Worksheet Solution: Computation

CS 101 Algorithmic Problem Solving

Fall 2023

1. Chairs Requirement

Chef's coding class is very famous in Chefland.

This year X students joined his class and each student will require one chair to sit on. Chef already has Y chairs in his class.

Determine the minimum number of new chairs Chef must buy so that every student is able to get one chair to sit on.

Constraints

- $0 \leq X, Y \leq 100$

Interaction

The input comprises a single line containing 2 space-separated integers denoting the values of X and Y respectively.

The output must contain a single number denoting the minimum number of extra chairs Chef must buy so that every student gets one chair.

Sample

Input	Output
20 14	6
41 41	0

In the first case, there are 20 students in the class and Chef has 14 chairs already. Therefore Chef must buy 6 more chairs.

In the second case, there are 41 students in the class and Chef already has exactly 41 chairs. Therefore Chef does not need to buy any more chairs.

Exercise

In the space provided, indicate the outputs for the given inputs.

Input	Output
35 0	35
50 100	50
37 8	29

Propose

Provide sample inputs and outputs below. Do not reuse any of the values from above.

Input	Output

Problem Identification

Briefly explain the underlying problem you identified in the above question that led you to your solution.

Answer: It is basic subtraction of chairs from students to figure out the number of new chairs needed.

2. Minimum Moves

You want to reach a destination but you decide that you can make moves in two directions only. If you are at position (x, y), then you can move to $(x+1, y+1)$ or $(x+1, y)$. You must start your journey from (x, y) and your destination is (X, Y).

Your task is to find the minimum number of moves that you require to reach the destination.

Constraints

- $Y \leq X$
- $0 \leq x, y \leq 1000$
- $0 \leq X, Y \leq 1000$

Interaction

The input comprises a single line containing 4 space-separated integers denoting the values of x, y, X and Y respectively.

The output must contain a single number denoting the minimum number of moves you must take.

Sample

Input	Output
0 0 5 5	5
4 4 11 10	7

In the first case, (x, y)=(0,0) which is the starting position and the destination is (X, Y)=(5,5). You can take (x+1,y+1) move for 5 times to reach the destination hence the minimum number of moves are 5.

In the second case, (x, y)=(4,4) which is the starting position and the destination is (X, Y)=(11,10). You can take (x+1,y+1) move for 6 times to reach (10,10) and (x+1,y) move once to reach the destination hence the minimum number of moves are 7.

Exercise

In the space provided, indicate the outputs for the given inputs.

Input	Output
0 0 7 4	7
2 3 9 9	7
3 9 11 11	8

Propose

Provide sample inputs and outputs below. Do not reuse any of the values from above.

Input	Output

Problem Identification
Briefly explain the underlying problem you identified in the above question that led you to your solution.
Answer: It is a simple mathematical subraction problem however, it has to be kept in mind that there is a move where y coordinate remains constant. So the coordinate to be used to calculate the moves is x coordinate.

3. Prize Pool

In a coding contest, there are prizes for the top rankers. The prize scheme is as follows:

- Top 10 participants receive rupees X each.
- Participants with rank 11 to 100 (both inclusive) receive rupees Y each.

Constraints

- $Y \leq X$
- $1 \leq X, Y \leq 1000$

Interaction

The input comprises a single line containing 2 space-separated integers denoting the values of X and Y respectively.

The output must contain a single number denoting the total prize money over all the contestants.

Sample

Input	Output
1000 100	19000
400 30	6700

In the first case, Top 10 participants receive rupees $X = 1000$ and next 90 participants receive rupees $Y = 100$ each. So, total prize money = 10*1000 + 90*100 = 19000.

In the second case, Top 10 participants receive rupees $X = 400$ and next 90 participants receive rupees $Y = 30$ each. So, total prize money = 10*400 + 90*30 = 6700.

Exercise

In the space provided, indicate the outputs for the given inputs.

Input	Output
1000 1000	100000
80 1	890
40 10	1300

Propose

Provide sample inputs and outputs below. Do not reuse any of the values from above.

Input	Output

Problem Identification

Briefly explain the underlying problem you identified in the above question that led you to your solution.

Answer: This problem calculates the total for which multiplication with the given amounts and addition is needed.

4. Finding Shoes

Chef has N friends. Chef promised that he would gift a pair of shoes (consisting of one left shoe and one right shoe) to each of his N friends. Chef was about to go to the marketplace to buy shoes, but he suddenly remembers that he already had M left shoes.

What is the minimum number of extra shoes that Chef will have to buy to ensure that he is able to gift a pair of shoes to each of his N friends?

Constraints

- $1 \leq N \leq 100$
- $0 \leq M \leq 100$

Interaction

The input comprises a single line containing 2 space-separated integers denoting the values of N and M respectively.

