Bullet Hole

Computer Science Society
Programming Contest
Spring 2008

A projectile is launched in three-dimensional space and travels through the air, forced downward by gravity, but otherwise unaffected by friction or other forces. There is a vertical target plane through which the projectile will eventually penetrate, unless it travels away from or parallel to the target plane. In this problem, we are given the initial velocity $\vec{v}$ (i.e. the speed and direction as a 3-dimensional vector) of a projectile and the position of a target plane and are asked to compute the exact point in 3-dimensional space at which the projectile impacts the target plane.

The projectile is launched at time $t = 0$ from the origin $(0, 0, 0)$ traveling at a velocity $\vec{v} = (v_x, v_y, v_z)$ whose speed components in the x-, y- and z-direction are v_x, v_y and v_z m/sec, respectively. The force of gravity causes a downward (i.e. negative z-direction) acceleration on the projectile of 9.8 m/sec^2. I'm sure you recall from your physics class that the position of the projectile after t seconds is

$$(v_x t, v_y t, v_z t - \frac{9.8t^2}{2}).$$

The target plane is a vertical plane consisting of all points (x, y, z) satisfying a linear equation

$$ax + by = c.$$

Input Format

The input contains one or more trials, each described on two lines of input followed by an empty line of input. The first line of each trial contains three integers v_x, v_y, v_z defining the initial velocity $\vec{v} = (v_x, v_y, v_z)$ of the projectile. The second line of each trial contains three integers a, b, c defining the vertical target plane $ax + by = c$.

Output Format

For each trial, compute the time t (in seconds after the launch) and the point (x, y, z) at which the projectile impacts the target plane. Report t, x, y and z rounded to two decimal places as shown in the output sample. If the projectile travels away from or parallel to the target plane, report that instead.

Input Sample

```
1 1 0
1 1 10

1 1 10
-1 1 -1

-1 -1 10
1 1 10

34 -25 201
-10 5 -32
```

Output Sample

```
Impacts after 5.00 seconds at position (5.00, 5.00, -122.50)
Travels parallel to plane
Travels away from plane
Impacts after 0.07 seconds at position (2.34, -1.72, 13.81)
```