Projectiles - Finding Time of flight and Horizontal Range

Ex1 Launch from ground with speed $10\ ms^{-1}$ at $35°$ to horizontal

$$y = u\sin\alpha \times t - 4.9t^2$$

$$x = u\cos\alpha \times t$$

$$y = 10\sin 35° \times t - 4.9t^2$$

Lands when $y = 0$

$$0 = 10\sin 35° \times t - 4.9t^2$$

$$0 = t(10\sin 35° - 4.9t)$$

$$\Rightarrow \quad t = 0 \quad \text{or} \quad 4.9t = 10\sin 35°$$

$$t = \frac{10\sin 35°}{4.9} = 1.17056$$

$$\underline{t = 1.17\ s}$$

$$x = 10\cos 35° \times 1.17056$$

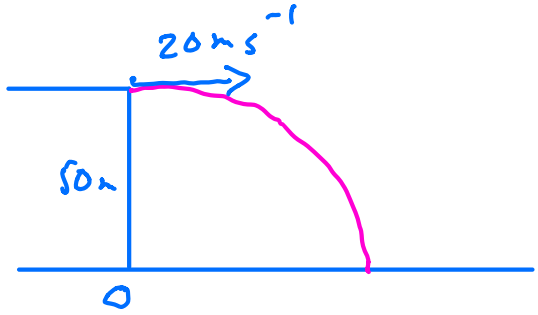
$$x = 9.5887$$

$$\underline{x = 9.59\ m}$$

Time $= 1.17\ s$

Range $= 9.59\ m$

Ex 2



Horizontal launch at $20\ ms^{-1}$, from top of 50m cliff

$$y - y_0 = u\sin\alpha \times t - 4.9t^2$$

$$x = u\cos\alpha \times t$$

$$y - 50 = 0 - 4.9t^2$$

lands when $y = 0$

$$-50 = -4.9t^2$$

$$\frac{-50}{-4.9} = t^2$$

$$t = \sqrt{\frac{50}{4.9}}$$

$$t = 3.1944 \text{ s}$$

$$\underline{t = 3.19 \text{ s}}$$

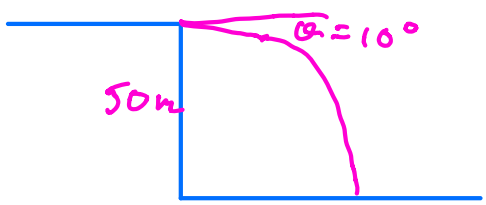
$$x = 20t = 20 \times 3.1944 = 63.888 \text{ m}$$

$$\underline{x = 63.9 \text{ m}}$$

Time = 3.19 s

Range = 63.9 m

Ex 3



Same problem as Ex2 but launched at angle 10° below horizontal

$$y = u\sin\alpha \times t - 4.9t^2$$

$$x = u\cos\alpha \times t$$

$$y - 50 = 20\sin(-10) \times t - 4.9t^2$$

lands when $y = 0$

$$0 - 50 = -20\sin 10^\circ t - 4.9t^2$$

$$4.9t^2 + 20\sin 10^\circ t - 50 = 0$$

$$t = 2.8596$$

$$\underline{t = 2.86\,s}$$

$$x = 20\cos(-10) \times 2.8596$$

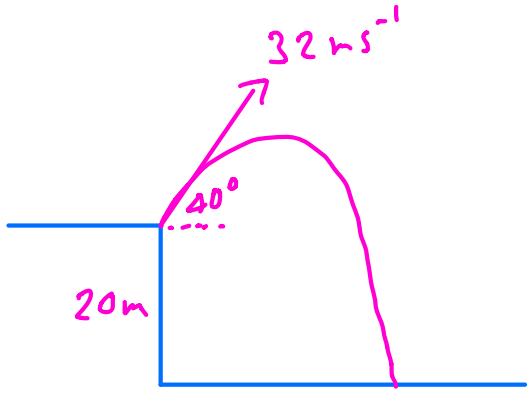
$$x = 56.323$$

$$\underline{x = 56.3\,m}$$

Time $= 2.86\,s$

Range $= 56.3\,m$

Ex 4



$$y - y_0 = u\sin\alpha \times t - 4.9t^2$$

$$x = u\cos\alpha \times t$$

$$y - 20 = 32\sin 40 \times t - 4.9t^2$$

Lands when $y = 0$

$$0 - 20 = 32\sin 40 \times t - 4.9t^2$$

$$4.9t^2 - 32\sin 40 t - 20 = 0$$

$$t = 5.01214\,s$$

$$\underline{t = 5.01\,s}$$

$$\underline{x = 32\cos 40 \times 5.01214 = 122.86\,m = 123\,m}$$