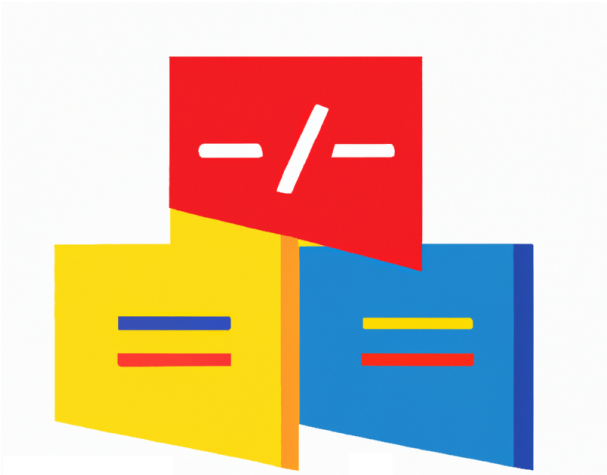

ANZAC CONTEST 6 (SPRINT)

SEPTEMBER 13, 2023

Contest Problems

A: Bottle Flip
B: Brothers in Arms
C: Cup Covering
D: Delf Distance
E: ETA
F: Triangles

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Problem A
Bottle Flip
Time limit: 1 second

It marks the year 2022 where the *bottle flip challenge* finally reached the last people on earth; the ANZAC Jury. As you may know, the objective of the challenge is to flip a bottle of water $360°$ through the air and hope that it lands standing upright. Figure A.1 demonstrates a successful bottle flip.

After many failed attempts, we noticed that this task gets significantly easier if the bottle is filled with just the right amount of water. The simple reason for this is that the amount of water affects the centre of mass of our bottle as it is about to land.[1] A lower centre of mass makes it easier for the bottle to stay upright after it lands. Unfortunately, the optimal amount of water depends on the bottle, and we already wasted enough time on this challenge...

Three bottles with different amounts of water.

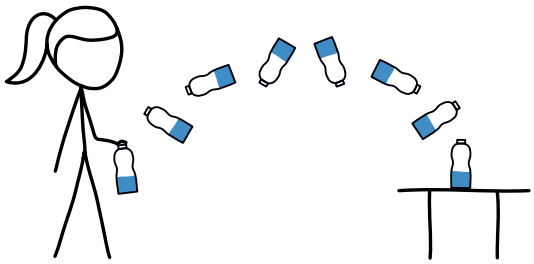

Figure A.1: Sketch of a bottle flip. The bottle is filled to roughly 33% to ease the challenge.

Given that our bottle is a perfect cylinder of height h and radius r, determine the optimal amount of water the bottle should contain so that our chances of landing a successful bottle flip are maximised. You can assume that both the water and the air contained in the bottle have uniform density, and that the weight of the bottle itself is negligible.

Input

The input consists of:

- One line with four integers h, r, d_a, and d_w ($1 \leq h, r, d_a, d_w \leq 1000$, $d_a < d_w$), where h and r are the height and radius of the bottle, and d_a and d_w are the densities of air and water, respectively.

Output

Output the height such that filling the bottle with water up to this height results in the lowest possible centre of mass while the bottle is standing upright. Your answer should have an absolute or relative error of at most 10^{-6}.

Sample Input 1	Sample Output 1
22 4 1 4	7.3333333333

[1] For the sake of completeness, we define the centre of mass as the unique point at which the whole mass of the bottle could be concentrated without changing the bottle's reaction to gravity, regardless of the orientation of the bottle. Note that we implicitly assume that the water will stay at the bottom of the bottle. This defines exactly what you would intuitively think of as centre of mass.

Sample Input 2	Sample Output 2
7 2 655 988	3.1415941720

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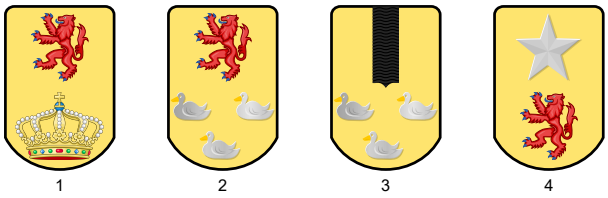
Problem B
Brothers in Arms
Time limit: 5 seconds

In medieval times, keeping track of the relationships between cities was extremely difficult, since most cities did not have access to the internet[citation needed]. However, it was possible to determine whether two cities were friendly with each other by examining their coats of arms. In those days, every coat of arms showed two symbols: one at the top, and one at the bottom. If two cities have an equal symbol at the top or they have an equal symbol at the bottom, they are friendly.

