Bee Problem

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Recall

For projective motion where a projectile is launched with velocity v_0 at an angle θ to the horizontal with gravity in the y direction, then

$$r(t) = v_0 cos(\theta)t\hat{i} + (\frac{-1}{2}gt^2 + v_0 sin(\theta)t + h_0)\hat{j}$$

Problem

Bee has position

$$r_{alive}(t) = 5cos(t)\hat{i} + 5sin(t)\hat{j} + 2t\hat{k}$$

Bee therefore has velocity

$$v_{alive}(t) = -5sin(t)\hat{i} + 5cos(t)\hat{j} + 2\hat{k}$$

when bee dies at $t = 10$

$$r_{10} = r_{alive}(10) = 5cos(10)\hat{i} + 5sin(10)\hat{j} + 2(10)\hat{k} = r_{x_{10}}\hat{i} + r_{y_{10}}\hat{j} + r_{z_{10}}\hat{k}$$

$$v_{10} = v_{alive}(10) = -5sin(10)\hat{i} + 5cos(10)\hat{j} + 2\hat{k} = v_{x_{10}}\hat{i} + v_{y_{10}}\hat{j} + v_{z_{10}}\hat{k}$$

Now, for ease of calculation, reset time when the bee dies $t_{free\ fall} = t_{alive} - 10$

In free fall,

$$r_{free}(t) = (r_{x_{10}} + v_{x_{10}}t)\hat{i} + (r_{y_{10}} + v_{y_{10}}t)\hat{j} + (r_{z_{10}} + v_{z_{10}}t - \frac{1}{2}gt^2)\hat{k}$$

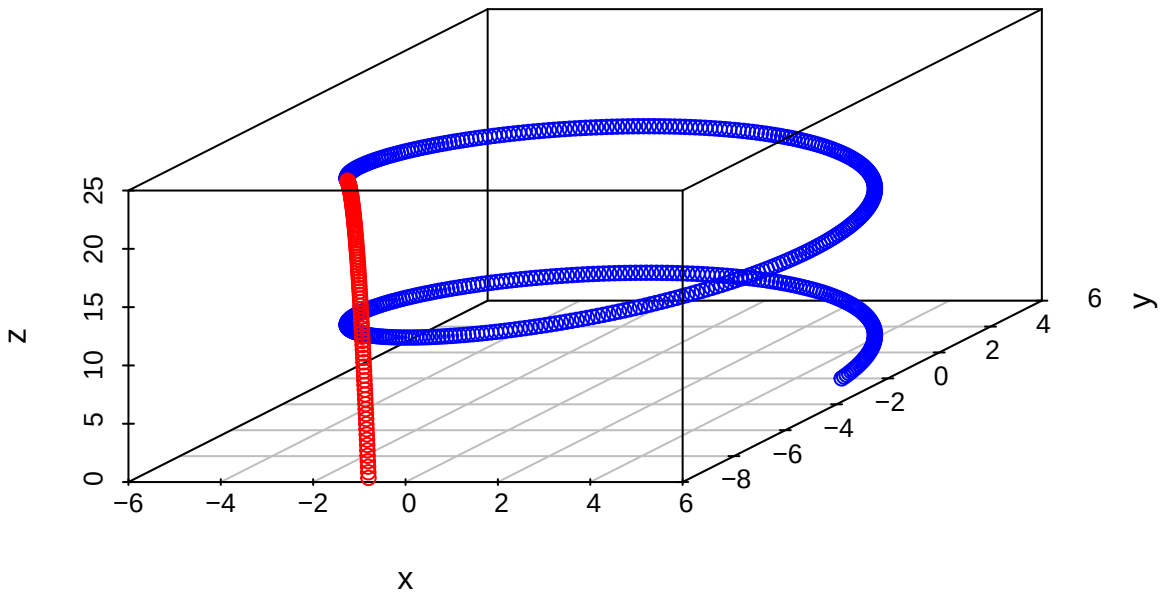
The bee hits the xy plane when $r_{free} \cdot \hat{k} = 0$

