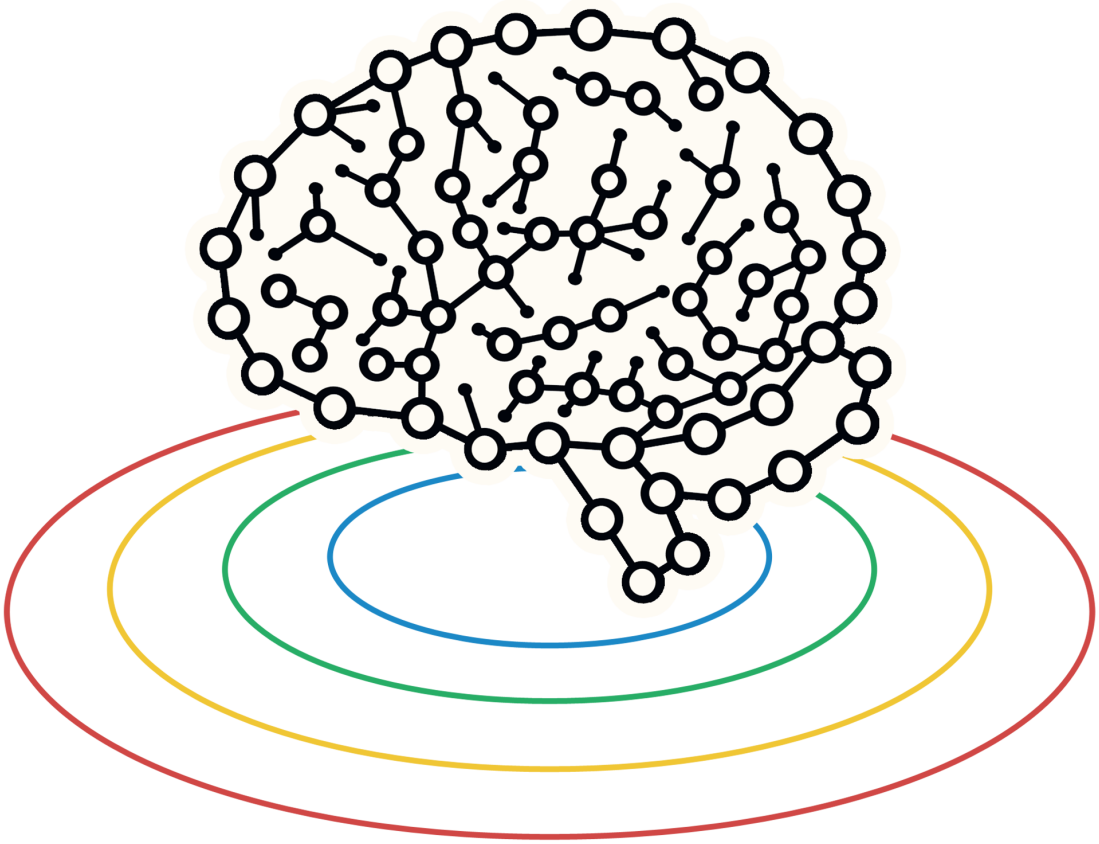
Association for Computing Machinery
University of the Philippines Diliman Student Chapter, Inc.



ALGOLYMPICS 2019

CONTEST PROBLEMS

February 23, 2019
UP Alumni Engineers Centennial Hall

Contents

Notes

Very important! Please read the following:

- Your solution will be checked by running it against several hidden test cases. You will not have access to these cases, but a correct solution is expected to handle them correctly.
- The output grader is **very strict**. Strictly follow these guidelines:
  - It is **space sensitive**. Do not output extra leading or trailing spaces. Do not output extra blank lines unless explicitly stated.
  - It is **case sensitive**. So, for example, if the problem asks for the output in lowercase, follow it.
  - Do not print any tabs. (No tabs will be required in the output.)
  - Do not output anything else aside from what's asked for in the Output section. So, no printing of "Please input n" or something.
  - Not following the output format strictly and exactly may result in a **Wrong answer** verdict.
- Many problems have large input file sizes, so we suggest using fast I/O.
  - In Java, we suggest using BufferedReader and PrintWriter.
  - In C/C++, we suggest using scanf and printf.
  - It is recommended to learn and test these functions during the Practice Session.
- Good luck and have fun!

Problem A

Quantum Superposition and the Copenhagen Interpretation

Time Limit: 2 seconds

Quantum mechanics has brought surprise and frustration among physicists. One moment, you thought you knew everything there is to know about the world, and the next thing you know someone tells you it is possible that a cat can both be dead and alive at the same time.

Let's explore a variation of the Schrödinger's cat experiment. We place a cat inside a box, and inside is a mechanism that releases a substance at certain times. The substance is either a poison or an antidote. (This is a mind experiment — no animals were harmed in the making of this problem).

The experiment goes like this: the cat is placed in the box with a "poison value", p, initially 0. At time i, a substance is released. If poison was released, then p increases by a_i. On the other hand, if the antidote was released instead, then p decreases by a_i. The value of p can even be negative, meaning the cat has stored some of the antidote. This happens from time 1 to n, after which the experiment is concluded. The box is then opened, and p is recorded.

However, if we don't open the box, then the state of the cat is the combination of all possible states at the same time! Let s be the sum of all p taken from all possible distinct outputs of the mechanism. Your task is to find s.

