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# C2. Guessing the Greatest (hard version)

time limit per test: 1 second memory limit per test: 256 megabytes input: standard input output: standard output

The only difference between the easy and the hard version is the limit to the number of queries.

This is an interactive problem.

There is an array a of n **different** numbers. In one query you can ask the position of the second maximum element in a subsegment a[l..r]. Find the position of the maximum element in the array in no more than **20** queries.

A subsegment a[l..r] is all the elements  $a_l, a_{l+1}, \ldots, a_r$ . After asking this subsegment you will be given the position of the second maximum from this subsegment **in the whole** array.

### Input

The first line contains a single integer n ( $2 \le n \le 10^5$ ) — the number of elements in the array.

### Interaction

You can ask queries by printing "? l r"  $(1 \le l < r \le n)$ . The answer is the index of the second maximum of all elements  $a_l, a_{l+1}, \ldots, a_r$ . Array a is fixed beforehand and can't be changed in time of interaction.

You can output the answer by printing "! p", where p is the index of the maximum element in the array.

You can ask no more than 20 queries. Printing the answer doesn't count as a query.

After printing a query do not forget to output end of line and flush the output. Otherwise, you will get Idleness limit exceeded. To do this, use:

- fflush(stdout) or cout.flush() in C++;
- System.out.flush() in Java;
- flush(output) in Pascal;
- stdout.flush() in Python;
- · see documentation for other languages

### **Hacks**

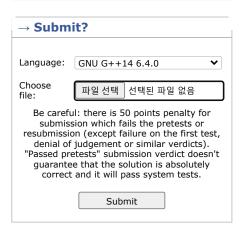
To make a hack, use the following test format.

In the first line output a single integer n ( $2 \le n \le 10^5$ ). In the second line output a permutation of n integers 1 to n. The position of n in the permutation is the position of the maximum

### Example

Example	
input	Сору
5	
3	
4	

# Contest is running 00:19:42 Contestant



→ Score table	
	Score
<u>Problem A</u>	270
<u>Problem B</u>	540
<u>Problem C1</u>	405
Problem C2	405
<u>Problem D</u>	945
<u>Problem E</u>	1215
<u>Problem F</u>	1620
Successful hack	100
Unsuccessful hack	-50
Unsuccessful submission	-50
Resubmission	-50
Unsuccessful submission	-50 -50

<sup>\*</sup> If you solve problem on 01:55 from the first attempt

output	Сору
? 1 5	
? 4 5	
! 1	

## Note

In the sample suppose a is [5, 1, 4, 2, 3]. So after asking the [1..5] subsegment 4 is second to max value, and it's position is 3. After asking the [4..5] subsegment 2 is second to max value and it's position in the whole array is 4.

Note that there are other arrays *a* that would produce the same interaction, and the answer for them might be different. Example output is given in purpose of understanding the interaction.

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