Exercise 2.4 *Given a pair of integers. Calculate the integer multiplication and division of these two integers using the linked list data structure. Use the Division Theorem which states that the remainder should be positive and less than the absolute value of the divisor.*

Input *The input consists of the number of test cases, m, in the first line and followed by m groups of 4 lines as inputs. The group consists of a symbol, either "$*$" or "/", two lines of integers followed by a carriage return. The integer can have 100 digits and can also be negative. An example is as follows,*

```
4
*
123456789123456789
111111111111

/
523
-10

/
-523
-10

/
10
0
```

Output *The output should be m groups of numbers. Each group should be the multiplication or the division of the two integers. For the integer division, you should include the quotient and the remainder.*

```
13717421013703703578986282579

-52 3

53 7

Error: division by zero.
```

Exercise 2.16 ***Train Re-arrangement***

You are a railroad operateor and you are asked to see whether you can re-arrange the carts in some order by using an auxiliary track, which can be regarded as a stack. The operations on the carts include the following:

- *'Straight Through', which means that you let the cart pass the main track directly without using the stack;*
- *'Push', which means that you put the cart into the stack;*
- *'Pop', which means that you pull the toppest cart out from the stack.*

Figure 1 shows an example of three carts, which are represented by rectangles of different colors. In this example, the initial order is Green, Yellow, and Red, the demanded final order is Yellow, Green, and Red. It shows that you can achieve the demanded order by operation sequence 'Push, Straight Through, Pop, Straight Through'. Please note that after you push the Green cart, you can push the Yellow cart and then pop it immediately. However, you will use one extra operation than straight through the Yellow cart. The manage hopes you to save the operations as many as possible.

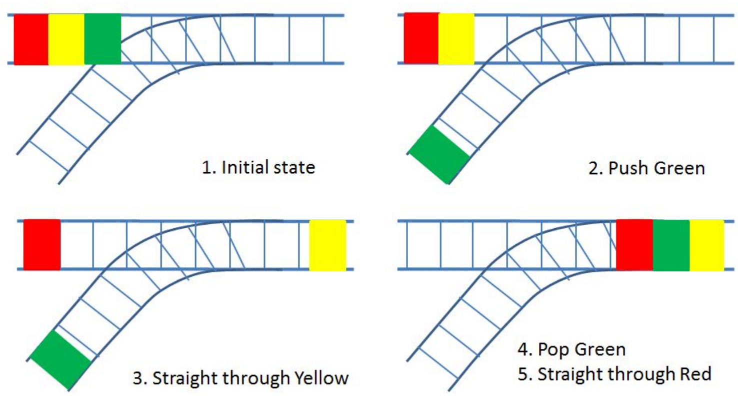

Figure 1: One example of re-arrangement

Input *The input consists of the number of test cases, m in the first line and followed by m test cases. In each test case, the first integer is the total number of carts, n $(1 \leq n \leq 100,000)$, followed by the order your manager wants you to achieve after your re-arrangement. Assume that in the initial state, all the carts are ordered from 1 to n, with Cart 1 in the first place.*

```
3
3 2 1 3
7 3 6 7 5 4 2 1
5 5 1 2 3 4
```

Output *The output should be m lines of operations. Each line should be the* ***shortest*** *sequence of 'S', 'I', and 'O' if you can achieve the demanded order by your re-arrangement.*

We use 'S' to denote 'Straight Through', 'I' to denote 'Push', and 'O' to denote 'Pop'. There is no space between operations. If you cannot achieve the demanded order, please output 'Impossible'.

```
ISOS
IISIISSOOOO
Impossible
```

Exercise 2.17 ***Fruit Merge***

The harvest season has come! Since Maggie works in an orchard, she has picked all the fruits and separated them into n piles according to the kind, e.g. one pile for apples, one pile for oranges, etc. After that, she wants to merge all these piles into one pile. Every time, she can only merge two piles, and the energy cost of merging them is the sum of weight of the two piles. It is easily to see that after $n-1$ merges, there is only one pile left, and the total energy cost is sum of energy cost in all these $n-1$ merges. Of course, Maggie wants to save her energy as much as possible.

Now, assume that the weight of each fruit is 1 and you have known the total number of piles and number of fruits in each pile. Your target is to output the minimum total energy cost of Maggie.

Hint *It has been proved that you can achieve the minimum total energy cost by merging the two piles with the smallest number of fruits every time.*

Input *There are multiple test cases. In each test case, the first line is an integer n $(1 \leq n \leq 1,000)$ representing the total number of piles. The next line includes n positive integers with each representing the number of fruits in each pile. Please note that we have sorted all these numbers in non-decreasing order for your convenience. The end of input is specified by a line in which $n = 0$.*

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

Output *For each test case, you should use one line to output your result. The result includes only one integer, which is the minimum total energy cost of Maggie after merging all the fruit piles into one pile. We guarantee that this value will be always less than 2^{31}.*

```
15
45
```