Input

The first line of input contains a single integer n. The second line contains n space-separated integers $a_1, \ldots, a_n$.

Output

Output a single line containing a single integer s denoting the answer.

Constraints

$1 \leq n \leq 20$
$1 \leq a_i \leq 10^7$

Sample Input	Sample Output
2 1 2	0

Problem B

ABCD Paths

Time Limit: 6 seconds

Alice is playing a game she made herself. There are n squares arranged in a playing field numbered 1 to n, and there are a unidirectional arrows, each connecting one square to another. Each arrow is given a corresponding letter. You play the game by starting at any square. You can then follow an arrow to another square while saying the corresponding corresponding letter. You can repeat this as many times as you can, but the rule is that **the sequence of letters followed must be alphabetically nondecreasing**. The goal is to see who can play the game the longest.

Bob wants to compete with Alice, so Alice needs to know how far the game can be played by following the rules. As a friend of Bob, your task is to output the longest sequence of moves that can be played. If the game can be played indefinitely, output `INFINITE` instead.

Input

The first line of input contains a single integer t denoting the number of test cases.

The first line of each test case contains two space-separated integers n and a denoting the number of squares and the number of arrows, respectively. The next a lines describe the arrows. Each of them contains three space-separated tokens, x, y, c, where x and y are integers and c is a letter, describing an arrow that goes from square x to square y and with a corresponding letter c.

Output

For each test case, output a single line containing the longest nondecreasing string that can be created. If there are multiple of them, output the lexicographically smallest one. If the game can be played indefinitely, output `INFINITE` instead.

Constraints

$1 \leq t \leq 2$
$1 \leq n, a \leq 2 \cdot 10^5$
$1 \leq x, y \leq n$
c is an uppercase letter.
$x \neq y$
There may be multiple arrows connecting the same pair of squares.

Sample Input	Sample Output
2 5 7 2 3 B 3 1 E 1 2 A 1 2 R 2 4 D 3 5 E 4 3 D 3 3 1 3 N 1 2 U 3 1 N	ADDER INFINITE

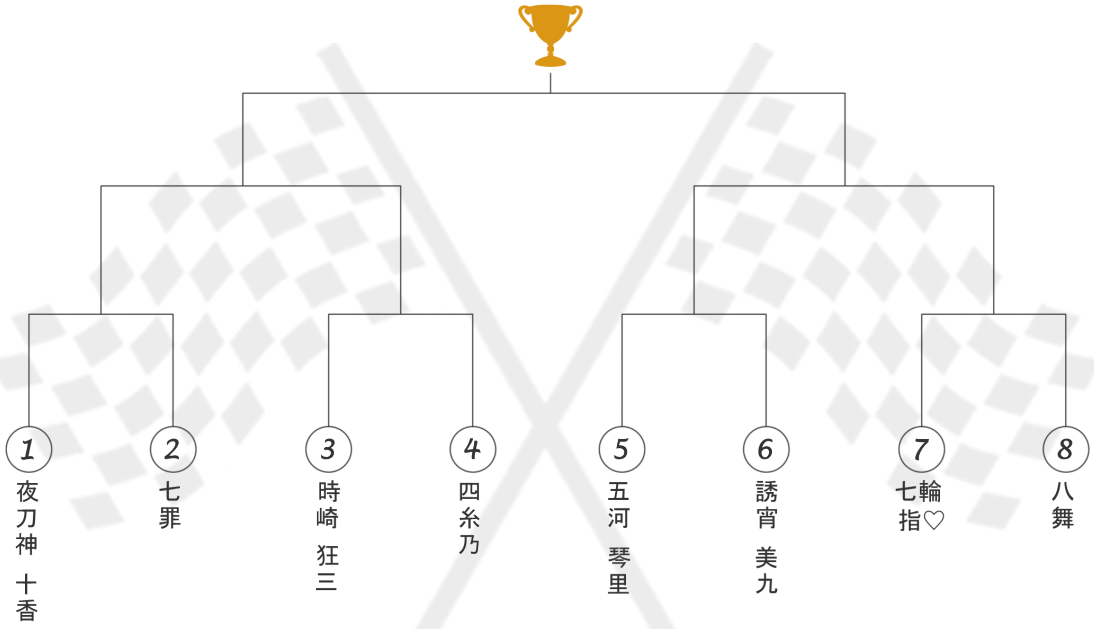
Problem C

Best Grill Contest

Time Limit: 2 seconds

In the forum based social media website Revvit, there exists a community whose members love everything to do with barbecuing. At this time of the year, the users of the barbecuing subrevvit have gathered to determine the One True Best Grill in their annual Best Grill Contest. In this contest you will find people making impassioned speeches about why their preferred grill is superior to all other grills.

This contest has a peculiar format. The contest runs for n rounds with 2^n grills numbered 1 to 2^n from left to right. For example, for $n = 3$, we have:

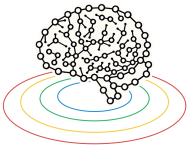


In the first round, grills will be grouped into pairs such that grill 1 is paired with grill 2, grill 3 is paired with grill 4, grill 5 is paired with grill 6, so on. Grill i receives v_i votes in the first round.

During each round, for each pair, we eliminate the grill that recieved the least votes. In the following round, the remaining grills will be paired up in a similar fashion to the first round. We describe the voting behavior of the consecutive rounds as follows. Let's say that grill A went up against grill B in the previous round, and won. For the current round, grill A is facing grill C. The supporters of grill A in the previous round will vote for grill A again. However, the supporters of grill B, out of spite, will vote for grill C.

