2022 University of Virginia High School Programming Contest

Welcome to the 2022 University of Virginia High School Programming Contest. Before you start the contest, please be aware of the following notes:

Rules

1. There are ten (10) problems in this packet, using letters A-J. These problems are *loosely* sorted by difficulty:

Problem	**Problem Name**
A	Cookie
B	Sudoku
C	Absolute
D	Pattern
E	Destiny
F	Maintain
G	Prime
H	Destiny 2
I	Black
J	Bitsquared

2. You may reference any online or print source *that existed before the start of the competition* that you would like. This includes language APIs and textbooks. You *may not* request or use the help of any human sources outside of your team members. This includes coaches, teachers, non-team member students, or internet forums.

3. You may use any language and IDE for writing solutions as you would like. Remember, only submissions in Java, C/C++, and Python 3 will be accepted.

4. Do *not* call in proctors or judges to your breakout room to ask about clarifications. You may only request proctors' or judges' assistance with regards to technical faults you are encountering with regards to the judging system or other HSPC-provided interfaces.

5. Solutions for problems submitted for judging are called runs. Each run will be judged in order of submission.
   The judges will respond to your submission with one of the following responses. In the event that more than one response is applicable, the judges may respond with any of the applicable responses.

Response	Explanation
CORRECT	Your submission was judged as being correct. Congratulations! *Correct submissions do not incur penalty time.*
COMPILER-ERROR	There was an error while compiling your submission. *Compilation errors do not incur penalty time.*
TIMELIMIT	Your submission took longer than the maximum allowed time for this problem to run.
RUN-ERROR	There was an error during the execution of your submission.
NO-OUTPUT*	Your submission did not generate any output.
OUTPUT-LIMIT*	Your submission generated more output than the allowed limit.
WRONG-ANSWER	The output of your program was incorrect.
TOO-LATE	Your submission was received after the competition ended. The submission will not be processed.

*** Note that these errors may often report as another error, such as WRONG-ANSWER.**

6. A team's score is based on the number of problems they correctly solve and the number of penalty minutes incurred, which reflect the amount of time and number of incorrect submissions made before the problem is solved. For each problem solved correctly, penalty minutes are issued equal to the time at which the problem was solved plus 20 minutes for each incorrect submission. No penalty minutes are added for problems that are never solved. Teams are ranked first by the number of problems solved and then by the fewest penalty minutes.

7. This problem set contains sample input and output for each problem. However, the judges will test your submission against several other more complex data sets, which will not be revealed until after the contest. One challenge is designing other input sets for yourself so that you may fully test your program before submitting your run. Should you receive a "WRONG-ANSWER" judgment, you should consider what other data sets you could design to further evaluate your program.

8. In the event that you think a problem statement is ambiguous or incorrect, you may request a clarification. Read the problem carefully before requesting a clarification. If the judges believe that the problem statement is sufficiently clear, you will receive the response, "The problem statement is sufficient; no clarification is necessary." If you receive this response, you should read the problem description more carefully. If you still think there is an ambiguity, you will have to be more specific or descriptive of the ambiguity you have found. If the problem statement is ambiguous in specifying the correct output for a particular input, please include that input data in the clarification request. You may not submit clarification requests asking for the correct output for inputs that you provide. Sample inputs may be useful in explaining the nature of a perceived ambiguity, e.g., "There is no statement about the desired order of outputs. Given the input: . . . , would not both this: . . . and this: . . . be valid outputs?".

If a clarification that is issued during the contest applies to all the teams, it will be broadcast to everybody.

9. Runs for each particular problem will be judged in the order they are received. However, it is possible that runs for different problem will be judged out of order. For example, you may submit a run for B followed by a run for C, but receive the response for C first.
   Do not request clarifications on when a response will be returned. *Only if* you have not received a response for a run within 30 minutes of submitting it may you contact your proctor to determine the cause of the delay.
   If judging for one or more problems begins to lag more than 30 minutes behind submissions, a clarification announcement will be issued to all teams. This announcement will include an updated time period which teams can expect to wait before receiving a response.

10. The submission of abusive programs or clarification requests to the judges will be considered grounds for immediate disqualification. This includes submitting dozens of runs within a short period of time (say, a minute or two). Submitting malicious code or otherwise attempting to comprise the security of our judging system is also grounds for dismissal.

Your Programs

11. All solutions must read from standard input and write to standard output. In C this is `scanf()`/`printf()`, in C++ it is `cin`/`cout`, and in Java this is `System.in`/`System.out`. The judges will ignore (and you will not receive feedback on) all output sent to standard error (`cerr` in C++ or `System.err` in Java).

