Problem Set 2 — Binary Search 15-295 Fall 2019

A. Hamburgers

time limit per test: 1 second
memory limit per test: 256 megabytes

Polycarpus loves hamburgers very much. He especially adores the hamburgers he makes with his own hands. Polycarpus thinks that there are only three decent ingredients to make hamburgers from: a bread, sausage and cheese. He writes down the recipe of his favorite "Le Hamburger de Polycarpus" as a string of letters 'B' (bread), 'S' (sausage) и 'C' (cheese). The ingredients in the recipe go from bottom to top, for example, recipe "BSCBS" represents the hamburger where the ingredients go from bottom to top as bread, sausage, cheese, bread and sausage again.

Polycarpus has n_b pieces of bread, n_s pieces of sausage and n_c pieces of cheese in the kitchen. Besides, the shop nearby has all three ingredients, the prices are p_b rubles for a piece of bread, p_s for a piece of sausage and p_c for a piece of cheese.

Polycarpus has r rubles and he is ready to shop on them. What maximum number of hamburgers can he cook? You can assume that Polycarpus cannot break or slice any of the pieces of bread, sausage or cheese. Besides, the shop has an unlimited number of pieces of each ingredient.

Input

The first line of the input contains a non-empty string that describes the recipe of "Le Hamburger de Polycarpus". The length of the string doesn't exceed 100, the string contains only letters 'B' (uppercase English B), 'S' (uppercase English S) and 'C' (uppercase English C).

The second line contains three integers n_b, n_s, n_c $(1 \le n_b, n_s, n_c \le 100)$ — the number of the pieces of bread, sausage and cheese on Polycarpus' kitchen. The third line contains three integers p_b, p_s, p_c $(1 \le p_b, p_s, p_c \le 100)$ — the price of one piece of bread, sausage and cheese in the shop. Finally, the fourth line contains integer r $(1 \le r \le 10^{12})$ — the number of rubles Polycarpus has.

Please, do not write the `%lld` specifier to read or write 64-bit integers in C++. It is preferred to use the `cin`, `cout` streams or the `%I64d` specifier.

Output

Print the maximum number of hamburgers Polycarpus can make. If he can't make any hamburger, print `0`.

input	output
BBBSSC 6 4 1 1 2 3 4	2

input	output
BBC 1 10 1 1 10 1 21	7

input	output
BSC 1 1 1 1 1 3 1000000000000	200000000001

B. Sagheer and Nubian Market

time limit per test: 2 seconds
memory limit per test: 256 megabytes

On his trip to Luxor and Aswan, Sagheer went to a Nubian market to buy some souvenirs for his friends and relatives. The market has some strange rules. It contains n different items numbered from 1 to n. The i-th item has base cost a_i Egyptian pounds. If Sagheer buys k items with indices $x_1, x_2, ..., x_k$, then the cost of item x_j is $a_{x_j} + x_j \cdot k$ for $1 \le j \le k$. In other words, the cost of an item is equal to its base cost in addition to its index multiplied by the factor k.

Sagheer wants to buy as many souvenirs as possible without paying more than S Egyptian pounds. Note that he cannot buy a souvenir more than once. If there are many ways to maximize the number of souvenirs, he will choose the way that will minimize the total cost. Can you help him with this task?

Input

The first line contains two integers n and S ($1 \le n \le 10^5$ and $1 \le S \le 10^9$) — the number of souvenirs in the market and Sagheer's budget.

The second line contains n space-separated integers $a_1, a_2, ..., a_n$ ($1 \le a_i \le 10^5$) — the base costs of the souvenirs.

Output

On a single line, print two integers k, T — the maximum number of souvenirs Sagheer can buy and the minimum total cost to buy these k souvenirs.

input	output
3 11 2 3 5	2 11

input	output
4 100 1 2 5 6	4 54

input	output
1 7 7	0 0

In the first example, he cannot take the three items because they will cost him $[5, 9, 14]$ with total cost 28. If he decides to take only two items, then the costs will be $[4, 7, 11]$. So he can afford the first and second items.