In the case of a tie, a fair coin toss determines the winner. We repeat this process until only one grill remains. This grill will be crowned as this year's One True Best Grill.

You, being a big fan of grills, want to see your favourite grill win. To make sure of it, you invite your friends to help boost your favourite grill's votes. Let a_i be the number of additional votes needed to *ensure* that grill i is crowned the winner.



You're still undecided as to which grill is your One True Best Grill, so you want to find a_i for all grills from 1 to 2^n.

Input

The first line of input contains a single integer n. The second line of input contains n space-separated integers $v_1, v_2, \ldots, v_{2^n}$.

Output

Output one line containing 2^n space-separated integers $a_1, \ldots, a_{2^n}$.

Constraints

$1 \leq n \leq 18$
$0 \leq v_i \leq 10^9$

Sample Input	Sample Output
2 6 9 4 2	6 0 2 6

Problem D

Extraordinary Machine

Time Limit: 5 seconds

You've found a blueprint of an extraordinary machine! This machine is composed of n gears labeled 1 to n. According to the blueprint, the ith gear has radius r_i and radial speed s_i.

There are a total of e pairs of gears that are connected to each other. If gear i is connected to gear j, then their relative speeds are defined by the formula $r_i s_i = r_j s_j$.

However, the blueprint being extraordinarily *ancient*, the actual radii and radial speeds of the gears are written in an unknown numerical system. The only thing you can decipher is, for each connection, either their relative radii or their relative speeds, but not both. In other words, for every connected pair (i, j) you are given exactly one of the following:

- r_i / r_j
- s_i / s_j

Your task is to confirm if such an extraordinary machine can truly exist. In other words, you must confirm whether there exists an assignment of positive real numbers for all values r_i and s_i such that the constraints of all connections are satisfied.

Input

The first line of input contains a single integer T denoting the number of test cases.

The first line of each test case contains two space-separated integers n, e. Each of the next e lines describes a connection and contains five space-separated tokens i, j, t, u, v:

- i and j are integers denoting gear labels.
- t is an uppercase letter which is either `R` or `S`.
- u/v is the ratio (u and v are integers).
  - If t is `R`, then this represents r_i / r_j.
  - If t is `S`, then this represents s_i / s_j.

Output

For each test case, output a single line containing either `REAL` if it is possible or `MYTH` if it is impossible.

Constraints

$1 \leq T \leq 10^4$
$1 \leq n \leq 10^5$
$1 \leq e \leq 2 \cdot 10^5$
The sum of the ns in a single file is $\leq 10^5$
The sum of the es in a single file is $\leq 2 \cdot 10^5$

$1 \leq i, j \leq n$
$i \neq j$
Each unordered pair $\{i, j\}$ appears at most once.
For every given ratio u/v, $1 \leq u, v \leq 10^9$

Sample Input	Sample Output
2 3 3 1 2 R 9 6 2 3 R 8 6 1 3 S 3 6 3 3 1 2 R 3 3 2 3 R 3 4 1 3 S 3 3	REAL MYTH

Problem E

NCIS 2 Experts 1 Keyboard

Time Limit: 4 seconds

Hackers have launched a DDoS attack against the servers of the Superior Academic Information System (SAIS). Hopeless against this, the University of Prerogia, the (undisputed) top university in Prerogia, has contracted your agency, the National agency for Cyber- and Information Security (NCIS), to help them survive this *clearly* malicious attack. Because of your established reputation in handling these kinds of requests, the agency has decided to send you and your partner to handle this.

You and your partner are famous for working together with only a single keyboard, since you can't afford more. Upon investigating, you and your partner find that the servers are setup in a peculiar manner. There are n servers in the network, numbered 1 to n, in which c pairs of them are directly connected to each other. They are connected in such a manner that for any two servers x and y, there is *exactly one* path of servers that connects them, i.e., there is exactly one sequence of servers such that

- it begins at server x,
- it ends at server y,
- consecutive pairs of servers are directly connected, and
- no server appears twice.

When a server receives a request from the outside world, it forwards the request to all other servers it is directly connected to, and those servers similarly forward it to their neighbors, excluding the server that sent the request and those that have already received the request previously. (Since the servers are connected, all servers will eventually receive the request.)

The university's IT staff tell you that the hackers only target a single server at any given time. The hackers change the targeted server every few minutes, probably to keep system administrators on their toes. The university staff tried simply disabling the targeted server (by just unplugging the power cord), but that caused a system outage in one campus which resulted in *unfavorable reactions*. Clearly, blindly disabling servers is not a good idea.

You thus decide to assign a **danger value** v_k to each server k. You then define the **danger index** d_k of each server k as follows. For each path in the network that includes server k, find the maximum danger value in the path. Once you have done this, the danger index d_k is the sum of those maximum danger values.

Your challenge now is to find the danger index of whatever server is being targeted in real time. You must do this for the next a attacks.

Input

The first line of input contains a single integer t denoting the number of test cases.

The first line of each test case contains three space-separated integers n, c, and a.

The second line contains n space-separated integers $v_1, \ldots, v_n$.

The third line contains a space-separated integers $k_1, \ldots, k_a$, where k_i denotes the server that is targeted in the ith attack.

