Noctem Virtual II
Division II

1. You have three hours to complete this contest. There are 6 problems, and you may complete them in any order.

2. Cheating is strictly prohibited. This includes conferring with people that are not on your team or using code written by someone not on your team. Failure to abide by this rule will result in automatic disqualification.

3. As you complete the questions, you should submit your solutions on the grader website. There, you will be able to see how many test cases you got correct for the given question. You may resubmit on the grader as many times as you would like during the three hour period for no penalty. However, only the last submission you make on the grader for a question will be used to calculate your final score.

4. Your final score will be calculated based off of your last submission on each question. Each test case will be worth 1 point, for a total of 10 points per question and 60 points in total. If there is a tie between two teams, the tie will be broken by looking at which team had more of the three hour time window remaining when they submitted for the last time.

5. Last but not least, we wish your team the best of luck!

Problem 1 - Duck Escapade

Problem:
Ducks are simple creatures. They can only do two things: quack or swim. In this case, they are doing both to escape Steven's reign of terror. Swimming takes up one unit of energy per unit of distance, but quacking restores it by K energy units. There are a total of N ducks on one side of a lake. They want to make it to the other side which is D units of distance away. Each duck starts with E_i energy. Between them, they can quack a total of Q times before Steven wakes up and turns them all into Beijing Duck. Find the maximum number of ducks that can make it to the other side.

Input Format (duck.in):
The first line contains $N(1 \leq N \leq 10^5)$, $Q(1 \leq Q \leq 10^5)$, $K(1 \leq K \leq 10^9)$ and $D(1 \leq D \leq 10^9)$. The next N lines contain $E_i(1 \leq E_i \leq 10^9)$, the initial energy of each duck.

Output Format (duck.out):
The number of ducks that can make it to the other side.

Sample Input:
4 3 3 10
4
14
7
6

Sample Output:
3

Credits: Marco Frigo

Problem 2 - Social Distancing

Problem:
The ducks have discovered a bakery. They have organized themselves into a line of N ducks, each with an integer position X_i. Some ducks are closer than 6 units away from another duck, which is dangerous because of the duck plague. Your task is to find the minimum number of ducks to remove so that everyone is at least 6 units apart.

Input Format (distancing.in):
The first line contains $N(1 \leq N \leq 10^5)$, number of people. The next N lines contains the position $X_i(1 \leq X_i \leq 10^9)$ of each person.

Output Format (distancing.out):
The minimum number of people that need to be removed.

Sample Input:
6
1
10
12
22
26
29

Sample Output:
2

Credits: Steven Tan

Problem 3 - Whitejack

Problem:
There is a common card game known as Blackjack, but today, we are playing Whitejack. A game of Whitejack is a collaborative card game played between two players, where players win if there exists a pair of cards, one from player 1 and one from player 2 that sum to a given number K. Player 1 already has a hand of N cards: $a_1, a_2, \ldots, a_N$. Player 2 must still draw his hand from a deck of M cards: $b_1, b_2, \ldots, b_M$. Player 2 is having a tough time deciding how to draw his hand, so he will ask you Q queries, each query asking if they will win the game if he draws his hand from the contiguous sub-array $[L, R]$ from the deck of cards. Note that L and R are one-indexed, and are in both in the range $[1, M]$. Help him answer the queries.

Input Format (whitejack.in):
The first line contains $N(1 \leq N \leq 10^5)$, $M(1 \leq M \leq 10^5)$, $K(1 \leq K \leq 10^9)$ and $Q(1 \leq Q \leq 10^5)$. The next line contains N space-separated integers giving the cards of player 1. The line after that will contain M space-separated integers giving the deck of cards that player 2 will choose from. All card values are in the range $[0, 10^9]$. Then, the next Q lines will each contain two integers, L, R asking if the players will win if player 2 draws cards from the contiguous sub-array $[L, R]$ of the deck of cards.

Output Format (whitejack.out):
For each query, output either "YES" or "NO" on separate lines without the quotation marks. Make sure they are all capital letters.

Sample Input:
5 10 10 2
1 2 3 4 5
3 2 5 8 9 2 1 12 12 14
1 2
5 6

Sample Output:
NO
YES

Credits: Steven Tan

Problem 4 - Evacuation

Problem:
A rogue monkey has come to a hotel to wreak havoc. A hotel has N rooms numbered 1 through N, connected by N - 1 walkways such that each room can reach every other room through a series of walkways. M people are all currently meeting in room 1 when they find out monster monkey has arrived. Since everyone is all packed in one room, this makes it very easy for monkey to eat everyone, so you will have to distribute the people to different rooms. Starting at room 1, you can choose any amount of people to stay. Then, you can split the rest of the people into at most K groups, and send each group off to a different room connected to room 1. Then, you do the same at each room you send a group off to, and then do the same on the next group, until you are done distributing. After distributing the people, the monkey will choose the room with most people and eat them all. Since you want to minimize the amount of people the monkey eats, minimize the maximum number of people among all rooms by distributing the people optimally.

Input Format (evacuation.in):
The first line contains N ($1 \leq N \leq 10^5$), M ($1 \leq M \leq 10^9$), and K ($1 \leq K \leq 10^5$). The next N - 1 lines each contains two numbers, indicating that there is a walkway between those two rooms.

Output Format (evacuation.out):
The minimum number of people that will be eaten by monkey.

Sample Input:
7 20 2
1 2
1 3
1 4
2 5
2 6
4 7

Sample Output:
4

Credits: Steven Tan

Problem 5 - Cleaning Windows

Problem:
Jerome is a window cleaner. Today, he is cleaning a N story building with a single window on each story. The window on the i-th story has dirtiness D_i. He starts at story 1, and can move up or down in one unit of time, as well as lower the dirtiness of one window in a unit time by 1. Given that Jerome only has K units of time to do his job, find the maximum number of windows he can clean (a window is clean if its dirtiness is 0). Note that Jerome cannot move below story 1 or above story N.

Input Format (windows.in):
The first line contains N ($1 \leq \text{N} \leq 10^5$) and K ($1 \leq \text{K} \leq 10^9$). The i-th line of the next N lines each contain an integer D_i ($1 \leq D_i \leq 10^9$).

Output Format (windows.out):
The maximum number of windows Jerome can clean.

Sample Input:
5 15
2
5
8
3
1

Sample Output:
4

Credits: Marco Frigo

Problem 6 - Word Game

Problem:
Given a string S, and target string K, two players play a game. The two players will maintain an interval [L, R] on the string S. Player 1 starts by picking any character from the string, and both L and R will be set to index of that character. Then starting with player 2, they will take turns extending the interval one to the left or one to the right ([L, R] becomes [L - 1, R] or [L, R + 1]), as long as the new L and R are still within string S. The game ends when the substring [L, R] becomes the target string, and the winner is the person who last moved. Note that if the target string is never reached and players run out of moves, it is a tie. If both players play optimally, determine who will win, or that it will be a draw.

Input Format (wordgame.in):
The first line contains T ($1 \leq T \leq 10^4$), the number of test cases. Each test case consists of two lines, the first line containing string S ($1 \leq |S| \leq 10^6$), and the second line containing string K ($1 \leq |K| \leq |S|$).

It is guaranteed that the sum of $|S|$ over all test cases does not exceed $2 \cdot 10^6$.

Output Format (wordgame.out):
For each test case, output a single integer on a new line. Output 1 if player 1 wins, 2 if player 2 wins, and 0 if its a draw.

Sample Input:
3
cfzaabe
ab
bcacacd
cac
abababab
abab

Sample Output:
0
1
2

Credits: Steven Tan