Problem A. Mischievous Problem Setter

Input file: `standard input`
Output file: `standard output`

> Now, I want a nice fair game, all of you... Mount your brooms, please.
>
> *Harry Potter and the Philosopher's Stone*

Mr. Sheep is participating in a programming contest. Mr. Panda, the mischievous problem setter gives him some "hints" on the difficulty level of the problems. As problem solving time matters for contestants who solve the same number of problems, it's always wise to solve from easiest to hardest problems.

Unfortunately, one man's meat is another man's poison. People can have different opinions on the difficulty level of the problems. Especially for Mr. Panda, who always underestimates the difficulty level for hard problems, as all problems are considered easy for him...

There are N problems in the contest and the contest will last for M minutes. The i^{th} problem has an estimated difficulty D_i by Mr. Panda, and it costs Mr. Sheep T_i minutes to solve. Mr.Sheep always solves problems in increasing order of difficulty (i.e., from the easiest problem to the hardest problem estimated by Mr. Panda). How many problems will Mr. Sheep solve at the end of the contest?

Input

The first line of the input gives the number of test cases, T $(1 \leq T \leq 20)$. T test cases follow.

For each test case, the first line contains two integers N $(1 \leq N \leq 10^5)$ and M $(1 \leq M \leq 10^5)$, where N is the number of problems in the contest and M is the length of the contest in minutes.

The next line contains N **distinct** integers $D_1, D_2, \ldots, D_N$ $(1 \leq D_i \leq 10^5)$ representing the difficulty levels estimated by the problem setter.

The following line contains N integers $T_1, T_2, \ldots, T_N$ $(1 \leq T_i \leq 10^5)$ representing the actual time (in minutes) it costs for Mr. Sheep to solve the problems.

Output

For each test case, output one line containing "`Case x: y`", where `x` is the test case number (starting from 1) and `y` is the number of problems solved by Mr. Sheep after the contest ends.

Example

standard input	standard output
2 5 120 5 10 20 35 100 10 20 35 100 100000 13 300 52 55 82 11 62 79 38 8 58 28 1 70 32 27 62 45 77 22 69 34 43 21 43 85 22 36	Case 1: 3 Case 2: 5

Problem B. Balance of the Force

Input file: `standard input`
Output file: `standard output`

A long time ago in a galaxy far, far away, there was a group of knights who mastered the ancient power - the Force. To bring order and balance to the universe, the Force is divided into two categories that conflict with each other: the Jedi, who acts on the light side of the Force through non-attachment and arbitration, and the Sith, who uses the dark side through fear and aggression.

There were N knights who mastered the Force. Each knight could join either the light side or the dark side. When joining the light side, the knight possesses L_i Force; when joining the dark side, the knight possesses D_i Force.

To maintain order and balance of the universe, the knights wanted to make the Force difference between the most powerful knight and the weakest knight as small as possible. To make things even tougher, some knights did not get along well, and they refused to join on the same side.

Input

The first line of the input gives the number of test cases, T $(1 \le T \le 20)$. T test cases follow.

For each test case, the first line contains two integers N $(1 \le N \le 2 \times 10^5)$ and M $(0 \le M \le 2 \times 10^5)$, where N is the number of knights and M is the number of knight pairs that didn't get along well.

The next M lines each contains two integers x and y $(1 \le x \ne y \le N)$, describing knight x and knight y didn't get along well.

The following N lines each contains two integers, L_i and D_i $(1 \le L_i, D_i \le 10^9)$, representing the Force when the knight joined the light side and the dark side.

Output

For each test case, output one line containing "`Case x: y`", where `x` is the test case number (starting from 1) and `y` is the minimum difference between the strongest knight and weakest knight, or "IMPOSSIBLE" (quotes for clarify) if it's impossible for the knights to pick side without violating the given constraints.