The next c lines descibe the pairs of servers that are directly connected. The ith one contains two space-separated integers x_i, y_i denoting a direct connection between servers x_i and y_i.

Output

For each test case, output a single line containing a single integer, defined as the following sum *modulo* 998244353:

$$\sum_{i=1}^{a} i \cdot d_{k_i}^2 = 1 \cdot d_{k_1}^2 + 2 \cdot d_{k_2}^2 + \ldots + a \cdot d_{k_a}^2.$$

Constraints

$1 \leq t \leq 3$
$1 \leq n, a, v_i \leq 10^5$
$0 \leq c \leq 2 \cdot 10^5$
$1 \leq x_i, y_i, k_i \leq n$
$x_i \neq y_i$
Each unordered pair $\{x_i, y_i\}$ appears at most once.

Sample Input	Sample Output
1 4 3 3 16 24 69 105 2 4 1 1 2 3 2 4 2	741189

Explanation

1. The danger index of server $k_1 = 2$ is $d_{k_1} = 501$.
2. The danger index of server $k_2 = 4$ is $d_{k_2} = 420$.
3. The danger index of server $k_3 = 1$ is $d_{k_3} = 214$.

Therefore, the output is

$$1 \cdot d_{k_1}^2 + 2 \cdot d_{k_2}^2 + 3 \cdot d_{k_3}^2 = 251001 + 352800 + 137388 = 741189$$

which is also 741189 modulo 998244353.

Problem F

Biko

Time Limit: 2 seconds

Francis is terribly homesick after having been working and living abroad in the strange country of Reciproca for a few years. It does not help that everything in this country seems so upside-down! People walk with their hands all the time, they put the doors of their homes in the roofs of their houses. Worst of all, they only eat something when it has split off in a specific way! Try as hard as he might, Francis cannot adapt to this, so he tries to keep a low profile. Francis' native co-workers give him weird looks, but they tolerate him and his upright ways because he is a foreigner.

Francis writes often about his problems to his lola, a wonderful woman who has taken care of Francis since his childhood. Understanding what he has been going through, his lola sends him boxes of his favorite sweet, Biko, to cheer him up. Francis is super happy, until he realizes his lola gave him too much - he can only eat so much Biko! In particular, Francis received a single box of Biko, but he can only eat p/q of the box ($p < q$). Thus he is left with some Biko leftover, and he's too full to eat.

Now, Francis came to you, a seasoned problem-solver, for help as he needs to give away the Biko left. But remember, all of his co-workers are Reciprocans! They might take it as an insult if Francis just gives them his Biko nonchalantly, so he needs to divide it in the traditional Reciprocan way. The Reciprocan way of dividing food to eat is by making sure that all pieces are unit fractions of the whole box, that is of the form $1/x$ boxes, where x is an integer. He asked you for a way to divide his remaining Biko in a way that will appease his Reciprocan co-workers.

He has limits though: he doesn't have the sharpest knives, so he wants you to limit the number of pieces to a reasonable amount (at most 100000), and not too tiny (pieces must be larger than or equal to $1/100000$ of the box). Of course, he also wants to impress his co-workers, so he wants you to make sure that there are at most 120 pieces of any given size, to show that he has a unique side to him too. Try to help Francis share his Biko!

Input

The first line of input contains a single integer t denoting the number of test cases.

Each test case consists of a single line containing two space-separated integers p and q. /

Output

For each test case, output a single line containing either:

- `CAN DO IT` if it is possible to do the task mentioned in the statement, or
- `CANNOT DO IT` if it is impossible.

In addition, if it is possible, output two more lines. The first line must contain a single integer k denoting the number of pieces Francis should cut the remaining Biko into. The second line

must contain k space-separated integers $x_1, x_2, \ldots, x_k$, where $1/x_i$ denotes the size of the ith portion.

There may be multiple possible valid ways to divide the remaining biko; any one will be accepted.

Constraints

$1 \leq t \leq 30$
$1 \leq p < q \leq 600$

Sample Input	Sample Output
1 7 12	CAN DO IT 3 8 6 8

Explanation

The sole sample input has $p = 7$ and $q = 12$.

The sample output says that he should cut the remaining Biko into $k = 3$ pieces, each with sizes $1/8$, $1/6$ and $1/8$ (of the original whole). You may verify that, all in all, they add up exactly to the remaining portion of the Biko.

Problem G

Frozen

Time Limit: 6 seconds

After finally accepting that her powers are not evil, Elsa has begun training to gain more control over her winter magic.

Although she cannot walk on liquid water, she can turn an area of water into ice by shooting magic from her hands. Since she can walk on ice, she can use this ability to be able to traverse bodies of water.

But this time it isn't that easy. She is trying to walk on water on a stormy night and the water is turbulent. The ice sheets were unstable, making her runs slower, so she must make the most stable ice sheets to step on. She is very bothered by this!

We can model the watery region in which Elsa is training on as an $r \times c$ grid, with r rows and c columns. The cell on the ith row and jth column will be denoted (i, j). Each cell is currently either:

- "#" denoting ice, or
- "~" denoting water.

Elsa performs a total of e actions. Each of her actions is one of three types, "#", "~" or "?", defined as follows:

- "# i j". Elsa turns cell (i, j) into ice.
- "~ i j". Elsa turns cell (i, j) into water.
- "? i_s j_s i_d j_d". Elsa attempts to walk from cell (i_s, j_s) to cell (i_d, j_d) without changing any cells along the way. It may or may not be possible for her to do this.