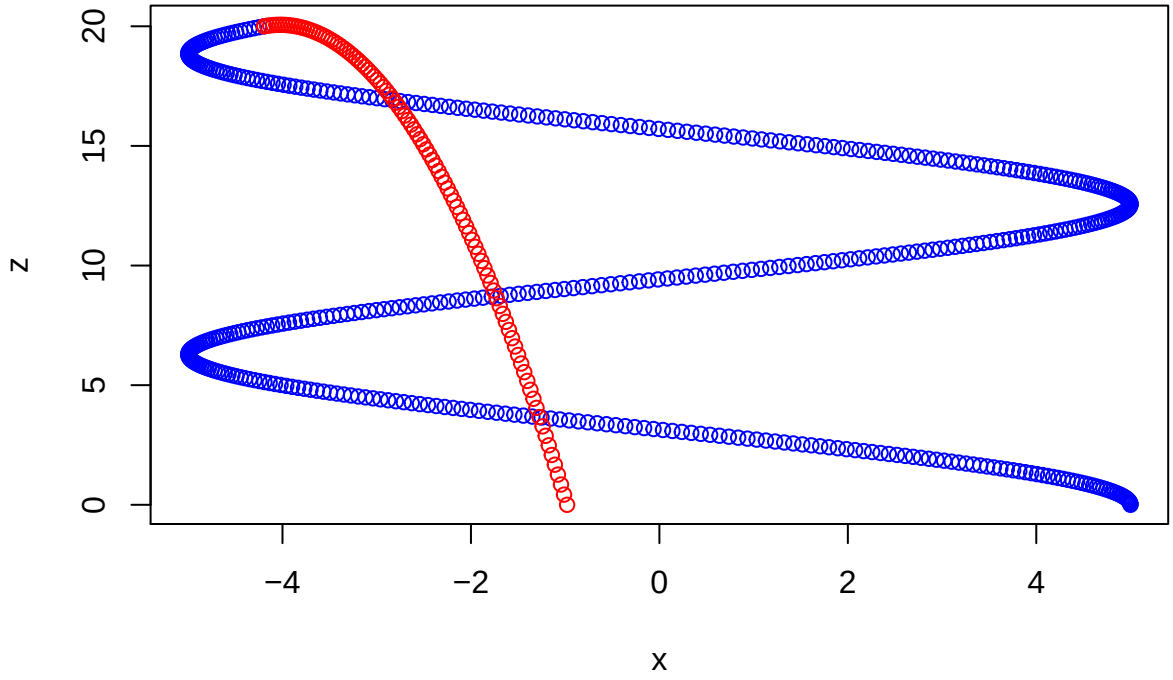
$$r_{z_{10}} + v_{z_{10}}t - \frac{1}{2}gt^2 = 0$$

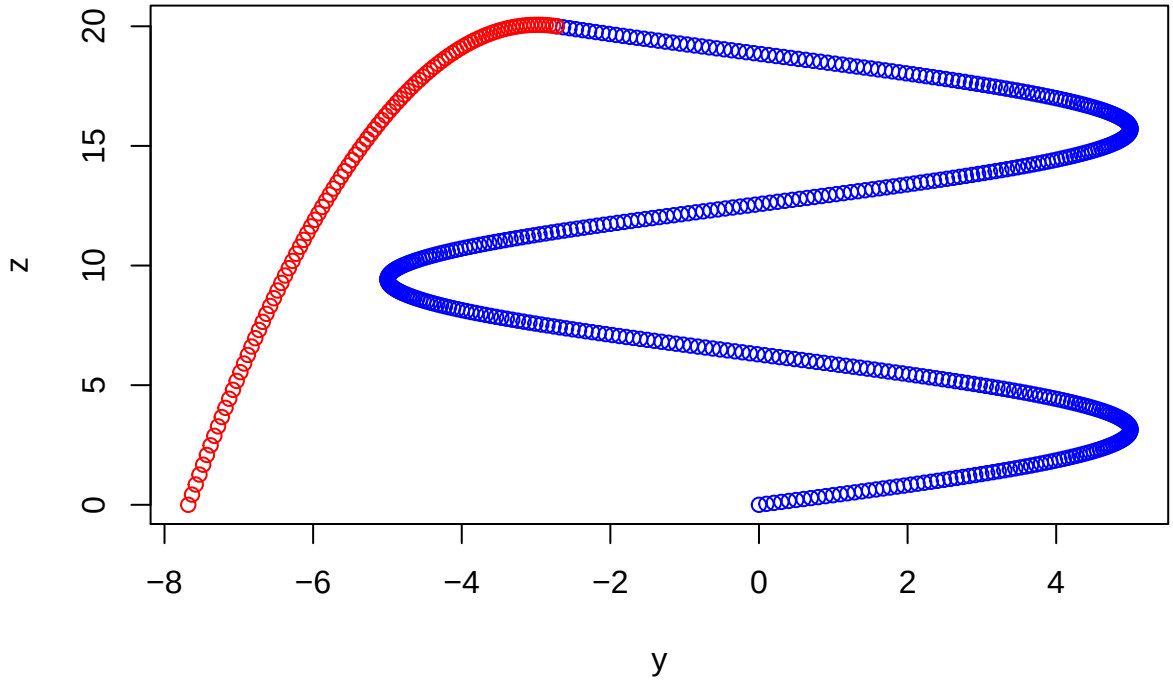
$$t_{xy\ plane} = \frac{-v_{z_{10}} \pm \sqrt{v_{z_{10}}^2 - 4(-1/2)(g)r_{z_{10}}}}{2(-1/2)(g)}$$

