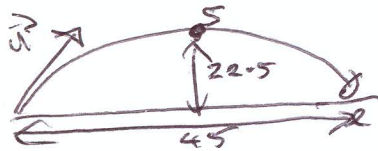


HK 94 Q3 (a)



$$\vec{u} = p\vec{i} + q\vec{j}$$

$$\vec{g} = 0\vec{i} - g\vec{j}$$

Total Range = 45
max Height = 22.5

(i) Calc p, q

$$\vec{u} = p\vec{i} + q\vec{j}$$

$$\vec{v} = (p)\vec{i} + (q - gt)\vec{j}$$

$$\vec{r} = pt\vec{i} + (qt - \frac{g}{2}t^2)\vec{j}$$

At $x = 45$ where $y = 0 \Rightarrow (qt - \frac{g}{2}t^2) = 0$
 $\Rightarrow t(q - \frac{g}{2}t) = 0$
 $\Rightarrow t = 0$ or $q - \frac{g}{2}t = 0$
 $\Rightarrow \frac{2q}{g} = t = T$

$$\therefore \left(r\left(\frac{2q}{g}\right)\right)_x = 45 \Rightarrow p\left(\frac{2q}{g}\right) = 45$$

$$\Rightarrow \boxed{2pq = 45g} \quad (1)$$

Also time to reach $s = \frac{T}{2} = \frac{q}{g}$

$$\therefore \left(r\left(\frac{q}{g}\right)\right)_y = 22.5 \Rightarrow q\left(\frac{q}{g}\right) - \frac{g}{2}\left(\frac{q}{g}\right)^2 = 22.5$$

$$\Rightarrow \frac{q^2}{g} - \frac{q^2}{2g} = 22.5$$

$$\Rightarrow \frac{q^2}{2g} = 22.5$$

$$\Rightarrow q^2 = 2(22.5)g = 441$$

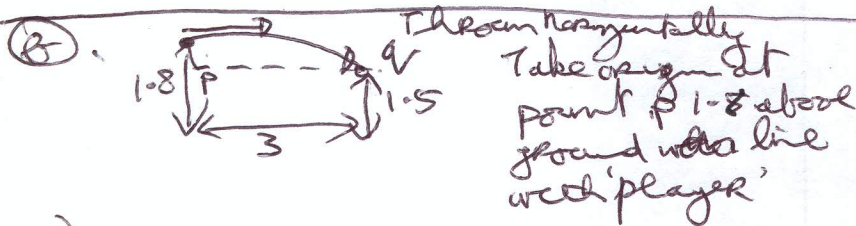
$$\Rightarrow \boxed{q = 21} \quad (2)$$

$$\therefore (1) \Rightarrow 2p(21) = 45(g)$$

$$42p = 441 \Rightarrow \boxed{p = \frac{441}{42} = 10.5 \text{ m/s}}$$

(ii) Time in flight = $\frac{2q}{g} = \frac{42}{9.8} = \frac{42}{9.8} \text{ sec}$

\Rightarrow Person running at 7 m/s can be $7\left(\frac{42}{9.8}\right)$ m from r if is to reach r at same time as ball \Rightarrow Max distance = 30 m.



Thrown horizontally

$$\vec{u} = u\vec{i} + 0\vec{j}$$

$$\vec{g} = 0\vec{i} - g\vec{j}$$

$$\vec{r}(t) = ut\vec{i} - \frac{g}{2}t^2\vec{j}, \text{ m/s}^2$$

$$\vec{v}(t) = u\vec{i} - gt\vec{j}, \text{ m/s}$$

(i) Hit board which is $r_j = -0.3$ at the point q $\Rightarrow -\frac{g}{2}t^2 = -0.3 \Rightarrow t^2 = \frac{0.6}{g} = 0.06122$
 $\Rightarrow \boxed{T = 0.247}$

Range = 3m $\Rightarrow r_x = 3 \Rightarrow u(T) = 3 \Rightarrow u(0.247) = 3 \Rightarrow u = \frac{3}{0.247} = 12.12$

(ii) speed at q = $|\vec{v}(T)| = |12.12\vec{i} - g(0.247)\vec{j}| = |12.12\vec{i} - 2.42\vec{j}|$
 $\Rightarrow |\vec{v}| = \sqrt{(12.12)^2 + (2.42)^2} = 12.36 \text{ m/s}$