Example

standard input	standard output
3 3 1 1 2 1 2 3 4 5 6 4 3 1 2 2 3 1 3 1 2 3 4 5 6 7 8 2 0 2 1 3 5	Case 1: 3 Case 2: IMPOSSIBLE Case 3: 1

Note

For the case 1, let knight 1 join the dark side then let knight 2 and 3 join the light side, the power of each knight are 2, 3 and 5, and the answer should be $5 - 2 = 3$.

For the case 3, let both knights join the light side, the answer becomes $3 - 2 = 1$.

Problem C. GCD Land

Input file: `standard input`
Output file: `standard output`

GCD land consists of N cities initially labeled from 1 to N. Two cities are connected by a highway if GCD (greatest common divisor) of their labels is greater than 1. For example, initially city 4 is connected with city 6, and there is no direct highway between city 4 and city 7.

As the president of GCD land, Mr. Panda doesn't want his nation to be divided into disconnected pieces. Mr. Ang, the wise prime minister of the nation, suggests to increase the label of each city by a non-negative magic number X, such that after reconnecting the highways according to cities' new labels, the whole nation is connected. For example, if Mr. Panda increases all cities' labels by 8, city 4 will be connected with both city 6 and city 7, because $\gcd(12, 14) > 1$ and $\gcd(12, 15) > 1$.

Can you help Mr. Panda find the magic number X when it should be lower than 10^N? If no such X exists, output -1 instead.

Input

The first line of input gives the number of test cases T $(1 \le T \le 20)$. T test cases follow. Each test case contains one integer N $(1 \le N \le 10^5)$, the number of cities in GCD land. For at least 75% test cases, it is guaranteed that $N \le 5 \times 10^4$.

Output

For each test case, output one line containing "`Case x: y`", where `x` is the test case number (starting from 1), `y` is the non-negative magic number if the solution exists, otherwise output -1 instead. Any valid solution will be accepted.

Example

standard input	standard output
2 6 30	Case 1: -1 Case 2: 151060

Problem D. Cube

Input file: `standard input`
Output file: `standard output`

Mr. Panda and his friends are trapped in a maze of N rooms. Rooms are connected by bidirectional doors and the maze happens to be a tree (i.e. there is no cycle of rooms in the maze). Each room has an assigned value v_i to it.

With some exploration inside the maze, Mr. Panda find out that a room can only be entered at most twice. After a room has been entered twice, the room's deadly trap will be activated and it's no longer safe to enter that room. Note that the room where Mr. Panda starts the exploration is considered being entered once at the beginning.

Mr. Panda and his friends are initially at room S. As they have no clue on how to escape the maze, they decide to move randomly. At each step, they pick the next room with equal probability among all adjacent rooms that are still safe. They keep moving from room to room until they are stuck at some room, i.e. there is no safe next room from the that room.

As an algorithm geek, Mr. Panda wonders what's the expected value of the last room.

Input

The first line of the input gives the number of test cases, T $(1 \le T \le 10)$. T test cases follow.

For each test case, the first line contains an integers N $(1 \le N \le 10^5)$ representing the number of rooms. The next line contains N integers $v_1, v_2, \ldots, v_N$ $(0 \le v_i \le 1000)$ representing the assigned value for each room.

The next $N-1$ lines each contains two integers x and y $(1 \le x, y \le N)$, describing the edges of the maze.

The last line contain an integer S $(1 \le S \le N)$ representing the initial room number.

Output

For each test case, output one line containing "`Case x: y`", where `x` is the test case number (starting from 1) and `y` is the expected value of the last room. The expected value `y` can be written as a reduced fraction p/q. You need to output a single integer $p \cdot q^{-1} \mod (10^9 + 7)$.

Example

standard input	standard output
2 2 5 8 1 2 1 4 1 2 3 4 1 2 2 3 2 4 2	Case 1: 8 Case 2: 666666674

Problem E. Mr. Panda and Cactus

Input file:	`standard input`
Output file:	`standard output`

Mr. Panda is exploring in a desert. He finds that there are many cactuses growing in the oasis in the center of the desert. The scenery inspires him to come up with a cactus problem.

