Minequake
Problem ID: minequake


Goodluck Mine, Passage by Ashley Dace. License CC BY-SA 2.0.

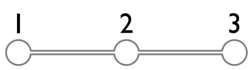
The fully autonomous microbreweries installed in the abandoned Dwarven mines of Moravia are truly a testament to the ingenuity and craftsmanship of Dwarven engineering! Alas, sometimes earthquakes rattle the mines, leading to misaligned pipes and funnels spilling precious liquid on the floor. As the Exalted Warden of Brewery Safety it is your responsibility to turn off the machines in every hall in case of an earthquake.

Walking through tunnels takes time, so you will inevitably arrive late at many of the machines. This cannot be avoided, but you want to minimise the total amount of spilled liquid.

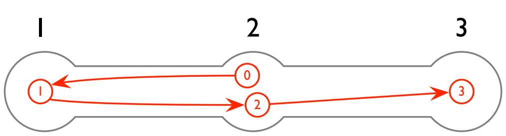
The Dwarven mines consist of n halls connected by $n-1$ tunnels. The entire system is connected, so it is possible to get from any hall to any of the others. It takes 1 unit of time to traverse a tunnel. Switching off a machines and traversing a hall takes no time. In each hall, turning off the machines at time t after the earthquake spills t liters of liquid. There is exactly one earthquake, the earthquake affects all halls at the same time, and you may not switch off any machines before the earthquake. You can start in any of the halls.

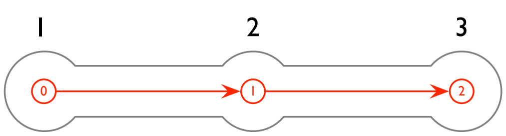
Example

In sample input 1, the mines look like this:



If you start in hall 2 and visit the rest of the halls in the order $2, 1, 2, 3$, then you can switch off their machines at time 0 (in hall 2), time 1 (in hall 1), and time 3 (in hall 3). This wastes $0+1+3=4$ liters of liquid in total. If instead you start in hall 1 and visit the halls in the order $1, 2, 3$, the total amount of liquid wasted is $0+1+2=3$ liters, which is better.





Input

The first line of input consists of the integer n, denoting the number of halls. We assume that the halls are numbered $1, \ldots, n$. The next $n-1$ lines each contain two space-separated integers u and v with $1 \leq u < v \leq n$, meaning that there is a tunnel between hall u and hall v.

Output

Print a single integer: the minimum amount of spilled liquid, in liters.

Constraints and Scoring

We always have $1 \leq n \leq 10^5$.

Your solution will be tested on a set of test groups, each worth a number of points. Each test group contains a set of test cases. To get the points for a test group you need to solve all test cases in the test group. Your final score will be the maximum score of a single submission.

Group	Points	Constraints
1	18	no hall has more than two tunnels
2	19	at most one hall has more than two tunnels
3	20	$n \leq 10$
4	21	$n \leq 1000$
5	22	*No additional constraints*

Sample Input 1	Sample Output 1
3 1 2 2 3	3

Sample Input 2	Sample Output 2
4 1 2 1 3 1 4	7

Sample Input 3	Sample Output 3
1	0

Mineral deposits
Problem ID: mineraldeposits

Eroding mud face exposing new minerals. Photo: Michael D. Turnbull, licence: CC BY-SA.

You handle signal processing for an extra-terrestrial mining company, and your vessel is currently approaching an asteroid. Preliminary scans show the presence of k mineral deposits on the asteroid, but their precise locations are unknown.

The surface of the asteroid can be seen as a grid of integer coordinates. Each of the mineral deposits is located at unknown integer coordinates such that the ith deposit has coordinates (x_i, y_i) with $-b \leq x_i \leq b$ and $-b \leq y_i \leq b$ for some integer b corresponding to the size of your initial scan.

To determine the precise locations of the mineral deposits, you may send probes to the surface of the asteroid. The probes are sent out in waves of several probes at once.

Say you sent a wave of d probes to the surface at coordinates (s_j, t_j) for $1 \leq j \leq d$. When a probe arrives at its coordinates, it determines the Manhattan distances to each of the k mineral deposits and sends the distances back to the ship. All data packets arrive at the same time, and it is not possible to determine which probes returned which distances. Thus the wave returns the $k \cdot d$ integer distances

$$|x_i - s_j| + |y_i - t_j| \qquad \text{for all } i \in \{1, \ldots, k\} \text{ and } j \in \{1, \ldots, d\}.$$

You need to minimise the number of waves of probes that is sent to the surface.

Interaction

This is an interactive problem. Interaction begins with you reading a single line containing three integers b, k, and w: the grid's boundary b, the number k of mineral deposits, and the maximum number w of waves you may send.