For each action of type `?`, determine if it is possible for Elsa to walk from cell (i_s, j_s) to cell (i_d, j_d) without changing any cells along the way.

Input

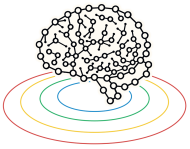
The first line of input contains three space-separated integers r, c and e.

The next r lines describe the grid. The ith of them contains a string of length c describing the ith row. Each character is either # (ice) or ~ (water).

The next e lines describe the actions in chronological order. Each of them is in one of the three forms described in the problem statement.

Output

For each `?` action, output one line containing either `LETITGO` (without spaces) if it is possible to reach (i_d, j_d) from (i_s, j_s), or `LETITSNOW` (without spaces) if it is impossible to do so.



Constraints

$1 \leq r \leq 10^5$
$1 \leq c \leq 10$
$1 \leq e \leq 40000$
$1 \leq i, i_s, i_d \leq r$
$1 \leq j, j_s, j_d \leq c$
For every ? action, cell (i_s, j_s) will contain ice.

Sample Input	Sample Output
9 10 11 ~#~~~~~#~~ ###~~~###~ ~#~~#~~#~~ ~~~~#~~~~~ ~~~~~~~~~~ #########~ ~~~~~#~~#~ ~~~~~~##~~ ~~~~~~~~~~ # 8 9 ? 6 7 8 7 # 8 6 ? 6 7 8 7 ~ 6 5 ? 6 1 6 6 ? 2 1 3 10 # 7 6 ~ 2 2 ~ 2 8 ? 1 2 3 2	LETITGO LETITGO LETITSNOW LETITSNOW LETITSNOW

Problem H

Pokémain

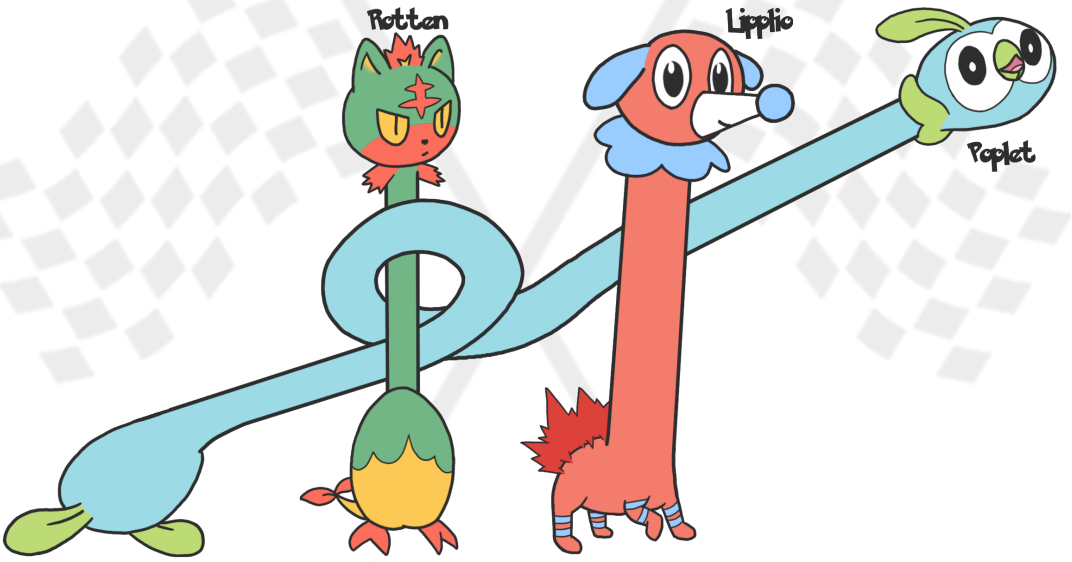
Time Limit: 2 seconds

Imane is a mainstream Twittuber, famous for livestreams of her doing LoL, that is, Laughing out Loud. She has a regular stream schedule; she streams every fourth night of the week.

Recently, Imane has decided to add a new game in her catalogue, Pokémain, now that new versions have been released: Pokémain Grow and Pokémain Glow.

Imane is currently in the Atita region, and she has the three Atita starter Pokémain types in her Pokébasket:

- *Poplet*, who can walk on water and grass (but not fire),
- *Lipplio*, who can walk on water and fire (but not grass), and
- *Rotten*, who can walk on grass and fire (but not water).



She now intends to grind until they all level up and evolve. To do so, she needs to train them in a region with the following requirements:

- The region is rectangular, with dimensions $r \times c$ (in terms of tiles), with $1 \leq r, c \leq 20$.
- Each tile must be one of five types:
  - "`S`" for starting point.
  - "`,`" (comma) for grass.
  - "`~`" (tilde) for water.
  - "`@`" ("at" sign) for fire.
  - "`^`" (caret) for mountain.
- There must be exactly one starting point `S`. Everyone starts from the `S` tile.

- Poplet can reach exactly x distinct cells.
- Lipplio can reach exactly y distinct cells.
- Rotten can reach exactly z distinct cells.

Each Pokémain can go towards one of four cardinal directions (up, down, left, and right) but cannot go outside the region. Also, they cannot walk through mountain tiles. Finally, note that the `S` tile is also considered reachable.