As we know, a cactus is a connected undirected graph with each edge belonging to at most one simple cycle. Given a weighted graph with each connected component being a cactus with no self loops, you are requested to color each vertex with one of the given K colors. Each color is required to be used at least once.

Mr. Panda wants to minimize the sum of weight of edges which connects vertices of different color. Could you help him?

Input

The first line of the input gives the number of test cases, T ($1 \le T \le 100$). T test cases follow.

For each test case, the first line contains three integers N, M and K ($1 \le N \le 10^5$, $0 \le M \le 2 \times 10^5$, $1 \le K \le \min\{N, 1000\}$), where N is the number of vertices, M is the number of edges, and K is the number of colors. We ensure the sum of N in all cases is not greater than 5×10^5.

The following M lines describe the edges between the vertices. Each line contains 3 integers x, y, w ($1 \le x \ne y \le N$, $1 \le w \le 10^9$), representing an edge with weight w between vertex x and vertex y.

Output

For each test case, output one line containing "`Case x: y`" first, where `x` is the test case number (starting from 1) and `y` is the minimum sum of weight of edges which connects vertices of different color.

Then output a line consists of N integers, the i^{th} integer is the color of i^{th} vertex, any valid way is acceptable. Make sure each color is used at least once.

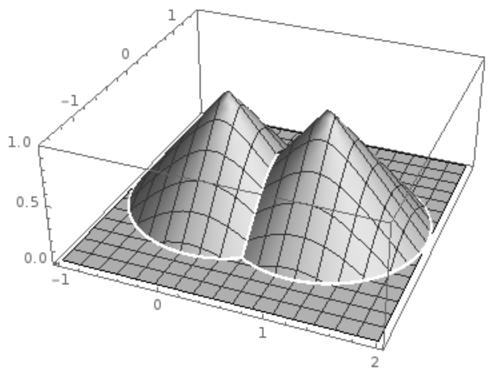
Example

<table>
<tr><th>standard input</th><th>standard output</th></tr>
<tr><td><pre>3
4 3 2
1 2 5
2 3 4
2 4 7
3 3 3
1 2 100
2 3 10
3 1 4
4 5 3
2 3 7
3 4 3
4 2 5
1 3 6
3 1 5</pre></td><td><pre>Case 1: 4
1 1 2 1
Case 2: 114
1 2 3
Case 3: 15
1 2 1 3</pre></td></tr>
</table>

Problem F. Cones

Input file:	`standard input`
Output file:	`standard output`

Here is a simple geometry problem: calculate the volume of union of identical cones. These cones are located on the $z = 0$ plane. A cone at $(x_0, y_0, 0)$ is defined as $\{(x, y, z) \mid 0 \le z \le 1 - \sqrt{(x - x_0)^2 + (y - y_0)^2}\}$. Given the locations of cones, (x_k, y_k), calculate the volume of the union of these cones.



Input

The first line of the input gives the number of test cases, T $(1 \le T \le 100)$. T test cases follow.

Each case starts with a line of a single integer N $(1 \le N \le 1000)$, indicating the number of cones, then N lines follow. Each line contains two real numbers x_k and y_k with 4 digits after decimal point indicating the location of the k^{th} cone, where $-20.0 \le x_k, y_k \le 20.0$, and no two points will be coincided.

For at least 90% test cases, it is guaranteed that $N \le 300$.

Output

For each test case, output one line containing "`Case x: y`", where `x` is the test case number (starting from 1) and `y` is the volume of the union of the cones. Your answer will be considered correct if it is within an absolute or relative error of 10^{-6} of the correct answer.