The output must contain a single number denoting the minimum number of extra shoes that Chef will have to buy to ensure that he is able to get N pairs of shoes.

Sample

Input	Output
2 4	2
6 0	12

In the first case, $N = 2$ and $M = 4$ which means Chef already has 4 left shoes, so he must buy 2 extra right shoes to form 2 pairs of shoes.

In the second case, $N = 6$ and $M = 0$ which means chef has no left shoes therefore, he must buy 6 more left shoes and 6 more right shoes to form 6 pairs of shoes which gives a total of 12.

Exercise

In the space provided, indicate the outputs for the given inputs.

Input	Output
4 3	5
8 8	8
9 3	15

Propose

Provide sample inputs and outputs below. Do not reuse any of the values from above.

Input	Output

Problem Identification

Briefly explain the underlying problem you identified in the above question that led you to your solution.

Answer: Every friend requires 2 shoes (left and right), therefore the value of N needs to be multiplied by 2 and then the available shoes are to be subtracted to find the total number of shoes that need to be bought.

5. Diwali Lights

On the eve of Diwali, Hari is decorating his house with a serial light bulb set. The serial light bulb set has N bulbs placed sequentially on a string which is programmed to change patterns every second. If at least one bulb in the set is on at any given instant of time, how many different patterns of light can the serial light bulb set produce?

Note: Lighting two bulbs *-* is different from **-.

Constraints

- $1 \leq N \leq 1000$

Interaction

The input comprises a single line containing an integer denoting the value of N.

The output must contain a single number denoting the total number of patterns that can be formed.

Sample

Input	Output
1	1
2	3

In the first case, $N = 1$, so 1 bulb can be lit in only 1 way.

In the second case, $N = 2$. 2 bulbs can be lit in -*, *-, ** which equals to a total of 3 ways.

Exercise

In the space provided, indicate the outputs for the given inputs.

Input	Output
8	255
11	2047
4	15

Propose

Provide sample inputs and outputs below. Do not reuse any of the values from above.

Input	Output

Problem Identification
Briefly explain the underlying problem you identified in the above question that led you to your solution.
Answer: Using the given inputs and explanation, if we try to make combinations from 1 till 3 we observe a pattern that gives a formula 2^n-1. 1 is subtracted because the state when all bulbs are turned off is not taken into consideration. This can also be thought of as the truth table combinations where the first one with all zeroes is not taken into consideration.

6. Handshake

At the annual meeting of Board of Directors of Acme Inc. If everyone attending shakes hands exactly one time with every other attendee, how many handshakes are there? Let number of attendants be denoted by a.

Constraints

- $1 \leq a \leq 1000$

Interaction

The input comprises a single line containing an integer denoting the value of a.

The output must contain a single number denoting the total number of handshakes.

Sample

Input	Output
1	0
3	3

In the first case, $a = 1$, which means there is only one attendant so there is no one to shake hands with. Therefore. total number of handshakes is 0.

In the second case, $a = 3$. There are 3 attendees, $p1, p2$ and $p3$. $p1$ shakes hands with $p2$ and $p3$, and $p2$ shakes hands with $p3$. Now they have all shaken hands after 3 handshakes.

Exercise

In the space provided, indicate the outputs for the given inputs.

Input	Output
2	1
9	36
12	66

Propose

Provide sample inputs and outputs below. Do not reuse any of the values from above.

Input	Output

Problem Identification
Briefly explain the underlying problem you identified in the above question that led you to your solution.
Answer: If we try to figure out the number of handshakes from 1 till 3, we can observe a pattern which gives the formula $(n-1)*(n/2)$. This question can also be solved using mathematical combinations, as for a handshake to happen we need 2 people so we need possible combinations in pairs of the given people which gives the formula a$C2$.

7. Single-use Attack

Chef is playing a video game, and is now fighting the final boss. The boss has H health points. Each attack of Chef reduces the health of the boss by X. Chef also has a special attack that can be used at most once, and will decrease the health of the boss by Y. Chef wins when the health of the boss is ≤ 0.

What is the minimum number of attacks needed by Chef to win?

Constraints

- $Y \leq X$
- $0 \leq X, Y, H \leq 100$

Interaction

The input comprises a single line containing three space-separated integers deonting the values of H, X and Y.

The output must contain a single number denoting the minimum number of attacks needed by Chef to win.

Sample

Input	Output
100 25 40	4
46 1 2	45

In the first case, $H = 100$, $X = 25$ while $Y = 40$. Chef can attack the boss 4 times normally. This results in 25+25+25+25=100 damage, which is enough to defeat the boss hence answer is 4.

In the second case, $H = 46$, $X = 1$ while $Y = 2$. Chef can first use the special attack. This leaves the boss with 46 - 2 = 44 health. Then, use 44 normal attacks to defeat the boss, since each one does 1 damage. So the total number of attacks equal 44 + 1 = 45.