Luckily, Imane is affiliated with the Atita townsfolk, and so she owns a patch of land which she can transform to her needs. She now turns to you, PewDiePie, for help. Can you find at least one design which satisfies all requirements above? If there is no such design, please say so as well.

Input

The first line of input contains a single integer t denoting the number of test case.

Each test case consists of a single line containing three space-separated integers x, y and z.

Output

For each test case, output a line containing either

- `PEWDIEPIE` if there is at least one design that satisfies all constraints, or
- `MARKIPLIER` otherwise.

In addition, if you outputted `PEWDIEPIE`, then you need to print a few more lines depicting the design. The first line must contain two integers r and c denoting the number of rows of columns of the design, respectively. Then print r more lines, each containing a string of c characters depicting a row.

Any valid design satisfying the requirements above will be accepted.

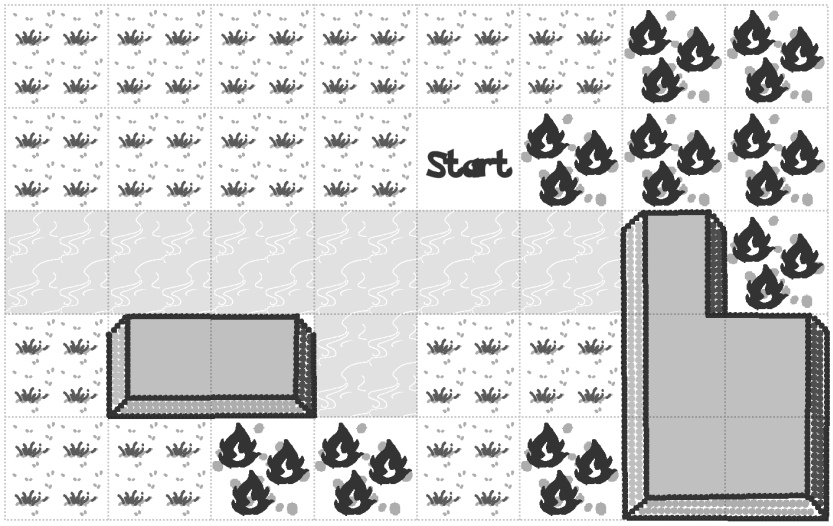
Constraints

$1 \leq t \leq 25000$
$x, y, z \geq 0$
$x + y + z \leq 300$

Sample Input	Sample Output
1 24 16 17	PEWDIEPIE 5 8 ,,,,,,@@ ,,,,S@@@ ~~~~~~^@ ,^^~,,^^ ,,@@,@^^

Explanation

The following illustrates the sample output:



Problem I

Wax

Time Limit: 2 seconds

The recent Wengwaxia controversy is thought to have caused the recent outbreak of weasels. In any case, it has generated a lot of distrust on wax throughout the country, and anti-wax groups have been growing in numbers ever since. Having the momentum they need, they are now planning to launch a massive campaign to inform the masses about the dangers of floor wax (such as slipping).

After a lot of discussions, the anti-waxxers have come up with four possible courses of action:

1. Tour the schools of Wetro Wanila for a ~~mis~~information and awareness campaign.
2. Rent all the billboards along WEDSA to display ~~propaganda~~ unbiased information on wax.
3. Hire the K-pop group WEXO to sing a catchy song about the dangers of ~~wex~~ wax.
4. Consult the ~~Dilawax~~ wax proponents and experts and have a civilized conversation with them (although no one is enthusiastic about doing this).

Each of these actions will require a certain budget. In particular, the ith action will cost w_i willion wesos.

Unfortunately, due to limited personnel, they can only perform two out of the four actions, so they have to choose two among them. Of course, they must choose the actions to maximize the effectiveness of the whole campaign.

It turns out that the effectiveness depends strongly on the budget they allocate, but in an unusual way. If they choose the ith and jth action, then the effectiveness is $(w_i - w_j)^2$.

If they choose their actions optimally, what is the ~~waximum~~ maximum possible effectiveness they can achieve?

Input

The input consists of four lines, each containing a single integer. The ith line contains the integer w_i ($-10^3 \leq w_i \leq 10^3$), the budget of the ith action (in willion wesos).

Output

Output one line containing an integer, the maximum possible effectiveness they can achieve.

Sample Input	Sample Output
3 5 2 7	25

Problem J

Does It Spark Joy?

Time Limit: 2 seconds

Marie has finally inspired you to fix your life. After several years of procastination, you now plan on tidying up your room, throwing away the things which don't spark joy (ときめく), and sorting out your priorities.

You also have a bunch of TO-DO lists that you've been happily collecting over the past several years. Unfortunately, you haven't gotten around doing any of them, since the number of lists has gotten very long and you don't know where to begin! As a first step in reorganizing your life, you decide to *sort* each of your TO-DO lists.

Since you were disorganized, instead of using something sane like TO-DO list apps or post-its, you simply write all your lists in a single file, with each list written in a single line. The items in each list are separated by commas. For example, one of your shopping lists looks like this:

```
Sata andagi, carrots, and green onions.
```

This represents a list of three items:

1. `"sata andagi"`,
2. `"carrots"`, and
3. `"green onions"`.

