WOBURN CHALLENGE

2018-19 Online Round 4

Friday, March 22nd, 2019

Intermediate Division Problems

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Problem I1: Inventory

14 Points / Time Limit: 2.00s / Memory Limit: 16M *Submit online: http://wcipeg.com/problem/wc184j3*

Billy, the king of video games, has received exclusive early access to play the upcoming action role-playing game *Diablo Immortal*! He's found that it truly revolutionizes the *Diablo* series, not only by moving to the superior gaming environment of a mobile phone, but by introducing a new system for managing the player's item inventory.

Billy has 1 or more items which he'd like his character to carry around, each of which has a certain size which indicates how many inventory slots it takes up. There are A size-1 items (which take up 1 inventory slot each), B size-2 items, and C size-3 items ($0 \le A, B, C \le 1{,}000{,}000{,}000$, $1 \le A + B + C \le 1{,}000{,}000{,}000$).

The character isn't allowed to carry all of these items around directly, as that would be unrealistic. Instead, they must be packed into knapsacks. Each knapsack has 3 inventory slots, meaning that it can fit 1 or more items as long as the sum of their sizes is at most 3. Each item must be packed entirely into a single knapsack.

The character may carry any number of knapsacks, but each one must be purchased through an in-game microtransaction, so Billy would prefer to use as few as possible. Help him determine the minimum number of knapsacks required to fit all of the items!

Subtask

In test cases worth 8/14 of the points, $A + B + C \le 100$.

Input Format

The first and only line of input consists of three space-separated integers, A, B, and C.

Output Format

Output a single integer, the minimum number of knapsacks required.

Sample Input 1

```
1 1 1
```

Sample Output 1

```
2
```

Sample Input 2

```
100 0 0
```

Sample Output 2

```
34
```

Sample Explanation

In the first case, Billy can fill one knapsack with both the size-1 and the size-2 items, and a second knapsack with the size-3 item. In the second case, Billy can fill 33 knapsacks with 3 size-1 items each, and pack the single leftover size-1 item into a 34th knapsack.

Problem I2: Your Name, Please

20 Points / Time Limit: 2.00s / Memory Limit: 16M *Submit online: http://wcipeg.com/problem/wc184j4*

Billy is just about to begin playing the classic role-playing game *EarthBound*! His first order of business will be to enter a name for his character.

EarthBound's name entry system displays the uppercase letters "`A`" through "`Z`" in a row, with a cursor indicating the one currently selected (initially "`A`"). It also displays the name which the player has entered so far (initially an empty string).

At any point in time, Billy may press a button to perform one of the following actions:

- "<": Move the cursor to the previous letter, wrapping around to the end if necessary (e.g. "`Y`"→"`X`", "`A`"→"`Z`")
- ">": Move the cursor to the next letter, wrapping around to the start if necessary (e.g. "`I`"→"`J`", "`Z`"→"`A`")
- "`A`": Append the currently-selected letter to the end of the current name (without moving the cursor)
- "+": Submit the current name, thus completing the name entry process

Given any name, there are multiple possible sequences of button presses which would end up submitting it. However, as the king of video games, Billy will showcase his skills right off the bat by entering his name of choice using the minimum possible number of button presses.

What remains is choosing an appropriate name…

Billy has decided that his name will consist of exactly N ($1 \le N \le 100$) letters. To make things particularly interesting, he's also decided to choose a name such that the minimum number of button presses required to enter it is exactly K ($1 \le K \le 10{,}000$). Help Billy come up with any name satisfying both of the above criteria, or determine that no such name exists!

Input Format

The first and only line of input consists of two space-separated integers, N and K.

Output Format

Output a single string, either a valid name consisting of N uppercase letters, or "`Impossible`" if no such name exists.

Sample Input 1

```
2 6
```

Sample Output 1

```
CB
```

Sample Input 2

```
1 20
```

Sample Output 2

```
Impossible
```

Sample Explanation

In the first case, "`CB`" meets both criteria: it consists of 2 letters, and requires a minimum of exactly 6 button presses to enter (">", ">", "`A`", "<", "`A`", "+"). Note that other outputs would also be accepted.

In the second case, there exists no single-letter name whose minimum number of required button presses is exactly 20.

Problem I3: World of StarCraft

28 Points / Time Limit: 3.00s / Memory Limit: 128M *Submit online: http://wcipeg.com/problem/wc184s1*

Billy, the king of video games, is (among other things) a top professional *StarCraft II* player. In light of his recent success as the only human to defeat the fearsome AlphaStar AI, he has received exclusive access to play the upcoming installment in the series, *World of StarCraft*. In a natural progression for the series, this is a massively multiplayer online role-playing game.