Following the saying "the friends of my friends are my friends", two cities c_0 and c_f can be indirectly friendly if there exist cities $c_1, \ldots, c_{f-1}$ such that c_k is friendly with c_{k+1} for $0 \leq k < f$. If c_0 and c_f are different and indirectly friendly, then we say that the friendship degree of these cities is the smallest possible f following this definition. See Figure B.1 for an example.



Parts of these coats of arms are CC BY-SA 4.0 on Wikimedia Commons.

Figure B.1: Illustration of Sample Input 1. Cities 1 and 2 are directly friendly, as well as cities 2 and 3. Cities 1 and 3 have a friendship degree of 2, because they are indirectly friendly via city 2. City 4 is not (indirectly) friendly with any other city.

You are given a list of coats of arms and a list of queries. For every query, determine the friendship degree of the two given cities.

Input

The input consists of:

- One line with two integers n and s ($2 \leq n \leq 90\,000$, $2 \leq s \leq 300$), the number of cities and the number of symbols that may appear on the coat of arms of some city.
- n lines, the ith of which consists of two integers t_i and b_i ($1 \leq t_i, b_i \leq s$). t_i is the symbol on the top side of the coat of arms of the ith city, and b_i is the symbol on the bottom side of the coat of arms of the ith city. If $i \neq j$, then $t_i \neq t_j$ or $b_i \neq b_j$.
- One line with an integer q ($1 \leq q \leq 10^5$), the number of queries.
- q lines, the ith of which contains two integers c and d ($1 \leq c, d \leq n$, $c \neq d$), two cities for which you should calculate the friendship degree.

Output

For every query, output an integer stating the friendship degree of the two cities, or -1 if the two cities are not (indirectly) friendly.

Sample Input 1

```
4 5
1 2
3 2
3 4
5 1
4
1 2
2 3
1 3
1 4
```

Sample Output 1

```
1
1
2
-1
```

Sample Input 2

```
7 5
1 1
2 1
2 2
3 2
4 2
3 5
3 4
6
1 2
1 3
1 7
1 4
1 5
6 7
```

Sample Output 2

```
1
2
4
3
3
1
```

Sample Input 3

```
2 4
1 2
3 4
1
1 2
```

Sample Output 3

```
-1
```

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Problem C
Cup Covering
Time limit: 1 second

Janneke is addicted to Dutch stroopwafels. She could eat them the whole day, every day. What she loves most during the colder seasons, is to put a stroopwafel on top of a cup full of hot, steaming cocoa. This way, the stroopwafel warms and softens and the caramel melts, leaving a gooey but delicious mess between her fingers when she picks it up.

A stroopwafel on a slightly too small cup.

For Janneke, this is pure heaven. Or well, it could be if she could just find the perfect cup for the round stroopwafels. Instead, she is left with unsatisfying stroopwafel experiences time and time again. Either the opening of the cup is too small for her stroopwafel and the edges stay hard and cold or – even worse – the opening is too large and the stroopwafel just falls in with a splash, becoming soggy and disgusting.

Janneke finally has had enough and decides to take matters into her own hands. She establishes the *Ideal Cup Production Company* (ICPC) which produces the ideal stroopwafel cups. Customers can simply tell her the area of the round stroopwafel they prefer and she delivers a cup with an opening that is perfectly covered by the stroopwafel. For the production, she needs to determine the diameter of the cup opening first. Soon, she will have orders from all over the world which she can barely keep up with, so she might need a little help here.

Input

The input consists of:

- One line with an integer a ($0 < a \leq 10^{15}$), the area of the round stroopwafel in cm^2.

Output

Output the diameter of the ideal cup in centimetres such that a stroopwafel with area a covers it perfectly. Note that the rim of the cup is so thin that it can be neglected.

Your answer should have an absolute or relative error of at most 10^{-9}.

Sample Input 1	Sample Output 1
42	7.3127327914

Sample Input 2	Sample Output 2
20221126	5074.0848694393

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Problem D
Delft Distance
Time limit: 5 seconds

You are currently in your hotel at the north-west corner of Delft, and want to go to the contest site at the university in the south-east corner of Delft. To get there, you have to go right through the historical centre of the city. Like Manhattan, the city consists of a grid of $h \times w$ buildings. But unlike Manhattan, the city does not only contain square residential buildings but also some round medieval towers. All the square buildings are axis aligned with a side length of 10 m and all round towers have a diameter of 10 m. There is just enough space for a small alley of negligible width between two neighbouring buildings.