For simplicity, you just want so sort such a list alphabetically, since anything more will probably be too complicated to perform (and you might lose interest in the whole tidying-up thing). For example, for the list above, the result should be:

```
Carrots, green onions, and sata andagi.
```

Note the following:

- The sorting is *case insensitive*. Thankfully, every letter is in lowercase, aside from the first letter which is always uppercase. (You weren't *that* disorganized.)
- The space character (`" "`) is considered to go before any other letter alphabetically.
- The string `" and "` that appears immediately after the last comma should be considered a part of the format. This is why (in the example above) the last item is interpreted as `"green onions"` and not `"and green onions"`.
- Similarly, the period character (`"."`) only appears at the end of the line and signifies the end of the list.

Write a program to sort each of your lists so that you may live a happier life.

Input

The first line of input contains a single integer t denoting the number of lists.

Each of the next t lines describes a single list, formatted as specified in the problem statement. See the *Constraints* section below for more details.

Output

For each list, output its sorted version in a single line. The output line must also satisfy the same format requirements as the input line.

Note: Although the sorting is case insensitive, the output is case sensitive.

Constraints

$1 \leq t \leq 10000$
Each line is at most 100 characters long.
Each line will only contain commas, periods, spaces and letters.
There is exactly one uppercase letter, and it is the first character of the line.
The period appears exactly once, at the end of the line.
The period is never preceded by a space.
Each comma is followed by a space and is never preceded by a space.
There are no two consecutive spaces.
The last comma, if it exists, is followed by `" and "`.

Sample Input

```
5
Sata andagi, carrots, and green onions.
Corn and carrots, and chips.
A late breakfast, and an early dinner.
Watch television.
Solve the first problem as early as possible, and relax.
```

Sample Output

```
Carrots, green onions, and sata andagi.
Chips, and corn and carrots.
A late breakfast, and an early dinner.
Watch television.
Relax, and solve the first problem as early as possible.
```

Problem K

A Song of Stacks and Queues

Time Limit: 2 seconds

Let p be a prime number. Two arrays $[a_1, \ldots, a_n]$ and $[b_1, \ldots, b_n]$ of equal length are **proportional mod** p if there exists two integers α and β, not both $\equiv 0 \pmod{p}$, such that

$$\alpha \cdot a_i \equiv \beta \cdot b_i \pmod{p}$$

for all i from 1 to n.

Let S be a string of length m, with each character being either + and −. This represents a sequence of m operations, where + corresponds to a *push*, and − corresponds to a *pop*. There are exactly k "+"es in S.

Note that we haven't specified what kind of container we're pushing to or popping from, but that's okay; the sequence of operations can be followed regardless of the container type, although the results will probably differ. We will define two possible outcomes:

- The **stack transform** of the array $[s_1, \ldots, s_k]$ is the sequence obtained from the pop operations by following the move sequence S with a *stack*, where the ith "+" means "*push s_i to the stack*".
- The **queue transform** of the array $[s_1, \ldots, s_k]$ is the sequence obtained from the pop operations by following the move sequence S with a *queue*, where the ith "+" means "*push s_i to the queue*".

For example, for $S =$ "++−−++−", you may verify that the stack transform of array $s = [69, 420, 143, 42]$ is $[420, 69, 42]$, and its queue transform is $[69, 420, 143]$.

The array $[s_1, \ldots, s_k]$ is said to be **p-erfect** if its stack transform and queue transform are proportional mod p.

How many p-erfect arrays $[s_1, \ldots, s_k]$ of length k are there such that $1 \leq s_i \leq p$ for all i?

Output the answer modulo 998244353.

Input

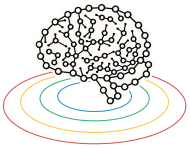
The first line of input contains a single integer t, the number of test cases.

The first line of each test case contains three space-separated integers p, m, k.

The second line contains S, the string of length m consisting of + and −.

Output

For each test case, output a single line containing a single integer, the answer for that test case (modulo 998244353).



Constraints

$1 \leq t \leq 30$
$1 \leq k \leq 10^5$
$k < m \leq 2k$
$2 \leq p \leq 10^6$
p is a prime.
There are exactly k +s and at least one $-$ in S.
It is guaranteed that the stack/queue will not be empty when popped, when following the move sequence S.

Sample Input	Sample Output
1 5 7 4 ++−−++−	65

Explanation

For $S =$ "++−−++−", two examples of 5-erfect arrays are $[2,3,4,1]$ and $[1,1,5,5]$.

For $[2,3,4,1]$, we can verify that it is 5-erfect as follows:

- Its stack transform is $[3,2,1]$.
- Its queue transform is $[2,3,4]$.
- $[3,2,1]$ and $[2,3,4]$ are proportional mod 5; to verify, we can select $\alpha = 2$ and $\beta = 3$.

Problem L

Ryu Quezacotl's Birthday

Time Limit: 3 seconds

Let $s_n := (s_{n,1}, s_{n,2}, \ldots)$ be an infinite sequence of integers defined as:

- $s_{n,1} = n$.
- For $i > 1$, $s_{n,i}$ is the product of all digits appearing in $(s_{n,1}, s_{n,2}, \ldots, s_{n,i-1})$, if every number is written in base ten.

For example, for $n = 41$,

$$s_{41} = (41, 4, 16, 96, \ldots).$$

It is Ryu's birthday, even though he denies it. He receives four integers as a present from his friend llama. Since he has nothing better to do, he takes out two of the integers from his left pocket, n_L and i_L, and the other two from his right pocket, n_R and i_R, and computes the sum of all $s_{n,i}$ for all pairs (n, i) such that $n_L \leq n \leq n_R$ and $i_L \leq i \leq i_R$, modulo 10^6.