Example

standard input	standard output
4 1 0.0000 0.0000 2 0.0000 0.0000 1.0000 0.0000 3 -4.1850 0.8550 3.8150 4.0400 2.1300 -2.6700 5 5.6422 7.8467 -5.7704 9.1233 -1.2843 5.2843 3.8242 -2.2140 -4.6870 1.8571	Case 1: 1.047197551196598 Case 2: 1.863867179374688 Case 3: 3.141592653589793 Case 4: 5.235987755982988

Problem G. Pastoral Life in Stardew Valley

Input file: `standard input`
Output file: `standard output`

Mr. Panda and Mrs. Panda is bored of the hustle and bustle of city life. They decide to make a change. They drop everything they belong to and move to a place where they can find real connections with people and nature. Here in Stardew Valley, they start their life as farmers. They are now embarking on tasks of reclaiming wastelands, sowing seeds, and planting trees.

They are now looking for a rectangle area from the reclaimed wasteland to cultivate their first crop. To prevent crops being damaged by annoying crows, they place several scarecrows **inside** this rectangle area. The scarecrows occupy a rectangle area that is **surrounded** by the crops. The wasteland is of N rows and M columns. They wonder how many different ways to pick a rectangle area and place crops and scarecrows inside the rectangle. As the number can be large, return the answer modulo $10^9 + 7$.

Input

The first line of input gives the number of test cases $T (1 \le T \le 10^5)$. T test cases follow. Each test case starts with a line consisting of two integers N, M $(1 \le N, M \le 10^5)$, the number of rows and columns of the wasteland.

Output

For each test case, output one line containing "`Case x: y`", where `x` is the test case number (starting from 1) and `y` is the number of different ways to place the crops and scarecrows, modulo $10^9 + 7$.

Example

standard input	standard output
3 2 3 3 3 4 4	Case 1: 0 Case 2: 1 Case 3: 25

Note

For test case 1, the wasteland is too small to place any scarecrows.

For test case 2, 3×3 is the minimal rectangle to place one scarecrow surrounded by 8 crops.

For test case 3, a 4×4 rectangle has 9 ways to place crops and scarecrows: 4 ways for 1×1 scarecrow, 2 ways for 1×2 scarecrows, 2 ways for 2×1 scarecrows, and 1 way for 2×2 scarecrows. Similarly, two 3×4 rectangles has $2 \times 3 = 6$ ways; two 4×3 rectangles has $2 \times 3 = 6$ ways, four 3×3 rectangles has $4 \times 1 = 4$ ways. In total, $9 + 6 + 6 + 4 = 25$ ways.

Problem H. Game on the Tree

Input file: `standard input`
Output file: `standard output`

Mr. Panda and Mr. Sheep are playing a game on a **connected** undirected graph with N vertices and N edges. Initially, Mr. Panda and Mr. Sheep stand on two distinct vertices A and B of the graph. The game plays in turns with Mr. Panda plays first. Each turn, a player can either stay where he/she is or move to an adjacent vertex. Mr. Panda can only move to vertices that are not visited by Mr. Sheep.

Some vertices are marked as destinations. The game ends when Mr. Panda reaches any destination vertex and Mr. Panda wins.

Please help Mr. Panda to answer whether he can win the game, assuming both players play optimally.

Input

The first line of the input gives the number of test cases, T $(1 \le T \le 20)$. T test cases follow.

Each test case contains one integer, N $(1 \le N \le 2 \times 10^5)$, where N is the number of vertices and edges of the graph.

The following N lines each contains two integers x and y $(1 \le x \ne y \le N)$, indicating there is an edge between vertex x and vertex y.

The following line contains an integer M $(1 \le M \le N)$, the number of destinations, followed by a line containing M distinct integers: $v_1, v_2, \ldots, v_M$ $(1 \le v_i \le N)$.

The last line contains two integers A and B $(1 \le A \ne B \le N)$, where A is the starting vertex of Mr. Panda and B is the starting vertex of Mr. Sheep.

Output

For each test case, output "`Case x:`" first, where `x` is the test case number (starting from 1). If Mr. Panda can win the game, output "Panda"; otherwise (draw or lose) output "Sheep".

