2023 Blazers Coding Invitational
Question Booklet

COMPUTER SCIENCE
BAYRIDGE SECONDARY SCHOOL

Thank you to Michael Cox and Aydan MacGregor for their assistance in putting these questions together.

Q1 - Substitution Cipher

Blazer has designed a scavenger hunt as an activity during the field trip and the students need to decrypt the coded messages for clues. Students are given coded messages which have been encrypted with a substitution cipher. A Substitution Cipher works by adding a shift into the alphabet that is used to create the message. For example, if we created a substitution cipher with a shift of 2 and encrypted the message “Hi” it would result in “Jk”. The table seen below shows what a shift of two (bottom row) does to the normal alphabet (top row).

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X

Your job is to ensure that the coded messages Blazer has made can actually be deciphered and read by the students. You need to work backwards and decrypt the encrypted messages Blazer has supplied you and print out the decrypted message.

<u>Input Specifications:</u>
The first line is the shift for the cipher. The second line is the encrypted message.

<u>Sample Input:</u>

```
4
Fpediv
```

<u>Sample Output:</u>

```
Blazer
```

Q2 - Dice Combinations

There are several games and puzzles that are done using dice. This problem will use standard dice that have six sides, numbered 1, 2, 3, 4, 5, and 6. If we roll some dice, the total sum is the sum of values on the top face of the dice. Given the total sum and the number of dice that were rolled, output all the combinations of rolls that are equal to the total sum. Your program should also output the total number of combinations found.

Input Format

The input format is the number of dice as a whole number, followed by the total as a whole number.

Output Format

All of the dice combinations should be outputted first, one per line. Finally, the total number of dice combinations should be outputted on its own line.

Sample Input

```
3 15
```

Sample Output

```
10
```

These combinations are not necessary to print, but just meant to illustrate where the 10 came from … 10 different combinations when rolling 3 dice and trying to get a sum of 15.

(3, 6, 6)
(4, 5, 6)
(4, 6, 5)
(5, 4, 6)
(5, 5, 5)
(5, 6, 4)
(6, 3, 6)
(6, 4, 5)
(6, 5, 4)
(6, 6, 3)

Q3 - Diamond Design

The data for this program will be a single word of not more than 9 letters. The output for the program will be a diamond-shaped array of letters centered on the screen. The word radiates up, down, left and right to spell the word. In addition while moving up, down, left or right, you can make one right-angled turn and still spell out the entire word. Notice that the last letter of the word, in each case, surrounds the outer edge of the array.

<u>Sample Input</u>

```
SCHOOL
DIAMOND
WEDNESDAY
LOTUS
X
```

<u>Sample Output</u>

```
     L
    LOL
   LOOOL
  LOOHOOL
 LOOHCHOOL
LOOHCSCHOOL
 LOOHCHOOL
  LOOHOOL
   LOOOL
    LOL
     L
```

```
      D
     DND
    DNOND
   DNOMOND
  DNOMAMOND
 DNOMAIAMOND
DNOMAIDIAMOND
 DNOMAIAMOND
  DNOMAMOND
   DNOMOND
    DNOND
     DND
      D
```

```
        Y
       YAY
      YADAY
     YADSDAY
    YADSESDAY
   YADSENESDAY
  YADSENDNESDAY
 YADSENDEDNESDAY
YADSENDEWEDNESDAY
 YADSENDEDNESDAY
  YADSENDNESDAY
   YADSENESDAY
    YADSESDAY
     YADSDAY
      YADAY
       YAY
        Y
```

```
    S
   SUS
  SUTUS
 SUTOTUS
SUTOLOTUS
 SUTOTUS
  SUTUS
   SUS
    S
```

```
X
```

Q4 - Family Trees

Family trees are trees that show relationships between family members. They begin with a root ancestor and show that ancestor's children, then every child's children, and so on. For example, Bob, the root ancestor, can have two daughters Alice and Eve. Alice can then have two children Jenna and Brian, and Eve can have one daughter Sarah. To help find people in the tree, we give each family member a family ID, formatted as a series of integers separated by dots (e.g. 0.1, 0.2.3, 0.5.1.7 and so on).

