Assignment 5

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Download all python codes from

https://github.com/Gayathri1729/SRFP/tree/main/Assignment5

and latex-tikz codes from

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1 QUADRATIC FORMS-2.64

A cricket ball is thrown at a speed of $28ms^{-1}$ in a direction 30° above the horizontal.Calculate

a) the maximum height
b) the time taken by the ball to return to the same level, and
c) the distance from the thrower to the point where the ball returns to the same level.

2 Solution

Initial velocity of the ball is given by

$$\mathbf{v_b} = 28\begin{pmatrix}\cos\theta\\ \sin\theta\end{pmatrix} = \begin{pmatrix}28\cos\theta\\ 28\sin\theta\end{pmatrix} = \begin{pmatrix}14\sqrt{3}\\ 14\end{pmatrix} \tag{2.0.1}$$

where θ is the angle made by $\mathbf{v_b}$ with the horizontal and let the initial displacement, $s_0 = \begin{pmatrix}0\\0\end{pmatrix}$.

Also, acceleration of the ball due to gravity is

$$\mathbf{a}(t) = \mathbf{g} = \begin{pmatrix}0\\-9.8\end{pmatrix} \tag{2.0.2}$$

$$\mathbf{v}(t) = \int \mathbf{a}(t) + \mathbf{v_b} \tag{2.0.3}$$

$$= \begin{pmatrix}14\sqrt{3}\\-9.8t + 14\end{pmatrix} \tag{2.0.4}$$

$$\mathbf{s}(t) = \int \mathbf{v}(t) + \mathbf{s_0} \tag{2.0.5}$$

$$= \begin{pmatrix}14\sqrt{3}t\\-4.9t^2 + 14t\end{pmatrix} \tag{2.0.6}$$

Velocity of the ball at the maximum height is

$$\mathbf{v_m} = \begin{pmatrix}0\\0\end{pmatrix} \tag{2.0.7}$$

a) To find the maximum height,we need to find the time at which the vertical velocity is zero.

$\implies$

$$-9.8t + 14 = 0 \tag{2.0.8}$$

$$t = 1.4286s \tag{2.0.9}$$

$\implies$

$$\mathbf{s}(1.4286) = \begin{pmatrix}14\sqrt{3}\times 1.4286\\-4.9\times(1.4286^2) + 14\times 1.4286)\end{pmatrix} \tag{2.0.10}$$

$$= \begin{pmatrix}34.64\\10\end{pmatrix} \tag{2.0.11}$$

$\therefore$ the maximum height $h_{max} = 10\ m$

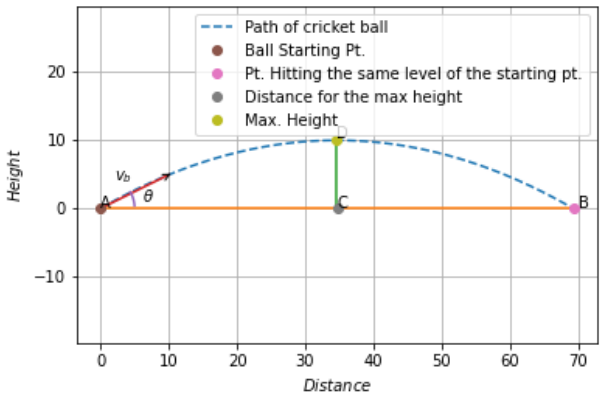

Fig. 2.1

b) The ball will return to the same level when vertical component of the distance function is equal to zero.

$$-4.9t^2 + 14t = 0 \tag{2.0.12}$$

$$t = 2.8572s \tag{2.0.13}$$

Thus the time taken by the ball to return to the same level = 2.8572 s

c) Consider,

$$\mathbf{s}(2.8572) = \begin{pmatrix} 14\sqrt{3} \times 2.8572 \\ -4.9 \times 2.8572^2 + 14 \times 2.8572 \end{pmatrix} \tag{2.0.14}$$

$$= \begin{pmatrix} 69.283 \\ 0 \end{pmatrix} \tag{2.0.15}$$

Thus the distance from the thrower to the point where the ball returns to the same level = 69.283 *m*