Problem 8: Into the CALICOre
4+6 Points

Problem ID: `celeste`
Rank: `3+3`

Introduction

After narrowly avoiding Mr. Oshiro's wrath at the Celestial Resort, confronting her inner demons in the Mirror Temple, and finally reaching the summit of Celeste Mountain, Madeline faces a new challenge unlike any she has faced before… the CALICOre. The CALICOre channels the power of the mountain itself and leaves Madeline with odd zero gravity and a lack of stamina. Madeline needs your help to find the path to inner peace at the heart of the mountain!

Problem Statement

You are given a grid of tiles with N rows and M columns. Each tile of the grid is represented by one of the following characters:

Tile	Character	Description
Empty	.	An empty space that Madeline can move through
Crystal	*	A crystal that refreshes Madeline's dash by turning her hair red
Wall	#	A wall that restricts Madeline's movement
Start	S	Madeline starts at this tile
End	E	Madeline's goal is to end at this tile

Madeline starts at the tile labeled S, and she must find the shortest series of *actions* to get to the tile labeled E. *Actions* she can take include the following:

- *Walk* one tile in any of the directions: up, down, left, or right.
  - Madeline can walk to any tile except wall tiles.
  - When Madeline walks to a crystal tile, her hair becomes red.
- *Dash* $\mathbf{K}$ tiles in any of the directions: up, down, left, or right.
  - Madeline can **only dash when her hair is red**. Madeline's hair is red at the start.
  - When Madeline dashes, her hair becomes blue. Then, she keeps moving in that direction until she's moved $\mathbf{K}$ tiles or reaches a wall, whichever happens first.
  - If Madeline moves through a crystal tile while dashing, her hair becomes red. In other words, if there is a dash crystal along the path of the dash, Madeline's hair will still be red after the dash. This includes ending her dash at a crystal tile, but **not when starting her dash at a crystal tile**.
  - Crystal tiles do not disappear and can be used **multiple times**.

Find the minimum number of *actions* needed to get from the start tile S to the end tile E. Madeline must end **exactly on this tile** (dashing through the tile does not count).

If there's no solution, output -1

Input Format

The first line of the input contains a single integer T denoting the number of test cases that follow. For each test case:

- The first line contains three space separated integers N M K denoting the number of rows, the number of columns, and the length of Madeline's dash, respectively.
- Each of the next N lines contain a single string with M characters. Together, they represent the grid Madeline is in.
  - `.` denotes an empty tile.
  - `#` denotes a wall tile.
  - `*` denotes a crystal tile.
  - `S` denotes Madeline's start tile.
  - `E` denotes Madeline's end tile.
- The edges of the map are guaranteed to be walls.

Output Format

For each test case, output a single integer denoting the minimum number of moves to get to E, or `-1` if it's impossible.

Constraints

Time limit: **4 seconds**
Memory limit: **1024 MB**

$1 \le T \le 100$
$1 \le N \le 2 \times 10^6$
$1 \le M \le 2 \times 10^6$
The sum of $N \times M$ over all test cases in a test file is guaranteed to be less than 2×10^6.

Main Test Set

$2 \le K \le 5$

Bonus Test Set 1

$2 \le K \le 2 \times 10^6$

Sample Test Cases

Sample Input
[Download]

```
5
3 9 5
#########
#S...E..#
#########
8 13 10
#############
#.####*....*#
#.####.####.#
#S....*.....#
#.####.######
#.####.######
#.#........E#
#############
4 5 2
#####
#S.##
#.#E#
#####
5 9 6
#########
#*......#
#S#####.#
##E.....#
#########
5 9 6
#########
#.*.....#
##S####.#
###E....#
#########
```

Sample Output
[Download]

```
2
5
-1
9
6
```

Sample Explanations

Test Case #1:

The fastest option is to first dash to the right, traveling 5 tiles. Then, walking back 1 step to end on E for a total of 2 actions.

Note that we need to end exactly on the E. Dashing through does not count.

Test Case #2:

Madeline can use her initial dash to travel to the right all the way to the end, refreshing her dash with the dash crystal in the middle. Then, dashing up, left, down, and right to the goal is the best option, refreshing her dash during each move, using a total of 5 moves.

Test Case #3:

The starting tile S is blocked from reaching the ending tile E. Since it's impossible to go through walls, we simply output -1

Test Case #4:

Madeline steps up, dashes to the right, then walks to the end for a total of 9 moves. Note that the crystal does not refresh her dash since she starts her dash at the crystal.

Test Case #5:

Madeline steps up, then dashes to the right, refreshing her dash on the way. Then she walks to the bottom right and dashes left, for a total of 6 moves.

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