A family ID is either:
• 0, which represents the root ancestor, or
• X.y, where X is a valid family ID, and where this ID represents the y^{th} child of X.

For the example above, the family IDs are:

```
Bob: 0
       Alice 0.1
              Jenna 0.1.1
              Brian 0.1.2
       Eve 0.2
              Sarah 0.2.1
```

Family IDs can give you an idea of how big a family is. For example, if you know that someone has the ID 0.2.3, then you know there are family members with IDs 0, 0.1, 0.2, 0.2.1, and 0.2.2. Given a list of family IDs, figure out the smallest possible size of the family.

<u>Input Specifications</u>
Each test case starts with an integer N (1 ≤ N ≤ 100,000). The next N lines each contain a family ID. For 50% of cases, N ≤ 100, and the total input size will not exceed 2,000 characters.

<u>Output Specifications</u>
For each test case, your program should output the minimum size of the family, modulo 1,000,000,007.[1]

<u>Sample Input (2 families shown)</u>

```
1
0.2.3
3
0
0.2.1
0.1.1
```

<u>Sample Output</u>

```
6
5
```

[1] This means that if the size of the family is 999999999999 you should output 999993006, the remainder after dividing 999999999999 by 1000000007. This is just guarding against really large numbers that might cause programs to crash.

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Q5 - Picture Time

Blazer is organizing a school wide picture, and everyone has to be seen! Everyone is standing with their friends though, so there are some restrictions as to how people can be rearranged.

The input is an integer n, followed by an 'n x n' grid (n < 100) of space-separated numbers from 1 to n^2 which represents the height of students, with 1 being the shortest student.

A perfect photo is a photo where the students are arranged with each row being in sorted order from smallest student on the left to the tallest student on the right, and every column is sorted from smallest student on top to the tallest student on the bottom.

However, because everyone wants to be with their friends, Blazer can only make moves consisting of swapping one entire row for another row, or swapping one entire column for another column.

For the input square, determine the minimum number of swaps required for Blazer to get a perfect photo? Output -1 if it is impossible to get a perfect photo.

- No students will ever be the same height.

Sample Input:	*Sample Output:*	*Sample Output Explanation:*

`3`
`1 2 3`
`6 8 9`
`4 5 7`
	`1`	`If we swap rows 1 and 2, we get`
		`1 2 3`
		`4 5 7`
		`6 8 9`
		`Which is in proper sorted order!`
		`This is one swap, so the answer is 1.`

Q6 - Sudoku Madness

Write a program to solve a Sudoku puzzle by filling the empty cells. A sudoku solution must satisfy all of the following rules:

1. Each of the digits 1-9 must occur exactly once in each row.
2. Each of the digits 1-9 must occur exactly once in each column.
3. Each of the digits 1-9 must occur exactly once in each of the 9 3x3 sub-boxes of the grid.

Input is in the form of 9 lines of 9 numbers, with a `.` representing an empty space.

Output is a number. This number is generated by adding and subtracting each number in the solved Sudoku Board as you go in a checkerboard pattern like so:

+−+−+−+−+

−+−+−+−+−

+−+−+−+−+

...

Sample Input:	Solved State of the Puzzle:	Sample Output:	Explanation For Sample Output:

`53..7....`
`6..195...`
`.98....6.`
`8...6...3`
`4..8.3..1`
`7...2...6`
`.6....28.`
`...419..5`
`....8..79`
	`534678912`
	`672195348`
	`198342567`
	`859761423`
	`426853791`
	`713924856`
	`961537284`
	`287419635`
	`345286179`
		-15	Taking each number we get:
			5-3+4-6+7-8+1-2-6+7-2+1-9+5-3+4-8+1-9+8-3+4-2+5-6+7-...
			= -15