Exercise

In the space provided, indicate the outputs for the given inputs.

Input	Output
100 29 45	3
78 15 78	1
0 30 45	0

Propose

Provide sample inputs and outputs below. Do not reuse any of the values from above.

Input	Output

Problem Identification

Briefly explain the underlying problem you identified in the above question that led you to your solution.

Answer: Here the strategy is to first subtract the impact of special attack and then divide the remaining health by the normal attacks X. However, we have to round up the quotient. Total attacks then equals quotient plus 1 for the special attack.

8. Zoo Creatures

A zoo have two types of creatures, type A has a hands and type B has b hands. Spawn the smallest number of creatures so they can grab each other hands in the following conditions:

- Each creature should only grab the hands of another creature type.
- Each creature should grab with all of its hands.

What is the smallest number of creatures needed?

Constraints

- $1 \leq a, b \leq 1000$

Interaction

The input comprises a single line containing 2 space-separated integers denoting the valued of a and b respectively.

The output must contain 2 space-separated integers denoting the number of type A creatures, and the number of type B creatures.

Sample

Input	Output
20 2	1 10
3 2	2 3

In the first case, One creature of type A has 20 hands. Ten creatures of type B have 20 hands as each has 2 hands. So they can grab each other hands in asked conditions.

In the second case, 2 type A creatures will have a total of 6 hands and for them to hold type B creatures, we need 3 of type B creatures whose total hands equal 6 as well.

Exercise

In the space provided, indicate the outputs for the given inputs.

Input	Output
1 6	6 1
15 5	1 3
7 3	3 7

Propose

Provide sample inputs and outputs below. Do not reuse any of the values from above.

Input	Output

Problem Identification

Briefly explain the underlying problem you identified in the above question that led you to your solution.

Answer: We basically need to find the LCM of the two and then divide LCM by each number of hands to find the number of that creature needed.

9. Simon cannot sleep

It's 12 o'clock at midnight (00:00) and Simon cannot sleep! So he decided to stare at the clock on his wall until he falls asleep. He saw the clock's hands and got to thinking 'How many times they'll pass each other until I fall asleep'. Imagine that he fell asleep at (00:00).

Now, you must figure out how many times clock's hands overlap from (00:00) to ($hh : mm$).

Hint: The hands of a clock coincide 11 times in every 12 hours.

Constraints

- $0 \leq m \leq 23$
- $0 \leq h \leq 59$

Interaction

The input comprises a single line containing 2 space-separated integers denoting the values of hh and mm.

The output must contain a single number denoting the total number of times clock's hands overlap.

Sample

Input	Output
01 05	1
08 22	8

In the first case, the hands pass each others only at (00:00).

In the second case, the hands will overlap 8 times from (00:00) to (08:22) which are a total of 502 minutes, including the overlap at (00:00). **Exercise**

In the space provided, indicate the outputs for the given inputs.

Input	Output
07 38	7
22 55	22
03 17	4

Propose

Provide sample inputs and outputs below. Do not reuse any of the values from above.

Input	Output

Problem Identification

Briefly explain the underlying problem you identified in the above question that led you to your solution.

Answer: If we do the calculation in minutes then we know that hands overlap 11 times every 720 minutes. Using unitary method we can easily form a formula which is (total minutes * 11) // 720 and then add 1 for the overlap at 00:00.

10. Subway Bread

Martha is interviewing at Subway. One of the rounds of the interview requires her to cut a bread of size $l * b$ into smaller identical pieces such that each piece is a square having

maximum possible side length with no left over piece of bread.

Find the number of squares of maximum size that can be cut.

Constraints

- $0 \leq l, b \leq 1000$

Interaction

The input comprises a single line containing two space separated integers l and b which denote length and breadth of the bread.

The output must contain a single number denoting the number of squares of maximum size, when the bread is cut as per the given condition.

Sample

Input	Output
2 2	1
6 9	6

In the first case, Martha has a bread whose original dimensions are 2 * 2, the bread is uncut and is a square. Hence the answer is 1.

In the second case, Martha has a bread of size 6 * 9. We can cut it into 54 squares of size 1 * 1, 6 of size 3 * 3. For other sizes we will have leftovers. Hence, the number of squares of maximum size that can be cut is 6.

Exercise

In the space provided, indicate the outputs for the given inputs.

Input	Output
4 4	1
8 3	24
2 6	3

Propose

Provide sample inputs and outputs below. Do not reuse any of the values from above.

Input	Output

Problem Identification

Briefly explain the underlying problem you identified in the above question that led you to your solution.

Answer: The question asks on how large can a square piece be to fit into the original area without any remainder which means we need the highest common factor. We need to divide both the length and the width each by the gcf/hcf so we get the formula (l * b)/(gcf * gcf).