World of StarCraft features N ($2 \le N \le 100{,}000$) planets, numbered from 1 to N. Each planet is under the control of one of three races (Protoss, Terran, or Zerg), with the character R_i representing planet i's race (either "P" for Protoss, "T" for Terran, or "Z" for Zerg).

There are M ($0 \le M \le 100{,}000$) space routes running amongst the planets, with the i-th space route allowing one to travel in either direction between planets A_i and B_i ($1 \le A_i, B_i \le N$, $A_i \ne B_i$). There may be multiple space routes connecting a single pair of planets.

Despite its secretive and unreleased development status, *World of StarCraft* somehow already has an enormous player-base. Billy himself has K ($1 \le K \le 100{,}000$) friends in the game. His i-th friend is currently on planet X_i, and would like to reach a different planet Y_i to complete an objective ($1 \le X_i, Y_i \le N$; $X_i \ne Y_i$).

When a player is on a planet i, they may travel along a space route to another planet j, assuming that a space route exists which connects planets i and j. However, due to open hostilities amongst the three races, it's only safe to do so if both planets are under the control of the same race (in other words, if $R_i = R_j$).

Billy would love to help all of his friends complete their objectives, but not without putting their in-game lives at risk! Help him determine how many friends i he has such that it's possible to safely travel through a sequence of planets beginning at planet X_i and ending at planet Y_i.

Subtask

In test cases worth 16/28 of the points, $N \le 1000$, $M \le 1000$, and $K \le 1000$.

Input Format

The first line of input consists of three space-separated integers, N, M, and K.
The next line consists of characters, $R_{1..N}$.
M lines follow, the i-th of which consists of two space-separated integers, A_i and B_i, for $i = 1..M$.
K lines follow, the i-th of which consists of two space-separated integers, X_i and Y_i, for $i = 1..K$.

Output Format

Output a single integer, the number of friends who can safely complete their objectives.

Sample Input

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

Sample Output

```
2
```

Sample Explanation

Billy's first friend can safely travel directly from planet 6 to planet 4 to complete their objective.

Billy's second friend may never safely reach planet 3.

Billy's third friend can safely travel through the sequence of planets 1 → 4 → 6 → 5.

Problem I4: Farming Simulator

38 Points / Time Limit: 3.00s / Memory Limit: 64M *Submit online: http://wcipeg.com/problem/wc184s2*

When Billy needs an extra dose of excitement in his life, he looks no further than to one of his favourite video game series, *Farming Simulator*. It's filled with wonderful games, though *Farming Simulator 16* takes the cake.

Billy's farm in *Farming Simulator 16* includes a certain long stretch of dirt, which can be represented as a number line. Billy's currently standing at position 0 along the stretch, while his farmhouse is at position H ($2 \le H \le 500{,}000{,}000$). He has also prepared N ($1 \le N \le 3000$) holes in the dirt, the i-th of which is at a distinct position P_i ($1 \le P_i \le H - 1$).

Billy can walk along the stretch in either direction at a speed of 1 unit per second, and he may also choose to stand still at any point. He'd like to walk around and get a tree growing in each of the N holes, before ending up at his farmhouse!

Getting a tree growing in the i-th hole is a two-step process. First, at any point in time when Billy is at position P_i, he may instantly plant a seed in the hole. Then, at any point in time at least W_i ($1 \le W_i \le 500{,}000{,}000$) seconds after the seed has been planted, when Billy is once again at position P_i, he may instantly water the seed to make it start growing. Note that the minimum waiting time W_i may differ from hole to hole, due to realistically complex details of dirt composition.

Help Billy determine the minimum amount of time required for him to begin at position 0, get a tree growing in each of the N holes, and then end up at position H.

Subtask

In test cases worth 28/38 of the points, $N \le 200$.

Input Format

The first line of input consists of two space-separated integers, N and H.
N lines follow, the i-th of which consists of two space-separated integers, P_i and W_i, for $i = 1..N$.

Output Format

Output a single integer, the minimum number of seconds required for Billy to complete his task.

Sample Input

```
3 10
7 3
8 1
4 2
```

Sample Output

```
15
```

Sample Explanation

One optimal strategy for Billy is as follows:

- Walk to position 4, and plant a seed in hole 3 (4s)
- Stand still for 2 seconds, and water the seed in hole 3 (2s)
- Walk to position 7, and plant a seed in hole 1 (3s)
- Walk to position 8, and plant a seed in hole 2 (1s)
- Walk to position 7, stand still for 1 second, and water the seed in hole 1 (2s)
- Walk to position 8, and water the seed in hole 2 (1s)
- Walk to position 10 (2s)