

Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

7 Projectiles

Exercise B, Question 10

Question:

A tennis ball is hit so that it initially moves horizontally at $V \text{ m s}^{-1}$ from a point at a height of 2 m. The net which has a height of 0.9 m is at a horizontal distance of 12 m from the point where the ball was hit.

(a) Find the minimum value of V for which the ball clears the net.

(b) If $V = 30 \text{ m s}^{-1}$ describe what happens to the ball when it has travelled 12 m horizontally.

Solution:

(a) The position of the ball, relative to its point of impact, is given by

$$x = Vt \quad [1]$$

$$y = -\frac{1}{2}gt^2 \quad [2]$$

If the ball passes over the net,

$$\begin{aligned} \text{then } y &= -(2 - 0.9) \\ &= -1.1, \quad x > 12 \end{aligned}$$

$$\text{When } y = -1.1, \quad [2] \Rightarrow -\frac{1}{2}gt^2 = -1.1,$$

$$t^2 = \frac{1.1}{\frac{1}{2}g}$$

$$\Rightarrow t = 0.4738 \text{ s}$$

$$[1] \text{ using } x = Vt \Rightarrow 12 < V \times 0.4738$$

$$\therefore V > 25.3 \text{ m s}^{-1}$$

(b) If $V = 30$ and the ball has travelled 12 m horizontally,

$$[1] \Rightarrow 12 = 30t, \quad t = 0.4 \text{ s}$$

$$\begin{aligned} [2] \Rightarrow y &= -\frac{1}{2}g(0.4)^2 \\ &= -0.784 \end{aligned}$$

i.e. the ball is $2 - 0.784 = 1.216$ above the ground.

Hence the ball clears the net by $1.216 - 0.9 \text{ m}$ or 0.316 m , or 31.6 cm .