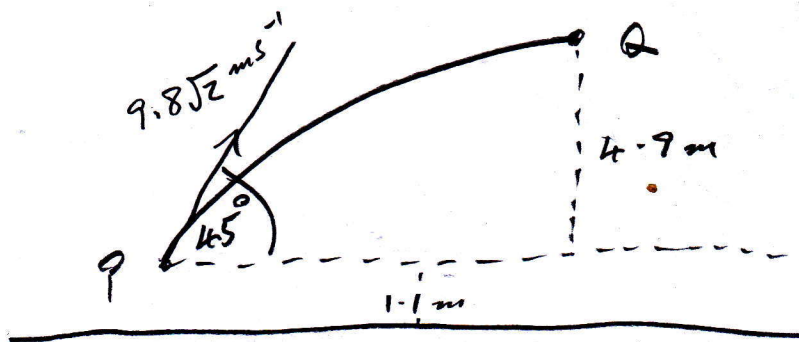


2010 Q3.

(a)



$$S_y = u_y t - \frac{1}{2} g t^2$$

$$4.9 = 9.8\sqrt{2} \sin 45^\circ t - \frac{1}{2} g t^2$$

$$\Rightarrow 0 = 9.8\sqrt{2} \frac{1}{\sqrt{2}} t - 4.9 t^2 - 4.9$$

$$\Rightarrow 0 = 4.9 t^2 - 9.8 t + 4.9$$

$$\Rightarrow 0 = t^2 - 2t + 1$$

$$\Rightarrow 0 = (t - 1)(t - 1)$$

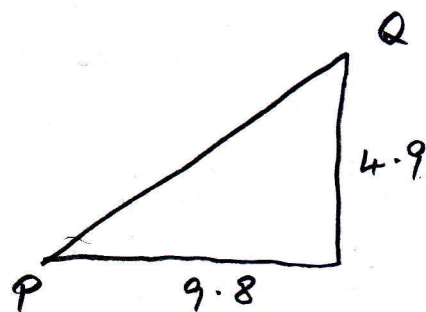
$$\Rightarrow t = 1 \text{ sec}$$

$$S_x = u_x t$$

$$= 9.8\sqrt{2} \cos 45^\circ (1)$$

$$= 9.8\sqrt{2} \frac{1}{\sqrt{2}}$$

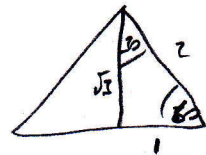
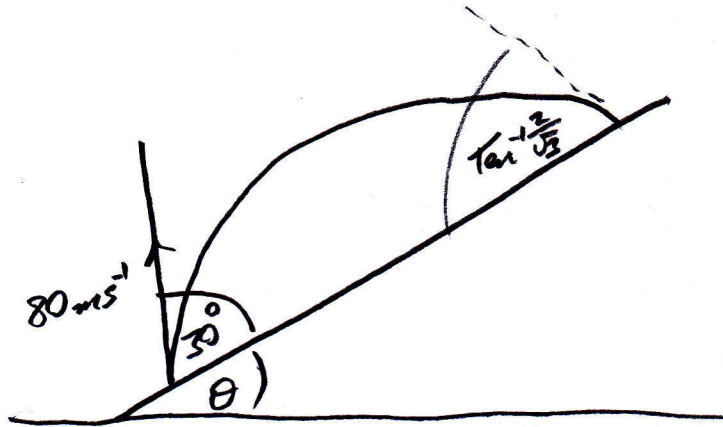
$$= 9.8 \text{ m}$$



$$\Rightarrow |PQ|^2 = 9.8^2 + 4.9^2$$

$$\Rightarrow |PQ| = 4.9\sqrt{5} \text{ m}$$

(b)



$$S_y = u \sin 30^\circ t - \frac{1}{2} g \cos \theta t^2$$

$$\Rightarrow 0 = 80 \cdot \frac{1}{2} t - \frac{1}{2} g \cos \theta t^2$$

$$\Rightarrow 0 = t \left(40 - \frac{1}{2} g \cos \theta t \right)$$

$$\Rightarrow t = 0 \quad \text{or} \quad 40 - \frac{1}{2} g \cos \theta t = 0$$

$$\Rightarrow t = \frac{80}{g \cos \theta}$$

$$V_x = u \cos 30 - g \sin \theta t$$

$$\Rightarrow V_x = 80 \cdot \frac{\sqrt{3}}{2} - g \sin \theta \left(\frac{80}{g \cos \theta} \right)$$

$$\Rightarrow V_x = 40\sqrt{3} - 80 \tan \theta$$

$$V_y = u \sin 30 - g \cos \theta t$$

$$\Rightarrow V_y = 80 \cdot \frac{1}{2} - g \cos \theta \left(\frac{80}{g \cos \theta} \right)$$

$$\Rightarrow V_y = 40 - 80$$

$$\Rightarrow V_y = -40$$

$$\tan \theta = \frac{-V_y}{V_x}$$

$$\Rightarrow \frac{2}{\sqrt{3}} = \frac{40}{40\sqrt{3} - 80 \tan \theta}$$

$$\Rightarrow 40\sqrt{3} = 80\sqrt{3} - 160 \tan \theta$$

$$\Rightarrow \frac{40\sqrt{3} - 80\sqrt{3}}{-160} = \tan \theta$$

$$\Rightarrow \frac{\sqrt{3}}{4} = \tan \theta$$

$$\Rightarrow 23.4^\circ = \theta$$

$$(ii) \quad V_x = 20\sqrt{3} \quad \text{i.e.} \quad 40\sqrt{3} - 80 \cdot \frac{\sqrt{3}}{4}$$

$$V_y = -40$$

$$\Rightarrow \text{Speed} = \sqrt{(20\sqrt{3})^2 + (-40)^2}$$

$$= 20\sqrt{7} \text{ ms}^{-1}$$