12. All line of program input and output should end with a newline character (\n, `endl`, or `println()`)

13. All input sets used by the judges will follow the input format specified in the problem description. You do not need to test for input that violates the input format specified in the problem.

14. Unless otherwise specified, all lines of program output should be left justified, with no leading blank spaces prior to the first non-blank character on that line.

15. Unless otherwise specified, all numbers in your input should begin with a '-' if negative, followed immediately by 1 or more decimal digits. If it is a real number, then the decimal point should be followed by as many decimal digits as can be printed. This means that for floating point values, use standard printing techniques (`cout` and `System.out.println`). Unless otherwise noted, the judging will check your programs with 10^{-3} accuracy, so only consider the sample output up until that point.

16. All input sets used by the judges will follow the input format specified in the problem description. You do not need to test for input that violates the input format specified in the problem.

Good luck and HAVE FUN!

A. Cookie

You have chosen the circle shape for the infamous Dalgona game! However, upon opening your tin, you realize that somebody has already poked some holes into it. The cookie is represented on a two dimensional grid, defined by a center point. There have also been some other points poked into the cookie, which are different from the center point. Making the slightly sub-optimal but still decent cookie choice, you wonder if the holes poked into the cookie will help you win this game or not. More specifically, you want to check if all the poked points fall on the perimeter of some circle. Solve this task quickly: you don't have much time to win this game!

Input Format

The first line of the input will be a single positive integer $t \leq 100$. There will be t test cases that follow.

The first line consists of a single integer $n \leq 150$. The next line will give $-100 \leq a, b \leq 100$, the coordinates of the center point you wish to check. The next n lines consists of two single-space-separated integers $-100 \leq x_i, y_i \leq 100$ representing the coordinates of the ith point poked into the cookie.

Output Format

For each test case, print on a new line "Circle" if the points given are on the perimeter of some circle centered at the given central point, and "Not circle" otherwise.

Sample Input

```
3
6
0 0
0 5
5 0
-5 0
0 -5
3 -4
-3 -4
1
-4 -5
3 9
2
0 1
3 3
-2 -3
```

Sample Output

```
Circle
```

```
Circle
Not circle
```

B. Sudoku

Gi-hun and Sae-byeok are both waiting for the next game to begin and are bored. As they are sitting in their boredom, Gi-hun spots some pieces of paper across the room. When he picks it up, he realizes that they are all copies of the same sudoku board, perfect material for a boring wait. Gi-hun decides to challenge Sae-byeok to see who can solve the sudoku in the fewest moves, but after multiple tries, Sae-byeok always seems to win. Can you help Gi-hun solve the sudoku grid in the fewest moves possible?

Input Format

The first line contains the number of test cases.

For each test case, you are given 9 lines with 9 numbers, which represents the sudoku board. A cell is marked as 0 if that cell is empty, and otherwise it is a number from 1 to 9. We can assure you that this board always has a correct solution corresponding to it.

Output Format

For each test case, print on a new line the number of moves needed to complete the sudoku puzzle.

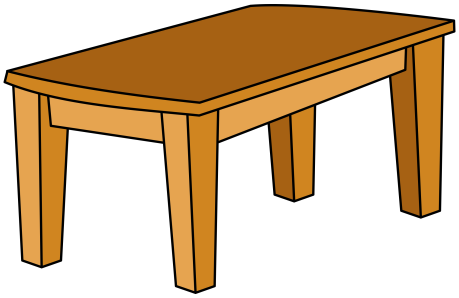
Sample Input

```
1
1 2 3 4 5 6 7 8 0
4 0 6 7 8 9 1 2 3
7 8 9 1 2 3 4 5 6
2 3 1 5 6 4 8 9 7
5 6 4 8 9 7 2 3 1
8 9 7 2 3 1 5 6 4
3 1 2 6 4 5 9 7 8
6 4 5 9 7 8 3 1 2
9 7 8 3 1 2 6 4 5
```

Sample Output

```
2
```

C. Absolute



The next squid game is about to begin! However, as a sick joke, the soldiers decide to prank the players before their next mini-game by giving them a challenge. For this challenge, players must choose a number from table a. Table a contains a list of positive integers indexed by $i \geq 1$ such that the value of each position is $1 \leq a_i \leq 10^9$. In order to win the game, a player must choose a position i such that $|a_i - a_j| = a_i - a_j$, where j is the position of every other number on the table. You are a player, and you need to win everything in order to feed your 16 children. What index i should you choose? If there are multiple answers which satisfy this case, output the smallest such index.