You then ask at most w queries, each corresponding to a wave. A query consists of `?` followed by $2d$ integers separated by space, such as "$?\ s_1\ t_1 \cdots s_d\ t_d$", where the number d of probes in this wave must satisfy $1 \leq d \leq 2000$. The values (s_i, t_i) are interpreted as the coordinates of the ith probe and must satisfy $-10^8 \leq s_i \leq 10^8$ and $-10^8 \leq t_i \leq 10^8$. The response is a single line with $k \cdot d$ integers in non-decreasing order: all pairs of Manhattan distances between the mineral deposits and the probe coordinates. The total number of probes across all waves may not exceed $2 \cdot 10^4$.

Interaction ends with you printing a single line consisting of `!` followed by k points $x_1, y_1, x_2, y_2, \ldots x_k, y_k$, separated by space. This must be your last line of output.

Your submission is considered correct if you print all locations of the mineral deposits. You may print them in any order.

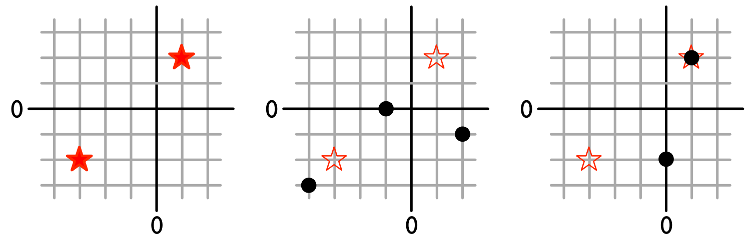
Constraints and Scoring

We always have $1 \leq b \leq 10^8$, $1 \leq k \leq 20$, and $2 \leq w \leq 10^4$.

Your solution will be tested on a set of test groups, each worth a number of points. Each test group contains a set of test cases. To get the points for a test group you need to solve all test cases in the test group. Your final score will be the maximum score of a single submission.

Group	Points	Constraints
1	9	$k = 1, w = 10^4$
2	19	$w \geq 500$
3	11	$w \geq 210$
4	7	$w \geq 130$
5	20	$w \geq 3$, $b \leq 10^4$
6	15	$w \geq 3$, $b \leq 10^7$
7	19	*No further constraints*

Example



In this example, there are $k = 2$ mineral deposits at positions $(1, 2)$ and $(-3, -2)$, shown as red stars. In the first wave, you might send $d = 3$ probes to $(-4, -3)$, $(-1, 0)$, and $(2, -1)$, shown as black dots. This wave would return the 6 distances

$$2, 4, 4, 4, 6, 10\,.$$

In the next wave, you might send $d = 2$ probes to $(1, 2)$ and $(0, -2)$. This wave would return the 4 distances

$$0, 3, 5, 8\,.$$

Read	Sample Interaction 1	Write
`4 2 10`		
		`? -4 -3 -1 0 2 -1`
`2 4 4 4 6 10`		
		`? 1 2 0 -2`
`0 3 5 8`		
		`! 1 2 -3 -2`

Sequence
Problem ID: sequence

A sequence of positive integers $(x_1, \ldots, x_m)$ is *good* if $x_1 = 1$ and for each $1 < j \le m$ we have either $x_j = x_{j-1} + 1$ or $x_j = x_k \cdot x_l$ for some k and l with $0 < k \le l < j$. For instance, the sequences $(1, 1)$ and $(1, 2)$ are both good, but the sequence $(1, 3)$ is not good. For n given integers $w_1, \ldots, w_n$ define the *weight* of an integer sequence $(x_1, \ldots, x_m)$ satisfying $1 \le x_j \le n$ for each $1 \le j \le m$ as

$$w_{x_1} + \cdots + w_{x_m} .$$

For instance, given the weights $w_1 = 10, w_2 = 42, w_3 = 1$, the weight of the sequence $(1, 1)$ is 20 and the weight of the sequence $(1, 3)$ is 11. For $1 \le v \le n$, define s_v as the smallest possible weight of a good sequence containing the value v.

Your task is to determine the values $s_1, \ldots, s_n$.

Input

The first line of input consists of the integer n, the number of weights. The next n lines contain the integer weights $w_1, \ldots, w_n$.

Output

Print n lines containing s_1, . . ., s_n in order.

Constraints and Scoring

We always have $1 \le n \le 30\,000$ and $1 \le w_i \le 10^6$ for each $1 \le i \le n$.

Your solution will be tested on a set of test groups, each worth a number of points. Each test group contains a set of test cases. To get the points for a test group you need to solve all test cases in the test group. Your final score will be the maximum score of a single submission.

Group	Points	Constraints
1	11	$n \le 10$
2	10	$n \le 300$, $w_1 = \cdots = w_n = 1$
3	10	$n \le 300$, $w_1 = \cdots = w_n$
4	9	$n \le 1400$, $w_1 = \cdots = w_n = 1$
5	45	$n \le 5000$
6	15	*No additional constraints*

Sample Input 1	Sample Output 1
3 10 42 1	10 52 53