2007 3 **(b)** A plane is inclined at an angle 45° to the horizontal. A particle is projected up the plane with initial speed u at an angle θ to the **horizontal**.
The plane of projection is vertical and contains the line of greatest slope.

The particle is moving horizontally when it strikes the inclined plane.

Show that $\tan\theta = 2$.

r

$$r_j = 0$$

$$0 = u\sin(\theta-45).t - \tfrac{1}{2}g\cos 45.t^2$$

$$\Rightarrow t = \frac{2u\sin(\theta-45)}{g\cos 45} \qquad 5$$

$$v_i = u\cos(\theta-45) - g\sin 45.t$$

$$= u\cos(\theta-45) - g\sin 45.\left(\frac{2u\sin(\theta-45)}{g\cos 45}\right) \qquad 5$$

$$= u\cos(\theta-45) - 2u\sin(\theta-45)$$

$$v_j = u\sin(\theta-45) - g\cos 45.t$$

$$= u\sin(\theta-45) - g\cos 45.\left(\frac{2u\sin(\theta-45)}{g\cos 45}\right) \qquad 5$$

$$= -u\sin(\theta-45)$$

$$\text{Landing angle} = 45° \Rightarrow \tan 45 = \frac{-v_j}{v_i}$$

$$1 = \frac{u\sin(\theta-45)}{u\cos(\theta-45) - 2u\sin(\theta-45)}$$

$$u\sin(\theta-45) = u\cos(\theta-45) - 2u\sin(\theta-45)$$

$$\tan(\theta-45) = \frac{1}{3} \qquad 5$$

$$\frac{\tan\theta - 1}{1+\tan\theta} = \frac{1}{3}$$

$$3\tan\theta - 3 = 1 + \tan\theta$$

$$\Rightarrow \tan\theta = 2 \qquad 5$$

25