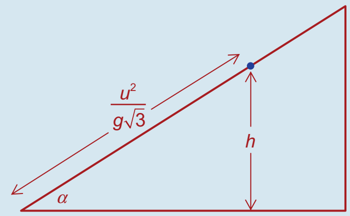


$$\sin\alpha = \frac{h}{\frac{u^2}{g\sqrt{3}}} = h\left(\frac{g\sqrt{3}}{u^2}\right)$$

$$\Rightarrow \frac{1}{\sqrt{3}} = h\left(\frac{g\sqrt{3}}{u^2}\right)$$

$$\Rightarrow 3gh = u^2$$

$$\Rightarrow h = \frac{u^2}{3g}$$

Velocity at landing is v_y when $t = \frac{u\sqrt{2}}{g}$

since $v_x = 0$ at landing

$$\Rightarrow v = \frac{u}{\sqrt{3}} - \frac{g\sqrt{2}}{\sqrt{3}}\left[\frac{u\sqrt{2}}{g}\right] = \frac{u}{\sqrt{3}} - \frac{2u}{\sqrt{3}}$$

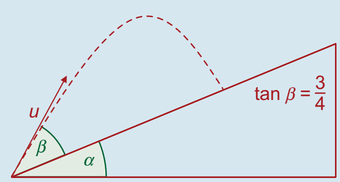
$$= -\frac{u}{\sqrt{3}}$$

$\Rightarrow$ Total Energy at landing

$$= \underbrace{\frac{1}{2}m\left[-\frac{u}{\sqrt{3}}\right]^2}_{\text{Kinetic Energy}} + \underbrace{mg\left[\frac{u^2}{3g}\right]}_{\text{Potential Energy}}$$

$$= \frac{mu^2}{6} + \frac{mu^2}{3} = \frac{1}{2}mu^2$$

Q. 5.



$\tan\alpha = \frac{3}{4}$, $\tan\beta = \frac{1}{2}$,

To prove: $\tan\theta = 2$

$$u_x = u\cos\beta$$

$$u_y = u\sin\beta$$

$$a_x = -g\sin\alpha$$

$$a_y = -g\cos\alpha$$

$$\therefore\ v_x = u\cos\beta - g\sin\alpha\, t$$

$$v_y = u\sin\beta - g\cos\alpha\, t$$

$$s_x = u\cos\beta\, t - \frac{1}{2}g\sin\alpha\, t^2$$

$$s_y = u\sin\beta\, t - \frac{1}{2}g\cos\alpha\, t^2$$

It lands when $s_y = 0$

$$\Rightarrow u\sin\beta\, t - \frac{1}{2}g\cos\alpha\, t^2 = 0$$

$$\Rightarrow t = 0 \quad \textbf{OR} \quad t = \frac{2u\sin\beta}{g\cos\alpha} = \text{time of flight}$$

At this time, $v_x = u\cos\beta - g\sin\alpha\left(\frac{2u\sin\beta}{g\cos\alpha}\right)$

$$= u\cos\beta - 2u\tan\alpha\sin\beta$$

$$v_y = u\sin\beta - g\cos\alpha\left(\frac{2u\sin\beta}{g\cos\alpha}\right) = -u\sin\beta$$

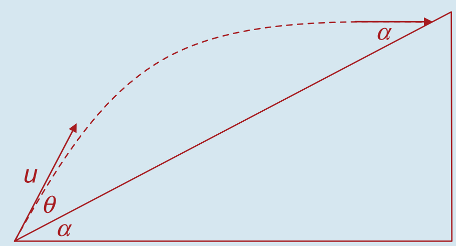
$$\tan\theta = -\frac{v_y}{v_x}$$

$$= \frac{u\sin\beta}{u\cos\beta - 2u\tan\alpha\sin\beta} \quad (\div u\cos\beta)$$

$$= \frac{\tan\beta}{1 - 2\tan\alpha\tan\beta}$$

$$= \frac{\frac{1}{2}}{1 - 2\left(\frac{3}{4}\right)\left(\frac{1}{2}\right)} = \frac{\frac{1}{2}}{1 - \frac{3}{4}} = 2 \quad \text{QED.}$$

Q. 6.



$\tan\alpha = \frac{1}{2} \Rightarrow \cos\alpha = \frac{2}{\sqrt{5}}$ and $\sin\alpha = \frac{1}{\sqrt{5}}$

$$v_x = u\cos\theta - gt\sin\alpha$$

$$= u\cos\theta - \frac{gt}{\sqrt{5}}$$

$$v_y = u\sin\theta - gt\cos\alpha$$

$$= u\sin\theta - \frac{2gt}{\sqrt{5}}$$

$$s_x = ut\cos\theta - \frac{1}{2}gt^2\sin\alpha$$

$$= ut\cos\theta - \frac{gt^2}{2\sqrt{5}}$$

$$s_y = ut\sin\theta - \frac{1}{2}gt^2\cos\alpha$$

$$= ut\sin\theta - \frac{gt^2}{\sqrt{5}}$$

For time of flight, let $s_y = 0$

$$\Rightarrow ut\sin\theta - \frac{gt^2}{\sqrt{5}} = 0 \quad \text{... multiply by } \sqrt{5}$$

$$ut\sqrt{5}\sin\theta - gt^2 = 0$$

$$t(u\sqrt{5}\sin\theta - gt) = 0$$