Example

standard input	standard output
2 5 1 2 2 3 3 4 4 5 5 2 1 3 1 5 5 1 2 2 3 3 4 4 5 5 3 1 3 1 5	Case 1: Panda Case 2: Sheep

Problem I. Cockroaches

Input file: `standard input`
Output file: `standard output`

There are N cockroaches in the field. Cockroach i is located at coordinate (x_i, y_i). No two cockroaches are located at the same spot. Boss Luo has a powerful pesticide that can instantly kill all cockroaches on the horizontal and vertical line of the spot where it is used. i.e. cockroaches with either the same `x` coordinate or `y` coordinate as the pesticide spot will be killed.

Boss Luo wonders how many cockroaches can be killed at most when the pesticide is used in one spot. He is also interested in the number of different subsets of the annihilated cockroaches when the pesticide kills most cockroaches.

Input

The first line of the input gives the number of test cases, T $(1 \leq T \leq 100)$. T test cases follow.

For each test case, the first line contains an integers N $(1 \leq N \leq 10^5)$, the number of cockroaches.

The next N lines each contains two integers x and y $(1 \leq x, y \leq 10^9)$, describing the coordinates of the cockroaches.

For at least 80 test cases, it is guaranteed that $N \leq 5\,000$.

Output

For each test case, output one line containing "`Case x: y z`", where `x` is the test case number (starting from 1), `y` is the maximum number of cockroaches that can be killed with pesticide applied on one spot, and `z` is the number of different subsets of the annihilated cockroaches when the pesticide kills most cockroaches.

Example

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

Note

For test case 1, 3 cockroaches can be killed if the pesticide is used optimally. There are 5 possible subsets: $\{1, 2, 3\}, \{1, 2, 4\}, \{1, 2, 5\}, \{2, 3, 4\}, \{2, 3, 5\}$.

For test case 2, 2 cockroaches can be kill at best. All subsets with 2 cockroaches are possible: $\{1, 2\}, \{1, 3\}, \{2, 3\}$.

Problem J. Mr. Panda and Sequence Puzzle

Input file: `standard input`
Output file: `standard output`

Mr. Panda enjoys solving hard puzzles. On Mr. Panda's birthday, Mr. Sheep gives Mr. Panda a puzzle as a birthday gift.

In the puzzle, Mr. Panda is given a sequence consisting of positive integers. He can perform multiple operations to the sequence. An operation is defined as taking a prefix of the sequence and reversing it[1]. Mr. Panda must perform the operations in increasing order of the length of prefixes. To solve the puzzle, Mr. Panda needs to figure out the smallest sequence in lexicographical order[2] after the operations.

Mr. Sheep feels the puzzle is too easy for Mr. Panda. Thus, Mr. Sheep blacklists some prefixes of the sequence. Mr. Panda cannot reverse any blacklisted prefixes.

Even though it is Mr. Panda's birthday, he feels sad because he has no idea on how to solve this puzzle. Could you please help Mr. Panda solve this puzzle to make him happy?

Input

The first line of input gives the number of test cases T ($1 \le T \le 100$). T test cases follow.

Each test case starts with a line consisting of two integers N ($1 \le N \le 3 \times 10^5$), the length of Mr. Panda's sequence, and M ($0 \le M \le N$), the number of blacklisted prefixes. It is guaranteed that the sum of N is not greater than 5×10^6.

Then, a line consisting of N integers follows, the i^{th} integer A_i ($1 \le A_i \le 10^9$) indicates the i^{th} integer in Mr. Panda's sequence.

Finally, a line consisting of M distinct integers follows, the i^{th} number B_i ($1 \le B_i \le N$) indicates i^{th} length of the blacklisted prefixes.

Output

For each test case, output one line containing "`Case x: y`", where `x` is the test case number (starting from 1) and `y` is the hash code of smallest sequence that Mr. Panda can make separated by spaces.

