READ THESE INSTRUCTIONS!

1) This is a take-home exam. So in principle, you are expected to do everything ALL BY YOURSELF.
2) To earn a mark, the program must finish running a test case with the correct output within 1 second of CPU processing time (excluding input/output time).
3) You can search on the internet for technical information. You can look up any materials that you have, but you MUST NOT COMMUNICATE with anyone concerning the exam problem, either directly or indirectly (through writing).
4) Make sure that you are aware of the submission deadline, which is 11:59PM of August 10. So you have at most 48 hours to work on them.
5) Name the programs as q1.py, q2.py, and q3.py for the three problems, respectively.
6) Zip all programs together. Submit the zip file!

VERIFIERS

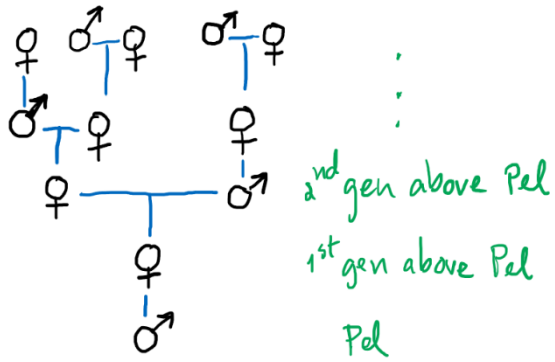
- No test case is provided for Question 1. You have to test the program totally by yourself.
- 3 test cases are provided for Question 2.
- 2 test cases are provided for Question 3.
- No solution is provided for any test case, BUT …
- There is an online verifier for Question 2 and Question 3 at the following URL. https://tinyurl.com/3b67kk8z.
  The web page will accept your answer for a specified test case, and respond with CORRECT or INCORRECT.

1. [10 Marks] The Harvesters, the alien race in the movie ID4, has a special form of breeding. In every hive, a queen (female) lays all the eggs. An unfertilized egg hatches into a drone (male). An egg that is fertilized by a male drone hatches in a female worker, who doesn't lay egg at all.

   A female worker can turn into a queen with a special process, but in the end there will be only one queen left per hive anyway.

   Consider a family tree of a male drone, named Pel. In the first generation above him, his parent is only the queen. In the second generation above Pel, the queen has two parents (from fertilization). The father of the queen has only one female parent, while the mother of the queen has two parents. So there are three Harvesters in the third generation above Pel.

   In diagram below, male is the symbol with arrow and female is the symbol with cross.



   Write a program that computes the number of Harvesters in the nth generation above Pel.

   INPUT:
   One number, the generation above Pel, n, $1 \leq n \leq 100$

   OUTPUT:
   the number of Harvesters in the n^{th} generation above Pel

   EXAMPLE

INPUT	OUTPUT
28	514229
97	135301852344706746049

   NOTE: Only three test cases (out of 10) will have $n \leq 30$

2. [10 Marks] You are considering buying and selling a stock. Your stock-prediction software estimates the stock price for the next n hours for you. Assuming that the predicted prices are correct, you want to know the maximum profit that you may earn from one time of investing in this stock.

   Write a program to determine the maximum possible profit that may be earned from ONE TIME of buying a unit of this stock and selling it.

   INPUT:

   A sequence of n numbers separated by a space; the stock price (per unit) in the next n hours, $1 \leq n \leq 100000$ (up to more than 10 years)

   OUTPUT:

   One number; the maximum profit possible from one time of buying and selling a unit

   EXAMPLE

INPUT	OUTPUT
5 15 11 2 8 12 15 18	16
10 9 8 7 6 5	0

   NOTE: Only three test cases (out of 10) will have $n \leq 10000$

   HINT: Compute how price changes from day to day. The max profit is the total change that increases the most.

3. [10 Marks] You are Quicksilver! You can travel K meters in 1 second. To qualify as an X-Men, you are required to also have a good judgement, so you are tested.

In this test, you will have to run along a 1-dimensional line trying to catch dropping balls. The line is marked every meter as positions 0, 1, … , 1,000,000,000. Every second, a ball labelled with a score will appear near the ground at a position on the line. If the ball is no farther than K meters from you, you can move to catch it. But you may decide not to, and the ball will drop on the ground and immediately disappears. The rule is, however, you cannot move from your position unless you really can catch a dropping ball. So in any second, if you move without catching a ball within that second, you will be disqualified.

The goal is to collect as high total score as possible.

To help you plan for the test, X-Men academy gives you the sequence of position and the score of the dropping balls. You then try to write a program to calculate your possible highest score!

INPUT:

First line: three integers separated by space; N (the number of balls, $N \leq 1000$), K (the maximum distance you can travel in one second), and S (the starting position on the line). $0 \leq K, S \leq 1{,}000{,}000{,}000$

The next N lines denotes events in the consecutive seconds. The first line is for the first second and so on. Each line contains two integers; the position and the score of the ball at the respective second.

OUTPUT:

One number; the highest possible total score.

EXAMPLE

INPUT	OUTPUT
3 4 2 5 4 1 3 8 5	9
5 10 100 90 10 81 10 99 5 105 10 85 10	30

NOTE: Only two test cases (out of 10) will have $n \leq 30$