $p = 3$ by picking $i = 4$:

- $a_1 = 2 \ge p - |i - 1| = 3 - |4 - 1| = 0;$
- $a_2 = 1 \ge p - |i - 2| = 3 - |4 - 2| = 1;$
- $a_3 = 4 \ge p - |i - 3| = 3 - |4 - 3| = 2;$

- $a_4 = 5 \geq p - |i - 4| = 3 - |4 - 4| = 3$;
- $a_5 = 2 \geq p - |i - 5| = 3 - |4 - 5| = 2$.

In the second test case, you can remove the first, second, and fifth elements to obtain the array $[4, \color{red}{5}]$. Clearly, the obtained array is *p-towering* for $p = 5$ by picking $i = 2$.