Hash code of an integer sequence can be computed by using the following formula.

$$\texttt{HashCode}(s) = \left(\sum_{i=1}^{\texttt{len}(s)} 37^{i-1} s_i\right) \mod 20181125$$

For example,

$$\texttt{HashCode}([1,2,3]) = (1 + 2 \times 37 + 3 \times 37^2) \mod 20181125 = 4182$$

and

$$\texttt{HashCode}([1,2,3,456789]) = (1 + 2 \times 37 + 3 \times 37^2 + 456789 \times 37^3) \mod 20181125 = 10168149$$

Example

standard input	standard output
5 4 0 2 2 1 2 5 0 1 1 1 1 1 3 0 3 2 1 3 1 3 2 1 3 3 2 3 2 1 3 2	Case 1: 104119 Case 2: 1926221 Case 3: 4182 Case 4: 1482 Case 5: 1446

Note

1. For a sequence x_1, x_2, ..., x_n after reversing it, it becomes x_n, x_{n-1}, ..., x_1.

2. For two sequences x and y of the same length, x is lexicographically smaller than y if there exists such i, that $x_1 = y_1$, $x_2 = y_2$, ..., $x_{i-1} = y_{i-1}$, $x_i < y_i$.

Problem K. Mr. Panda and Kakin

Input file: `standard input`
Output file: `standard output`

Mr. Panda and Mr.Sheep want to hack into the system of a famous mobile game. They have already dumped the resource code as following and intercepted the encrypted message n and c outputted from this encryption pseudo code.

---

function GETKAKINENTRYPOINT(FLAG)
    $x \leftarrow$ a uniformly random integer in range $[10^5, 10^9]$
    $p \leftarrow$ the largest prime less than x
    $q \leftarrow$ the smallest prime not less than x
    $n \leftarrow p \cdot q$
    $c \leftarrow \text{FLAG}^{(2^{30}+3)} \bmod n$

The most important thing is the variable `FLAG`. If they get its value, they can get infinite magic stones as the common currency in this mobile game. So this is the reason they come to you, the master of cryptography. You need to help them to get the value of `FLAG`, to be more accurate, the remainder of dividing `FLAG` by n.

Input

The first line of the input gives the number of test cases, T $(1 \le T \le 10^5)$. T test cases follow.

Each test case contains two integer n and c $(10^{10} \le n \le 10^{18},\ 0 < c < n)$, indicating the output of the encrypting code. It is guaranteed that these numbers are valid and are suitable for only one value of `FLAG`.

Output

For each test case, output "`Case x: y`", where `x` is the test case number (starting from 1), and `y` is the value of `FLAG`.

Example

standard input	standard output
3 181857896263 167005790444 218128229323 156323229335 352308724847 218566715941	Case 1: 175267324024 Case 2: 209603568635 Case 3: 282077284785

Problem L. Ultra Weak Goldbach's Conjecture

Input file: `standard input`
Output file: `standard output`

In number theory, Goldbach's conjecture states that every even integer greater than 2 is the sum of two prime numbers. A weaker version of this conjecture states that every odd number greater than 5 is the sum of three prime numbers.

Here is an ultra weak version of Goldbach's conjecture: every integer greater than 11 is the sum of **six** prime numbers. Can you help to verify or disprove this conjecture?

Input

The first line of the input gives the number of test cases, T ($1 \le T \le 200$). T test cases follow.

Each test case contains one integer N ($1 \le N \le 10^{12}$).

Output

For each test case, output "`Case x:`" first, where `x` is the test case number (starting from 1). If the solution exist, output six prime numbers separated by spaces; otherwise output "IMPOSSIBLE" (quotes for clarity) when the solution does not exist. When the solution exists, any valid solution is acceptable.

Example

standard input	standard output
5 6 13 200 570 680	Case 1: IMPOSSIBLE Case 2: 2 2 2 2 2 3 Case 3: 43 29 31 29 31 37 Case 4: 97 101 103 107 101 61 Case 5: 137 137 107 113 89 97