If he does his calculations correctly, what number does he get?

Input

The first line of input contains a single integer t denoting the number of test cases.

Each test case consists of a single line containing four space-separated integers n_L, n_R, i_L, i_R.

Output

For each test case, output a single line containing a single integer containing the answer for that test case, i.e., the required sum modulo 10^6.

Constraints

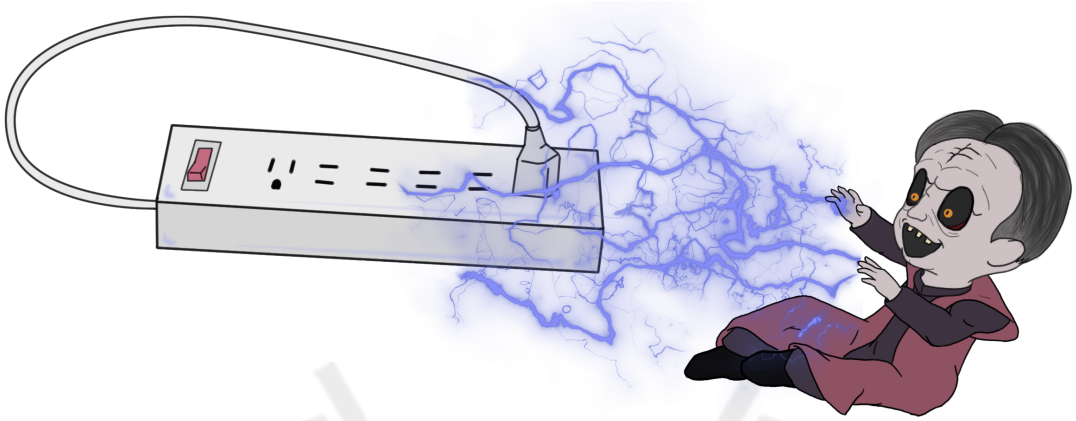
$1 \leq t \leq 500$
$1 \leq n_L \leq n_R < 10^{10}$
$1 \leq i_L \leq i_R < 10^{10}$

Sample Input	Sample Output
2 41 41 2 4 9111111 9111111 1 1	116 111111

Problem M

Unlimited Powah

Time Limit: 4 seconds



The **powah** of a lattice point (x, y, z) is defined to be xyz. For example, the powah of $(5, -7, -11)$ is 385. Note that the powah can also be negative (or zero). For example, the powah of $(-2, -2, -2)$ is -8.

A lattice point (x, y, z) is said to be a **powah point** if, by decreasing x, y and z by exactly 1, its powah is also decreased by exactly 1. For example, verify that the point $(5, -7, -11)$ is a powah point. Powah points are good sources of electric powah.

Senator Sheeeeeeeeeeev has been gathering powah lately. He intends to collect all the powah points that he can, and use those to finally defeat his enemy, Juday. However, he has little time to do this, so he only intends to gather the *nearby* powah points.

He is currently sitting at the origin, $(0, 0, 0)$, and he wants to gather all powah points whose *Manhattan distance* from the origin is at most n. Help Sheeeeeeeeeeev obtain lots of powah by finding the number of such powah points!

The Manhattan distance between two points (x_1, y_1, z_1) and (x_2, y_2, z_2) is defined as:

$$|x_1 - x_2| + |y_1 - y_2| + |z_1 - z_2|.$$

Input

The first line of input contains a single integer t denoting the number of test cases.

Each test case consists of a single line containing a single integer n.

Output

For each test case, output a single line containing a single integer denoting the number of powah points whose Manhattan distance from the origin is at most n.

Constraints

$1 \leq t \leq 10^5$
$1 \leq n \leq 10^6$

Sample Input	Sample Output
2 7 8	8 14

Problem N

Cursed Printer

Time Limit: 2 seconds

Your office has a weird printer with a weird behavior. If you issue a print job with n pages, then it also includes a blank page between every two consecutive pages, for a total of $2n - 1$ pages.

You need k pieces of blank paper, but the only source is this weird printer. You believe it is cursed, so instead of opening it up to get blank pages stored inside (which requires you to touch it), you issue print jobs instead.

You can issue multiple print jobs of varying pages each. For each print job of size n, you can even choose some of the pages to be blank. For example, if you print 5 pages of which 3 are blank, then you get a total of 9 pages with 4 extra blank pages for a total of 7 blank pages.

Your office IT department has caught on your wasteful plan, and reminds you that for any print job, at least x pages must be non-blank. Otherwise, you'll be hearing from your manager. This also means that a print job must have a size of at least x pages, i.e., $n \geq x$.

You want to receive *exactly* k blank pages by issuing zero or more print jobs. Let N be the sum of all n from all the print jobs. What is the minimum N to do this? If it is impossible, output `IMPOSSIBLE`.

Input

The first line of input contains a single integer t denoting the number of test cases.

Each test case consists of a single line containing two space-separated integers k, x.

Output

For each test case, output a single line containing a single integer denoting the answer, or `IMPOSSIBLE` if it is impossible to do so.

Constraints

$1 \leq t \leq 10^5$
$0 \leq k, x \leq 10^6$
The sample input/output is on the next page.

Sample Input	Sample Output
9 42 24 420 69 24 11 2019 1 2019 42 420 42 1111 111 2222 222 214 71	34 245 18 1011 1031 232 612 1223 143