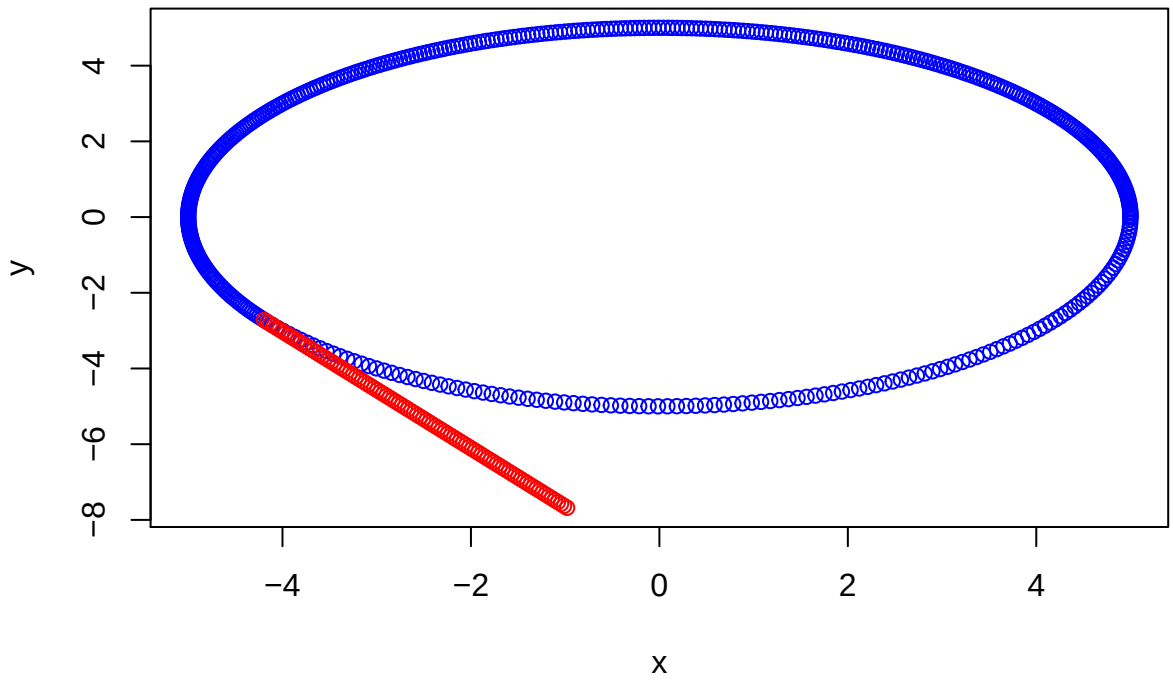
$t_{xy\ plane} = 1.1822796$

The bee impacts the xy plane at (x, y, z) = (-0.979, -7.68, 0)




z
0
5
10
15
20
−4
−2
0
2
4
x


z
0
5
10
15
20
−8
−6
−4
−2
0
2
4
y


y
4
2
0
−2
−4
−6
−8
−4
−2
0
2
4
x