Input Format

The first line contains a positive integer $n \leq 1000$, the number of test cases to solve.

The first line of each test case contains $k < 20000$, a single integer representing the size of the array/table. The next line will contain k integers representing the value of each of the table's positions.

Output Format

For each test case, print the index i of the best a_i in the table. Print output on a separate line for each test case.

Sample Input

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

Sample Output

```
5
1
```

D. Pattern

You are in the middle of taking your algebra final. However, because you procrastinated too much, you only got one hour of sleep the night before and it has finally caught up to you. Unable to keep your eyes open as you stare at a watermelon shopping question, you topple and are suddenly reborn as a player in Squid Game! Before your soul has been completely transported into the game though, the mediator, who lives in between universes, takes pity on your poor, sleep deprived soul and gives you a chance to return to your world as well as travel to any time you desire in your universe. You dreaded taking that final, so returning to your world to take a test didn't quite do it for you, but time travel? That's an opportunity that you can't miss. The mediator gives you a string of English uppercase letters. If you are able to count the number of substrings that are either SQUID, GAME, or UVA, he will allow you to return to your world in the time frame of your choosing. Can you solve this?

Input Format

First you read in an integer ($t = 100$) describing the number of test cases. For each test case, you are given a single string on a new line consisting solely of uppercase English letters. The length of each string will not exceed 100.

Output Format

For each test case, print on a new line the number of substrings that are either SQUID, GAME, or UVA.

Sample Input

```
5
SQUID
GAME
UVA
UWQIFWEUOEFOEJSDFKJ
JISQUIDGUVAMEEGAME
```

Sample Output

```
1
1
1
0
3
```

E. Destiny

Glorious Cash Destiny! That is what you aspire to win after all of these games are over. Imagine that you're almost there, completed every hurdle thrown at you, and you have arrived at the final boss of Squid Game: mathematics! Specifically, this final task requires you to consider the greatest common divisor. You will be given two positive integers (let's call them a and b) and are tasked to solve the following problem: find the smallest positive integer (call this x) such that the greatest common divisor of a and x equals b. If no such integer exists, then you need to report the game soldiers immediately, or you may get eliminated by being forced to retake algebra! Oh no!

Input Format

The first line of the input will be a single positive integer $t \leq 200$. There will be t test cases that follow.

For each test case, you are given two positive integers $a, b \leq 10^9$ on a single line.

Output Format

For each test case, print on a new line the appropriate value of x or -1 if no suitable positive integer x exists.

Sample Input

```
3
20 4
15 4
13 1
```

Sample Output

```
4
-1
1
```

F. Maintain

Squidward is really annoyed of Patrick and Spongebob's antics so in order to maintain his sanity, Squidward made a game and he would like you to play it.

You are given Q queries ($1 \leq Q \leq 200000$) which includes either a + or - operation and a number A ($1 \leq A \leq 10^9$). + operation means to add A to an initially empty array and a - operation means to remove one instance of A from the array. It is guaranteed the - operation will be valid, that is, there will be at least one instance of A in the array. After each operation, output the bitwise OR of all elements in the array. The bitwise OR of all elements for an empty array is assumed to be 0.

You can read more about bitwise operations here: `https://en.wikipedia.org/wiki/Bitwise_operation`

Input Format

The first line contains Q, the number of queries.

Then, Q lines follow. Each line represents a single query. Each line contains a + or a -, followed by an integer.

Output Format

For each of the Q queries, output a single integer on its own line, the answer to the query.

Sample Input

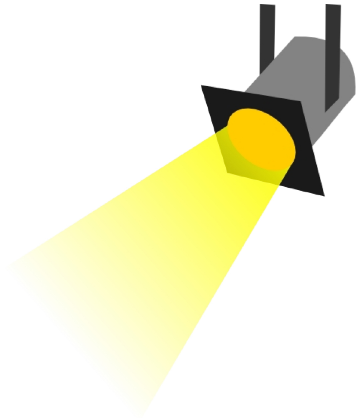
```
8
+ 5
- 5
+ 6
+ 7
+ 15
- 6
- 7
- 15
```

Sample Output

```
5
0
6
7
15
15
15
0
```

G. Prime

Who is coming up with all of these weird games? The seventh game has just been announced, and it's called. . . prime time! Of course, the contest directors are being intentionally vague again, so you have no choice but to guess what kind of mathematically twisted game this could be. You decide that the following problem is the best guess as to what the game could be: you have an array of prime integers. You are curious as to the number of triples of distinct indices (a, b, c) such that the sum of elements at index a and index b equals the element at index c. The clock is ticking, so you better solve this in (prime) time!



