1)

i) $\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 30\cos 45 \times t \\ 30\sin 45 \times t - 4.9t^2 \end{pmatrix}$

$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 21.2t \\ 21.2t - 4.9t^2 \end{pmatrix}$

ii) $x = 21.2t \Rightarrow t = \frac{x}{21.2}$

Subst gives

$y = \frac{21.2x}{21.2} - \frac{4.9x^2}{21.2^2}$

$y = x - 0.0109x^2$

$y = x - 0.011x^2$

iii) When $x = 10$

$y = 10 - 0.011 \times 100$

$y = 8.9$

iv) When $y = 20$

$20 = x - 0.011x^2$

$0.011x^2 - x + 20 = 0$

From graphics calculator

$x = 29.7$ or 61.2

---

2) i)

At time t

$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 10\cos 14° \times t \\ 10\sin 14° \times t - 4.9t^2 + 1.5 \end{pmatrix}$

$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 9.703t \\ 2.419t - 4.9t^2 + 1.5 \end{pmatrix}$

$x = 9.703t \Rightarrow t = \frac{x}{9.703}$

Subst gives

$y = 2.419 \times \frac{x}{9.703} - \frac{4.9x^2}{9.703^2} + 1.5$

$y = 1.5 + 0.25x - 0.052x^2$

ii) At top of wicket $y = 0.7$

$0.7 = 1.5 + 0.25x - 0.053x^2$

$0.053x^2 - 0.25x - 0.8 = 0$

From graphics calculator

$x = 6.9$ m

---

3)

At time t

$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 25\cos 5° \times t \\ 2.5 + 25\sin 5° \times t - 4.9t^2 \end{pmatrix}$

3 cont)

$$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 24.9t \\ 2.5 + 2.18t - 4.9t^2 \end{pmatrix}$$

$x = 24.9t \Rightarrow t = \frac{x}{24.9}$

Subst gives

$$y = 2.5 + 2.18 \times \frac{x}{24.9} - \frac{4.9x^2}{24.9^2}$$

$$y = 2.5 + 0.0876x - 0.0079x^2$$

---

ii) Ball lands when $y = 0$

$0 = 2.5 + 0.087x - 0.0079x^2$

From calculator

$x = 24.1$ m

---

iii)

When $x = 12$

$y = 2.5 + 0.087 \times 12 - 0.0079 \times 12^2$

$y = 2.4064$ m

Yes it clears the 1m high net

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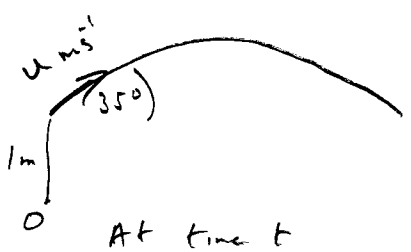
4)



At time t

$$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} u\cos 35° \times t \\ 1 + u\sin 35° \times t - 4.9t^2 \end{pmatrix}$$

$$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 0.819ut \\ 1 + 0.574ut - 4.9t^2 \end{pmatrix}$$

$x = 0.819ut \Rightarrow t = \frac{x}{0.819u}$

Subst gives

$$y = 1 + \frac{0.574x}{0.819u} - \frac{4.9x^2}{0.819^2u^2}$$

$$y = 1 + 0.701x - \frac{7.31x^2}{u^2}$$

---

ii) Using $y = 1 + 0.7x - \frac{7.45x^2}{u^2}$

To clip top of net $y = 2$ when $x = 3$

$$2 \leq 1 + 0.7 \times 3 - \frac{7.45 \times 9}{u^2}$$

$$2 \leq 1 + 2.1 - \frac{67.05}{u^2}$$

$$\frac{67.05}{u^2} \leq 1.1$$

$$67.05 \leq 1.1u^2$$

$$\frac{67.05}{1.1} \leq u^2$$

$$u \geq 7.8 \text{ ms}^{-1}$$

---

iii) To land in court

$y \leq 0$ when $x = 3 + 5 = 8$

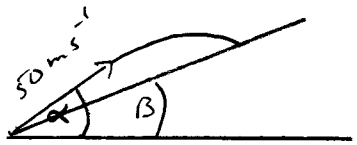
$$0 \geq 1 + 0.7 \times 8 - \frac{7.45 \times 8^2}{u^2}$$

$$\frac{476.8}{u^2} \geq 6.6$$

$$\frac{476.8}{6.6} \geq u^2 \Rightarrow u \leq 8.5 \text{m}$$

---

10) i)



$$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 50\cos\alpha \times t \\ 50\sin\alpha t - 4.9t^2 \end{pmatrix}$$

$\sin\alpha = \frac{4}{5} \Rightarrow \cos\alpha = \frac{3}{5}$

$$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 30t \\ 40t - 4.9t^2 \end{pmatrix}$$

$x = 30t \Rightarrow t = \frac{x}{30}$

Subst in y

$$y = \frac{40x}{30} - \frac{4.9x^2}{900}$$

$$y = \frac{4x}{3} - \frac{x^2}{184}$$

ii) $\tan\beta$ is gradient of slope line passes through origin

$\therefore \quad y = \frac{1}{2}x + 0 = \frac{1}{2}x$

iii) Using answer from book

$$y = \frac{4x}{3} - \frac{x^2}{180}$$

Subst $\frac{1}{2}x$ for y

$$\frac{x}{2} = \frac{4x}{3} - \frac{x^2}{180}$$

$\times 180$

$$90x = 240x - x^2$$

$$x^2 - 150x = 0$$

$$x(x - 150) = 0$$

Hits slope when $x = 150$, $y = 75$

At point $(150, 75)$

iv) Range $= \sqrt{150^2 + 75^2}$

$= 167.7\text{ m}$

v)

$$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 50\cos 45 \times t \\ 50\sin 45 \times t - 5t^2 \end{pmatrix}$$

Taking $g = -10\text{ ms}^{-2}$ as book does

$$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 35.36t \\ 35.36t - 5t^2 \end{pmatrix}$$

$$\Rightarrow \quad y = \frac{35.36x}{35.36} - \frac{5x^2}{35.36^2}$$

$$y = x - \frac{5x^2}{35.36^2}$$

Subst $\frac{1}{2}x$ for y

$$\frac{x}{2} = x - \frac{5x^2}{35.36^2}$$

$$\frac{5x^2}{35.36^2} - \frac{x}{2} = 0$$

$$10x^2 - 1250x = 0$$

$$x^2 - 125x = 0$$

$$\Rightarrow x = 0 \text{ or } x = 125$$

Hits at point $(125, 62.5)$

Range up slope $= \sqrt{125^2 + 62.5^2}$

$= 140\text{ m}$

vi) No since $140 < 167.7\text{ m}$