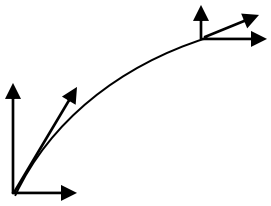
Q- In the javelin throw at a track-and-field event, the javelin is launched at a speed of 40.0 m/s at an angle of 37° above the horizontal. As the javelin travels upward, its velocity points above the horizontal at an angle that decreases as time passes. How much time is required for the angle to be reduced from 37° at launch to 30°?

The horizontal velocity of the javelin (constant) is

$v_x = 40.0*\cos 37^0 = 40.0*0.8 = 32.0$ m/s



Initial vertical velocity of the javelin

$v_y = 40.0*\sin 37^0 = 40.0*0.60 = 24.0$ m/s

Vertical velocity after time t is given by

$v_y' = v_y + (-9.8)*t = 24.0 - 9.8*t$

Now as at this time the angle the velocity vector makes with horizontal is 30^0 hence we have

$$\tan\theta = \frac{v_y'}{v_x}$$

Or $\tan 30^0 = \frac{24.0-9.8\,t}{32.0}$

Or $\frac{1}{\sqrt{3}} = \frac{24.0-9.8\,t}{32.0}$

Gives $32.0 * 0.577 = 24.0 - 9.8\,t$

Or $t = \frac{(24.0-18.5)}{9.8} = 0.56\ s$

Hence the time required to reduce the angle is **0.56 s**