Input Format

The first line of the input will be a single positive integer $t \leq 20$. There will be t test cases that follow.

For each test case, you are first given an integer $n \leq 10000$. The next line will have n space separated prime integers at most 1000000.

Output Format

For each test case, print a single integer on a new line: the number of triples of indices such that the condition described in the problem holds true.

Sample Input

```
2
5
2 3 3 7 5
10
5 3 5 2 2 13 17 13 23 3
```

Sample Output

```
3
8
```

H. Destiny 2

Another one?? Are you just destined to encounter tasks like these? You guessed it: we have yet another problem related to the GCD for you! Turns out the Front Man is sleep deprived: who knew? Therefore, he will just try to explain this problem as simply as possible.

You are given an integer $2 \leq N \leq 10^5$ and $2 \leq k \leq 30$. Find the number of ways you can construct an array of size N such that each element is $\leq k$ and the GCD of each pair of adjacent elements is at least 2. Since the number can be large, output your answer mod 1000000007.

Input Format

The first line will consist of a single integer $j < 10000$ representing the number of test cases to follow.

Each test case consists a single line with two space-separated integers N and k.

Output Format

For each test case, print the answer on a new line.

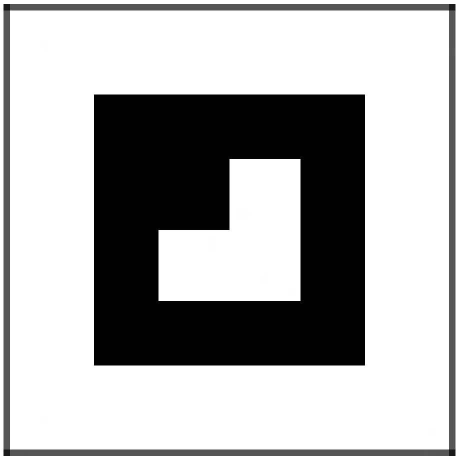
Sample Input

```
2
3 3
10 10
```

Sample Output

```
2
17974565
```

I. Black



Patrick the Problemsetter hasn't watched squid game so he doesn't know how to make his problem fit the theme.

Squidward the Squid has been given a game from Omkar the Octopus. The game consists of a square board of NxN cells ($1 \leq N \leq 1000$). Each cell is either white ('**.**') or black ('**#**'). Omkar the Octopus has instructed Squidward the Squid to count the number of squares with a completely black outline on the board.

The following board has 15 complete outlines of squares (13 1x1 squares, 1 2x2 square, and 1 4x4 square).

```
......
.####.
.##.#.
.#..#.
.####.
......
```

The following board has 7 complete outlines of squares (all 7 are 1x1 squares).

```
.....
.##..
.#.#.
.###.
.....
```

Input Format

The first line contains a single integer T ($1 \leq T \leq 10000$), which is the number of test cases.

The first line of each test case will contain a single integer N ($1 \leq N \leq 1000$), the side length of the grid The next N lines will contain N '**.**' or '#' characters, representing the cells of the board.

It is guaranteed that the sum of N^2 across all test cases will be ≤ 1000000.

Output Format

Output T lines, one for each test case. On each line, output a single integer representing the number of squares with complete black outlines on the board.

Sample Input

```
3
1
#
6
......
```

```
.####.
.##.#.
.#..#.
.####.
......
5
.....
.##..
.#.#.
.###.
.....
```

Sample Output

```
1
15
7
```

J. Bitsquared

All of these games are starting to make all the players (including you) a bit scared! Or...should I say a bit squared? Surprise! This next game is sure to catch even our best contestants off guard and make them almost trip and fall in red light green light. Will you be caught off guard too by this hard problem?

Consider the bitwise XOR function. This function is defined as addition of two integers in base 2 ignoring carrying in addition. This is the definition of XOR that the Front Man announced, which is consistent with the XOR function that we all know and love. Given an array of non-negative integers, find the XOR of the square of sum of all sub-arrays such that the sub-array sum = sub-array xor. Here, a sub-array is defined as some contiguous range of the original array. Are you a bit squared off by this task?

Input Format

The first line of the input will be a single positive integer $t \leq 20$. There will be t test cases that follow.

On the first line of each test case, you will be given $n \leq 100000$, the length of the array. The next line will contain n space separated non-negative integers, none of which are larger than 1000000000.

Output Format

For each test case, print on a new line the answer for the given array.

Sample Input

```
3
5
0 0 0 0 0
3
43 1 5
5
9 0 0 8 1
```

Sample Output

```
0
1825
65
```