Spherical Polygons

Input file:	*standard input*
Output file:	*standard output*
Time limit:	1 second
Memory limit:	2048 megabytes

You are given N points on the unit sphere in $\mathbb{R}^3$, denoted by S^2, (that is the set of points in $\mathbb{R}^3$ which are at a distance 1 away from the origin), arriving one by one as a stream. A great circle on a sphere is the intersection of the sphere with a plane passing through the origin. As an example, consider the great circle defined by the intersection of the unit sphere with the xy-plane:

$$S^1_{xy} = \{(x, y, 0) | x^2 + y^2 = 1\}$$

A pair of points (x_1, y_1, z_1) and (x_2, y_2, z_2) is called *antipodal* if and only if

$$(x_2, y_2, z_2) = (-x_1, -y_1, -z_1)$$

For any pair of *non-antipodal* points, there is a unique great circle passing through both, and moreover, there exists a shorter circle arc between them i.e. the two possible arcs are of different lengths.

A *spherical k-gon* is an ordered collection of k points on the sphere, called its vertices, joined consecutively by great circle arcs, called its edges. Thus the spherical 3-gon (spherical triangle) (p_1, p_2, p_3) has an edge from p_1 to p_2, an edge from p_2 to p_3, and an edge from p_3 to p_1. The specific arc that defines the edge is the shortest of the two great circle arcs defined by two points.

A simple spherical k-gon divides the sphere into two regions. The *area bounded* by the k-gon is defined as the smaller of the two areas.

After the first two points p_1, p_2 have arrived, for every subsequent point p_k $(3 \le k \le N)$ you must compute the area bounded by the spherical k-gon $(p_1, p_2, \ldots, p_k)$.

Each point is given by its polar coordinates (θ, ϕ) in degrees, with $\theta \in [0, 360)$ and $\phi \in [0, 180]$. Polar coordinates are defined as:

$$\begin{aligned} x &= \sin\left(\tfrac{\pi}{180}\phi\right)\cos\left(\tfrac{\pi}{180}\theta\right), \\ y &= \sin\left(\tfrac{\pi}{180}\phi\right)\sin\left(\tfrac{\pi}{180}\theta\right), \\ z &= \cos\left(\tfrac{\pi}{180}\phi\right). \end{aligned}$$

It is guaranteed that at every step the resulting k-gon is a simple spherical k-gon (edges do not intersect except at shared vertices), and that it is entirely contained in some hemisphere. Moreover it's also guaranteed that no two of the points are antipodal, and that no three of the points lie on a common great circle.

Input

The first line contains N, the number of points.

Each of the next N lines contains two integers T and P, representing the k-th point such that the polar angles are given by $(\theta, \phi) = (T/10^5, P/10^5)$.

Constraints

- $3 \le N \le 10^5$
- $0 \le T < 36\,000\,000$

- $0 \le P \le 18\,000\,000$
- All N points lie inside a hemisphere,
- All points are distinct
- No two points are antipodal,
- No three points lie on the same great circle,
- No two edges intersect at any point that is not a vertex.

Output

Output $N - 2$ lines. The i-th line must contain the area bounded by the spherical $(i + 2)$-gon $(p_1, p_2, \ldots, p_{i+2})$.

Your answer is considered correct if its absolute or relative error does not exceed 10^{-6}.

Examples

standard input	standard output
3 0 0 0 9000000 9000000 9000000	1.5707963
4 4500000 5473561 13500000 5473561 22500000 5473561 31500000 5473561	1.0471975 2.0943951
4 4500000 6000000 9000000 1000000 13500000 6000000 0 1000000	0.5056142 0.1327840

Explanation

In the first example, the three points are the north pole and two points on the equator separated by $90°$. The resulting spherical triangle covers one eighth of the sphere, so its area is $\frac{1}{8} \cdot 4\pi = \frac{\pi}{2}$.

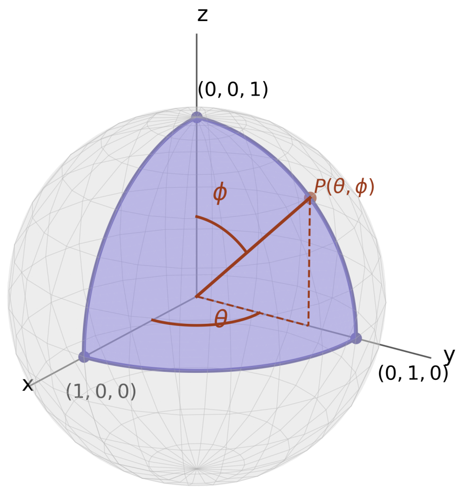

Figure 1: The unit sphere with the spherical triangle spanned by $(0,0,1)$, $(1,0,0)$ and $(0,1,0)$ shaded all interior angles equal $90°$ and the area is $\pi/2$. The marked point $P(\theta, \phi)$ has $\theta = 90°$ and $\phi = 45°$, i.e. Cartesian coordinates $\left(0, \frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}\right)$. The angle θ is measured in the xy-plane from the x-axis to the projection of P (dashed), and the angle ϕ from the z-axis down to OP.