In the second example, he can buy all items as they will cost him $[5, 10, 17, 22]$.

In the third example, there is only one souvenir in the market which will cost him 8 pounds, so he cannot buy it.

C. As Fast As Possible

time limit per test: 1 second
memory limit per test: 256 megabytes

On vacations n pupils decided to go on excursion and gather all together. They need to overcome the path with the length l meters. Each of the pupils will go with the speed equal to v_1. To get to the excursion quickly, it was decided to rent a bus, which has seats for k people (it means that it can't fit more than k people at the same time) and the speed equal to v_2. In order to avoid seasick, each of the pupils want to get into the bus **no more than once**.

Determine the minimum time required for all n pupils to reach the place of excursion. Consider that the embarkation and disembarkation of passengers, as well as the reversal of the bus, take place immediately and this time can be neglected.

Input

The first line of the input contains five positive integers n, l, v_1, v_2 and k ($1 \le n \le 10\,000$, $1 \le l \le 10^9$, $1 \le v_1 < v_2 \le 10^9$, $1 \le k \le n$) — the number of pupils, the distance from meeting to the place of excursion, the speed of each pupil, the speed of bus and the number of seats in the bus.

Output

Print the real number — the minimum time in which all pupils can reach the place of excursion. Your answer will be considered correct if its absolute or relative error won't exceed 10^{-6}.

input	output
5 10 1 2 5	5.0000000000

input	output
3 6 1 2 1	4.7142857143

In the first sample we should immediately put all five pupils to the bus. The speed of the bus equals 2 and the distance is equal to 10, so the pupils will reach the place of excursion in time $10 / 2 = 5$.

D Financial Planning

Time limit: 3s

Being a responsible young adult, you have decided to start planning for retirement. Doing some back-of-the-envelope calculations, you figured out you need at least M euros to retire comfortably.

You are currently broke, but fortunately a generous gazillionaire friend has offered to lend you an arbitrary amount of money (as much as you need), without interest, to invest in the stock market. After making some profits you will then return the original sum to your friend, leaving you with the remainder.

Available to you are n investment opportunities, the i-th of which costs c_i euros. You also used your computer science skills to predict that the i-th investment will earn you p_i euros per day. What is the minimum number of days you need before you can pay back your friend and retire? You can only invest once in each investment opportunity, but you can invest in as many different investment opportunities as you like.

For example, consider the first sample. If you buy only the second investment (which costs 15 euros) you will earn $p_2 = 10$ euros per day. After two days you will have earned 20 euros, exactly enough to pay off your friend (from whom you borrowed 15 euros) and retire with the remaining profits (5 euros). There is no way to make a net amount of 5 euros in a single day, so two days is the fastest possible.

Input

- The first line contains the number of investment options $1 \leq n \leq 10^5$ and the minimum amount of money you need to retire $1 \leq M \leq 10^9$.
- Then, n lines follow. Each line i has two integers: the daily profits of this investment $1 \leq p_i \leq 10^9$ and its initial cost $1 \leq c_i \leq 10^9$.

Output

Print the minimum number of days needed to recoup your investments and retire with at least M euros, if you follow an optimal investment strategy.

Sample Input 1	Sample Output 1
2 5 4 10 10 15	2

Sample Input 2	Sample Output 2
4 10 1 8 3 12 4 17 10 100	6

Sample Input 3	Sample Output 3
3 5 4 1 9 10 6 3	1

E. Chip 'n Dale Rescue Rangers

time limit per test: 1 second
memory limit per test: 256 megabytes

A team of furry rescue rangers was sitting idle in their hollow tree when suddenly they received a signal of distress. In a few moments they were ready, and the dirigible of the rescue chipmunks hit the road.

We assume that the action takes place on a Cartesian plane. The headquarters of the rescuers is located at point (x_1, y_1), and the distress signal came from the point (x_2, y_2).

