South African Computer Olympiad
Camp 3 - 2010
Day 1

Overview

Problem	**bidding**	**ncubes**	**pgame**	**walk**
Source	bidding.c bidding.cpp	ncubes.c ncubes.cpp	pgame.c pgame.cpp	walk.c walk.cpp
Input file	stdin	stdin	stdin	stdin
Output file	stdout	stdout	stdout	stdout
Time limit	0.5 seconds	2 seconds	1 second	3 seconds
Memory limit	64MiB	64MiB	64MiB	128MiB
Number of tests	10	10	10	10
Points per test	10	10	10	10
Detailed feedback	No	Yes	No	No
Total points	**100**	**100**	**100**	**100**

The maximum total score is 400 points.

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Manic Bidding

Kosie van der Merwe

Introduction

Fred the Manic Storekeeper has decided to leave shopkeeping for the fast-paced world of auctions. At his first auction he is selling all of his old stock. Unfortunately, most of it is junk like boxes of exploded explosives, lethal joke books, etc. Luckily he also has a flux capacitor up for grabs, which may or may not allow you to fulfill your dream of time travel (depending on whether it is a fake or not). You have decided you must win it at all costs; the chance to achieve time travel is not something that should be squandered.

Due to Fred's mania, his auctions do not work like normal auctions. He imposes an upper limit, U, and lower limit, L, on the money you are allowed to bid.

This is not the end to his craziness, however: instead of the usual method of determining the winning bid, he first *bitwise or*s the bids with some unknown number and then chooses the largest. Since you really want the flux capacitor, you carefully watched previous bids and have determined the value to be N.

Unlike Fred, you have a normal sense of what money is worth. So you would like to make Fred think you are paying largest amount possible subject to his restrictions—thus guaranteeing yourself the win—while actually paying him the least amount of actual money to make this happen. You have found that determining this amount to be slightly difficult, so you have decided to write a program to do this for you.

Task

Your task is to find the smallest number, B, that maximises the value of $B|N$ such that B is at least L and at most U. You must output B and not the value of $B|N$. $B|N$ is the *bitwise or* of N and B.

Example

Given, $N = 100$, $L = 30$ and $U = 100$. We know $N = 1100100_2$ in base 2. So by not breaking the upper limit, U, we see $B = 27$ or 11011_2 in base 2 gives us the maximum value of $N|B$ of 127. But B is less than L, therefore, $B = 31$ or 11111_2 in binary is the smallest value of B that respects the limits and maximise $N|B$.

Input (stdin)

The input consists of a single line with three space-separated integers: N, L and U, in that order.

Sample input

```
100 30 100
```

Output (stdout)

The output must be a single integer B.

Sample output

```
31
```

Constraints

- $0 \leq N \leq 2^{64} - 1$
- $0 \leq L \leq U \leq 2^{64} - 1$

Additionally, in 30% of the test cases:

- $U - L \leq 10^7 = 10\,000\,000$

Time limit

0.5 seconds.

Scoring

A correct solution will score 100% while an incorrect solution will score 0%.

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Forming N-Cubes

Graham Manuell

Introduction

Fred the Manic Storekeeper has recently become the proud owner of an infinite-dimensional room and plans to use it to store his prized collection of boxes. Each box measures precisely 1 cm in each direction.

Fred is determined to pack the boxes into a regular structure and has decided only a rectilinear (axis-aligned) arrangement will suffice. Thus, Fred will only be satisfied if the boxes can be arranged into a square, cube, tesseract or some higher-dimensional hypercube. (A hypercube is the generic term for the analogue of a cube in any number of dimensions.)

Alas, Fred cannot find the slip of paper saying how many boxes are in his collection. Luckily, he can still vaguely recall a range in which he can be sure this number lies.

