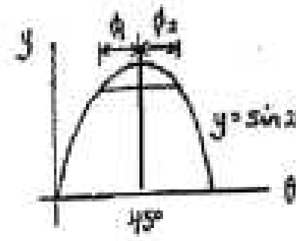
SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

COIMBATORE-35

DEPARTMENT OF MECHANICAL ENGINEERING

The girl at A can throw a ball at $v_A = 10$ m/s. Calculate the maximum possible range $R = R_{max}$ and the associated angle θ at which it should be thrown. Assume the ball is caught at B at the same elevation from which it is thrown.



Solution:

Horizontal motion $(\xrightarrow{+})$ $\quad S = S_0 + V_0 t$

$$R = 0 + [10\cos\theta]t$$

Vertical motion $(+\uparrow)$ $\quad V = V_0 + a_c t$

$$-10\sin\theta = 10\sin\theta - 9.81t$$

$$t = \frac{20}{9.81}\sin\theta$$

$$\hookrightarrow R = 10\cos\theta\left[\frac{20}{9.81}\right]\sin\theta$$

$$= \frac{200}{9.81}\sin\theta\cos\theta$$

$$= \frac{100}{9.81}\sin 2\theta$$

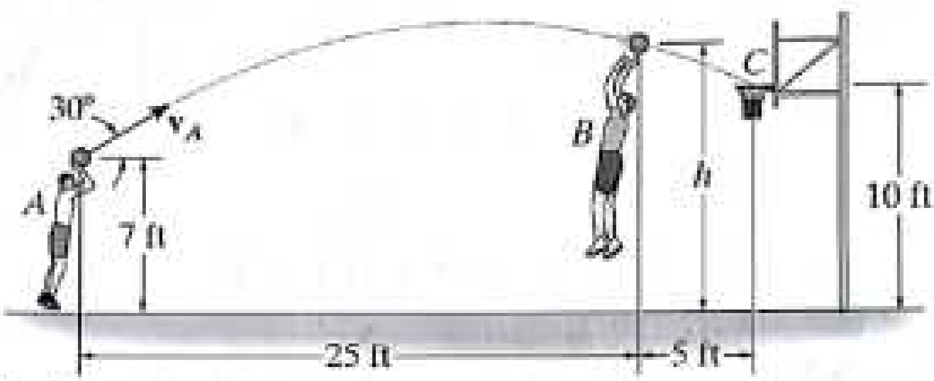
$$\hookrightarrow \frac{dR}{d\theta} = 0$$

$$\frac{100}{9.81}\cos 2\theta(2) = 0 \qquad \cos 2\theta = 0$$

$$\theta = 45^\circ$$

$$R = \frac{100}{9.81}[\sin 90^\circ] = 10.2\,m$$

Measurements of a shot recorded on a videotape during a basketball game are shown. The ball passed through the hoop even though it barely cleared the hands of the player B who attempted to block it. Neglecting the size of the ball, determine the magnitude v_A of its initial velocity and the height h of the ball when it passes over player B. Measurements of a shot recorded on a videotape during a basketball game are shown. The ball passed through the hoop even though it barely cleared the hands of the player B who attempted to block it. Neglecting the size of the ball, determine the magnitude v_A of its initial velocity and the height h of the ball when it passes over player B.



Solution: point A & C

Horizontal motion: $(\xrightarrow{+})$ $S = S_0 + V_0 t$

$30 = 0 + V_A \cos 30° \, t_{AC}$ — 1

Vertical motion: $(+\uparrow)$ $S = S_0 + V_0 t + \frac{1}{2} a_c t^2$

$10 = 7 + V_A \sin 30° \, t_{AC} - \frac{1}{2}(32.2) t_{AC}^2$

Solve eqn (1) & (2)

$30 = V_A [866.025 \times 10^{-3}] t_{AC}$

$t_{AC} = 30 / V_A [866.025 \times 10^{-3}] = \underline{34.641} / V_A$

$10 - 7 = V_A \times \frac{1}{2} t_{AC} - \frac{1}{2} \times 32.2 [t_{AC}^2]$

$3 = \frac{1}{2} V_A t_{AC} - 16.1 t_{AC}^2$

$$3 = \frac{1}{2}(V_A)\left[\frac{34.641}{V_A}\right] - \frac{1}{2}\times 32.2\left[\frac{34.641}{V_A}\right]^2$$

$$= \frac{1}{2}(\cancel{V_A})\left[\frac{34.641}{\cancel{V_A}}\right] - \frac{1}{2}\times 32.2\left[\frac{1199.9988}{V_A^2}\right]$$

$$3 = 17.3205 - \frac{19319.98}{V_A^2}$$

$$-17.3205 + 3 = -\frac{19319.98}{V_A^2}$$

$$\cancel{-}14.3205 = \cancel{-}\frac{19319.98}{V_A^2}$$

$$V_A^2 = \frac{19319.98}{14.3205} = 1349.1135$$

$$V_A = \sqrt{1349.1135} = 36.73 \text{ ft/s}$$

$$t_{AC} = \frac{34.641}{36.73} = 0.943 \text{ s}$$

Point A & C

Horizontal motion $\xrightarrow{+}$ $S = S_0 + V_0 t$

$$25 = 0 + 36.73 \cos 30^\circ \, t_{AB} \quad \text{—} (3)$$

Vertical motion $(+\uparrow)$ $\quad s = s_0 + v_0 t + \frac{1}{2} a_c t^2$

$$h = 7 + 36.73 \sin 30^\circ \, t_{AB} - \frac{1}{2}(32.2)(t_{AB}^2) \quad -④$$

Solving eq ③ & ④

$$25 = 31.809113 \, t_{AB}$$

$$t_{AB} = \frac{25}{31.809113} = 0.7859 = 0.786 \, s$$

$$h = 7 + 18.365[0.786] - [0.786]^2 \times 16.1$$

$$= 7 + 14.435 - 9.947$$

$$= 11.488 \Rightarrow \underline{\underline{11.5 \text{ ft}}}$$