Midterm exam

Please submit the source code only. The file name should include your student ID number. For example, if your ID number is 406290123, then the file names for problems 1 and 2 should be 406290123_1.cpp and 406290123_2.cpp, respectively.

1. **Triangle**

   Given the coordinates of a triangle in *xy* plane, A(10, 3), B(-4, 4), and C(2,-9). Ask the user to input the coordinates of a point P. Check if this point is inside the triangle, on the border, or outside the triangle ΔABC. You can use outer products of vectors to calculate the area of a triangle.

$$\begin{aligned}\Delta ABC &= \frac{1}{2}\left|\overrightarrow{AB}\times\overrightarrow{AC}\right| \\ &= \frac{1}{2}\left|(xb-xa)(yc-ya)-(xc-xa)(yb-ya)\right|\end{aligned}$$

   Input

   Ask the user to input two integers as the coordinates of the point P.

   Output

   If P is inside the triangle, output the integer number 1. If P is on the border of the triangle, output the integer 2. If P is outside the triangle, output the integer 3.

2. **Largest distance between prime numbers**

   Find the largest distance between two adjacent prime numbers in the range of $[2, 10000]$. Hint: we know that 2 is a prime number. Declare a variable to save the previous prime number (oldprime, for example) and set it equal to 2. Declare a variable to store the maximum distance (maxdist, for example) and set it to be zero at the beginning. When you find the next prime number, find the distance to the previous prime number. If it is larger than replace maxdist by this new distance.

   Input

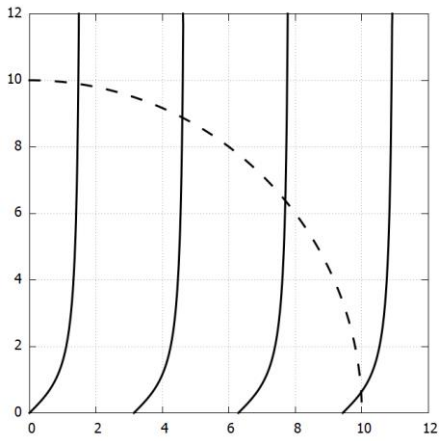
   None

   Output

   One single number gives the largest distance between two adjacent prime numbers in the range of $[2,10000]$.

3. Bisection algorithm for root finding

$\mathrm{f(x)} = \tan x - \sqrt{r^2 - x^2}$



$\mathrm{r} = 10$ in the figure.

One can see that, if $(n-1)\pi \leq r < n\pi$, there are n roots. Ask the user to input the positive number r. Find all roots of this functions **using the bisection method**. The error tolerance is set to be 10^{-5}. Since the bisection method finds at most one root only from an initial interval, you have to first find the integer n such that $(n-1)\pi \leq r < n\pi$. Then, split the range $[0, n\pi]$ into n intervals of π. Use the bisection method to find the root in each interval.

Input

Ask the user to input a positive float-point number, r. Repeat until the input is indeed positive.

Output

Show all roots in ascending order with one number in each line.