Task

Fred knows that there are at least a boxes and at most b boxes in his collection. It will clearly not always be possible for Fred to pack his boxes exactly. Help Fred gauge how likely it is for him to be able to meet his objective by computing how many numbers of boxes, in the range from a to b, can form cubes of some dimension.

Example

Suppose Fred knows that he owns at least 10 and at most 32 boxes. He would be able to form a hypercube out of the follow number of boxes: 16 (a 4x4 square), 25 (a 5x5 square), 27 (a 3x3x3 cube) or 32 (a 2x2x2x2x2 5-cube). So there are 4 possibilities.

Input (stdin)

The first and only line of the input consists of two space-separated decimal integers, a and b.

Sample input

```
10 32
```

Output (stdout)

Output a single decimal integer, the number of box collection sizes that would allow for the arrangement into a hypercube of some dimension. The integer must be output without leading zeros.

Sample output

```
4
```

Constraints

- $1 \leq a \leq b \leq 10^{250}$

Additionally, in 50% of the test cases $b \leq 10^{12}$ and in 30% of the test cases $b \leq 400\,000$.

Time limit

2 seconds.

Detailed feedback

Detailed feedback is enabled for this problem.

Scoring

A correct answer will score 100% while an incorrect answer will score 0%.

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Prime Game

Sean Wentzel

Introduction

Archibald Lvovich Schläfli-Schicklgruber is locked in battle with his arch-nemesis, Bob, for control over the universe. Because of the high cost of a full-on war, they will decide the fate of the universe with a game about positive integers.

The game is played with a number n. On any turn, the player must replace n with $\frac{n}{p}$, where p is a prime factor of n. In addition, if the resulting number is odd, they may add 1 to it. The first player who is unable to move loses, that is, the person who reaches 1 wins.

Task

Archibald wants to know whether he can win the game for a certain n. Bob is an evil genius-type villain, so he will always play optimally. Write a program to find whether Archibald can win.

Example

If n is twelve, then Archibald can replace it with 4. Bob must then replace it with 2 or 3. Archibald can replace either with 1 to win. If n is 4, Bob can win by the same strategy.

Input (stdin)

A single positive integer, n.

Sample input

```
12
```

Output (stdout)

Output "Archibald" if Archibald can win; otherwise output "Bob".

Sample output

```
Archibald
```

Constraints

- $n \leq 10^7 = 10\,000\,000$

In addition, for 60% of the test cases:

- $n \leq 10^5 = 100\,000$

Time limit

1 second.

Scoring

A correct solution will score 100% while an incorrect solution will score 0%.

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Walking Home

Francois Conradie

Introduction

After a late night Ben is very thirsty and decides to walk to the nearest store in order to get some refreshments. Unfortunately Ben is feeling very disorientated and is struggling to walk in a straight line. Instead Ben is moving in a series of one-fifth circular arcs (72^o), with a free choice of a clockwise or an anti-clockwise arc for each step, but no turning on the spot. After a while Bens mother starts to get very worried because Ben is taking way too long. Bens mother also knows Ben has the energy to take exactly N steps.

Task

Given that Ben started facing North, help Bens mother determine how many journeys consisting of exactly N steps Ben can make that will return him home after his final step, again facing Northward. You have to output the answer modulo 1 000 007

Example

Consider the case where $N = 5$. Then there are two possible journeys that Ben can make that will take him back to his original position: Either all his moves are in the clockwise direction or all his moves are in a counter clockwise direction. All other possible journeys will not take him back home.

Input (stdin)

The first and only line of input contains a single integer, N.

Sample input

```
5
```

Output (stdout)

Output a single integer: the number of journeys that Ben can take consisting of exactly N steps that gets him back to his starting position facing Northwards. Output the answer modulo 1 000 007

Sample output

```
2
```

Constraints

$1 \leq N \leq 100$
Additionally, in 40% of the test cases: $1 \leq N \leq 20$

Time limit

3 seconds.

Scoring

A correct solution will score 100% while an incorrect solution will score 0%.