Since you are already late for the contest start, you need to find a shortest path from your hotel to the contest site. Fortunately, you have a map of the city. See Figure D.1 for an example.

Delft water tower.
CC BY-SA 3.0 by Michiel1972 on Wikipedia

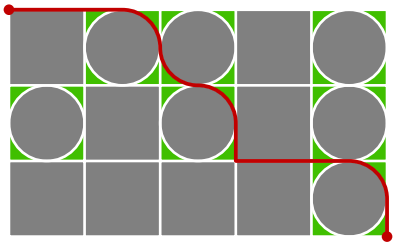

Figure D.1: Illustration of Sample Input 1, with a shortest path shown in red.

Input

The input consists of:

- One line with two integers h and w ($1 \leq h, w \leq 700$), the number of rows and the number of columns of buildings shown on the map of the city.
- h lines, each with w characters which are either '`O`' (for round towers) or '`X`' (for square buildings) describing the shapes of the buildings.

The map is oriented with the north side up.

Output

Output the length of a shortest path from the north-west corner to the south-east corner of Delft in metres. Your answer may have a relative or absolute error of at most 10^{-6}.

Sample Input 1	Sample Output 1
3 5 XOOXO OXOXO XXXXO	71.4159265359

Sample Input 2	Sample Output 2
1 4 XOOX	45.7079632679

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Problem E
ETA
Time limit: 2 seconds

You want to design a level for a computer game. The level can be described as a connected undirected graph with vertices numbered from 1 to n. In the game, the player's character is dropped at one of the n vertices uniformly at random and their goal is to reach the exit located at vertex 1 as quickly as possible. Traversing an edge takes exactly 1 second.

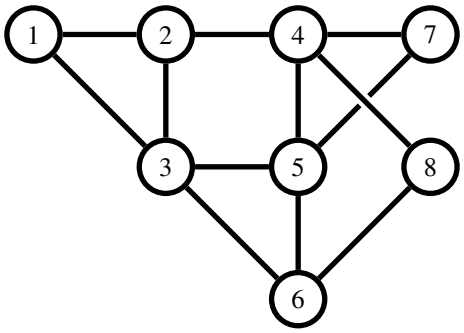

Figure E.1: Illustration of Sample Output 3, a level where the average optimal time to reach vertex 1 is $\frac{7}{4}$.

The difficulty of the level is determined by the average optimal time to reach the exit. Given a target value for this average optimal time, construct a level so that this target value is reached. See Figure E.1 for an example.

Input

The input consists of:

- One line with two coprime integers a and b ($1 \leq a, b \leq 1000$) separated by a '`/`', giving the desired average optimal time to reach the exit as the fraction $\frac{a}{b}$.

Output

If no connected graph with the average optimal time $\frac{a}{b}$ to reach vertex 1 exists, output "`impossible`". Otherwise, output one such graph in the following format:

- Two integers n and m ($1 \leq n, m \leq 10^6$), the number of vertices and the number of edges.
- m pairs of integers u and v ($1 \leq u, v \leq n$), indicating an edge between vertices u and v.

The graph may include self loops and parallel edges. You are given that if there exists a valid graph, then there also exists one with $1 \leq n, m \leq 10^6$.

If there are multiple valid solutions, you may output any one of them.

Sample Input 1	Sample Output 1
`1/2`	`2 1` `1 2`

Sample Input 2	Sample Output 2
`1/3`	`impossible`

Sample Input 3	Sample Output 3
7/4	8 12 1 2 1 3 2 3 2 4 3 5 3 6 4 5 5 6 4 7 5 7 4 8 6 8

Problem F
Triangles

Determine if it is possible to produce two triangles of given side lengths, by cutting some rectangle with a single line segment, and freely rotating and flipping the resulting pieces.

Input

The input consists of two lines. The first line contains three space-separated positive integers, indicating the desired side lengths of the first triangle. Similarly, the second line contains three space-separated positive integers, denoting the desired side lengths of the second triangle. It is guaranteed that the side lengths produce valid triangles. All side lengths are less than or equal to 100.

Output

Print, on a single line, whether there exists a rectangle which could have been cut to form triangles of the given side lengths. If such a rectangle exists, print `YES`. Otherwise, print `NO`.

Sample Input 1	Sample Output 1
3 4 6 4 6 3	NO

Sample Input 2	Sample Output 2
39 52 65 25 60 65	NO

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