

1. A ball is thrown at 22 m/s at 45 degrees to the horizontal. A 5 foot tall fence is located 100 meters away. Does the ball make it over the fence?

$$v_0 = 22 \text{ m/s}$$

$$\varphi = 45^\circ$$

$$h = 5 \text{ ft} = m$$

$$l = 100 \text{ m}$$

fly over?

*Solution.*

Let write the kinematic equations of a ball motion. Let introduce the coordinate system, so that  $X$ -axis is directed towards a ball motion and  $Y$ -axis is directed vertically upwards. If the center of coordinate system is in its initial position, then the ball's coordinates depend on time as:

$$\begin{cases} x = v_0 \cos \varphi \cdot t \\ y = v_0 \sin \varphi \cdot t - \frac{gt^2}{2} \end{cases}$$

The total time of a fly (without any obstacles) can be find from the equation  $y = 0$ :

$$v_0 \sin \varphi \cdot t - \frac{gt^2}{2} = 0, \quad t_1 = \frac{2v_0 \sin \varphi}{g} = \frac{2 \cdot 22 \cdot \sin 45^\circ}{9.8} \approx 3.17(s).$$

The total distance in  $X$ -direction will be  $x(t_1) = v_0 \cos \varphi \cdot t_1 = 22 \cdot \cos 45^\circ \cdot 3.17 = 49.3(m)$ .

$x(t_1) < l = 100 \text{ m}$ , so, the ball will drop before the fence.

**Answer:** the ball will not make the fence over.