Due to Gadget's engineering talent, the rescuers' dirigible can instantly change its current velocity and direction of movement at any moment and as many times as needed. The only limitation is: the speed of the aircraft relative to the air can not exceed $v_{\max}$ meters per second.

Of course, Gadget is a true rescuer and wants to reach the destination as soon as possible. The matter is complicated by the fact that the wind is blowing in the air and it affects the movement of the dirigible. According to the weather forecast, the wind will be defined by the vector (v_x, v_y) for the nearest t seconds, and then will change to (w_x, w_y). These vectors give both the direction and velocity of the wind. Formally, if a dirigible is located at the point (x, y), while its own velocity relative to the air is equal to zero and the wind (u_x, u_y) is blowing, then after τ seconds the new position of the dirigible will be $(x + \tau \cdot u_x,\ y + \tau \cdot u_y)$.

Gadget is busy piloting the aircraft, so she asked Chip to calculate how long will it take them to reach the destination if they fly optimally. He coped with the task easily, but Dale is convinced that Chip has given the random value, aiming only not to lose the face in front of Gadget. Dale has asked you to find the right answer.

It is guaranteed that the speed of the wind at any moment of time is strictly less than the maximum possible speed of the airship relative to the air.

Input

The first line of the input contains four integers x_1, y_1, x_2, y_2 ($|x_1|,\ |y_1|,\ |x_2|,\ |y_2| \le 10\,000$) — the coordinates of the rescuers' headquarters and the point, where signal of the distress came from, respectively.

The second line contains two integers $v_{\max}$ and t ($0 < v, t \le 1000$), which are denoting the maximum speed of the chipmunk dirigible relative to the air and the moment of time when the wind changes according to the weather forecast, respectively.

Next follow one per line two pairs of integer (v_x, v_y) and (w_x, w_y), describing the wind for the first t seconds and the wind that will blow at all the remaining time, respectively. It is guaranteed that $v_x^2 + v_y^2 < v_{\max}^2$ and $w_x^2 + w_y^2 < v_{\max}^2$.

Output

Print a single real value — the minimum time the rescuers need to get to point (x_2, y_2). You answer will be considered correct if its absolute or relative error does not exceed 10^{-6}.

Namely: let's assume that your answer is a, and the answer of the jury is b. The checker program will consider your answer correct, if $\frac{|a-b|}{\max(1,b)} \le 10^{-6}$.

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input	output
0 0 5 5 3 2 -1 -1 -1 0	3.729935587093555327

input	output
0 0 0 1000 100 1000 -50 0 50 0	11.547005383792516398

F. Simple Skewness

time limit per test: 3 seconds
memory limit per test: 256 megabytes

Define the *simple skewness* of a collection of numbers to be the collection's mean minus its median. You are given a list of n (not necessarily distinct) integers. Find the non-empty subset (with repetition) with the maximum simple skewness.

The mean of a collection is the average of its elements. The median of a collection is its middle element when all of its elements are sorted, or the average of its two middle elements if it has even size.

Input

The first line of the input contains a single integer n ($1 \le n \le 200\,000$) — the number of elements in the list.

The second line contains n integers x_i ($0 \le x_i \le 1\,000\,000$) — the ith element of the list.

Output

In the first line, print a single integer k — the size of the subset.

In the second line, print k integers — the elements of the subset in any order.

If there are multiple optimal subsets, print any.

input	output
4 1 2 3 12	3 1 2 12

input	output
4 1 1 2 2	3 1 1 2

input	output
2 1 2	2 1 2

In the first case, the optimal subset is $\{1, 2, 12\}$, which has mean 5, median 2, and simple skewness of $5 - 2 = 3$.

In the second case, the optimal subset is $\{1, 1, 2\}$. Note that repetition is allowed.

In the last case, any subset has the same median and mean, so all have simple skewness of 0.