Q. 13. $\frac{u^2\sin^2\alpha}{2g} = \frac{2u^2\sin\alpha\cos\alpha}{g}$

$\Rightarrow \tan\alpha = 4$

$\Rightarrow \alpha = 76°$

Q. 14. Let the speed of projection $= u$ and the angle of projection $= \alpha$

$u_x = u\cos\alpha \qquad u_y = u\sin\alpha$

$v_x = u\cos\alpha$

$v_y = u\sin\alpha - gt$

$s_x = ut\cos\alpha$

$s_y = ut\sin\alpha - \frac{1}{2}gt^2$

Maximum height: s_y when $v_y = 0$

$v_y = 0$

$\Rightarrow u\sin\alpha - gt = 0$

$\Rightarrow t = \frac{u\sin\alpha}{g}$

$\Rightarrow$ Maximum height $= u\left(\frac{u\sin\alpha}{g}\right)\sin\alpha - \frac{1}{2}g\left(\frac{u\sin\alpha}{g}\right)^2$

$\Rightarrow$ Maximum height $= \frac{u^2\sin^2\alpha}{g} - \frac{u^2\sin^2\alpha}{2g}$

$\Rightarrow$ Maximum height $= \frac{2u^2\sin^2\alpha - u^2\sin^2\alpha}{2g}$

$\Rightarrow$ Maximum height $= \frac{u^2\sin^2\alpha}{2g}$

OR

$v_y^2 = u_y^2 + 2a_y s_y$

$\therefore 0 = (u\sin\alpha)^2 + 2(-g)H$

$\therefore H = \frac{u^2\sin^2\alpha}{2g}$

Range: s_x when $s_y = 0$

$s_y = 0$

$\Rightarrow ut\sin\alpha - \frac{1}{2}gt^2 = 0$

$\Rightarrow 2ut\sin\alpha - gt^2 = 0$

$\Rightarrow t(2u\sin\alpha - gt) = 0$

$\Rightarrow \underbrace{t = 0}_{\text{Point of Projection}} \qquad \underbrace{t = \frac{2u\sin\alpha}{g}}_{\text{Time of Flight}}$

$\Rightarrow$ Range $= u\left(\frac{2u\sin\alpha}{g}\right)\cos\alpha$

$\Rightarrow$ Range $= \frac{2u^2\sin\alpha\cos\alpha}{g}$

Maximum Height $= 2$(Range)

$\Rightarrow \frac{u^2\sin^2\alpha}{2g} = 2\left(\frac{2u^2\sin\alpha\cos\alpha}{g}\right)$

$\Rightarrow \sin^2\alpha = 8\sin\alpha\cos\alpha$

$\Rightarrow \sin\alpha(\sin\alpha - 8\cos\alpha) = 0$

$\Rightarrow \cancel{\sin\alpha = 0} \qquad \sin\alpha - 8\cos\alpha = 0 \quad \ldots$ divide by $\cos\alpha$

$\Rightarrow \tan\alpha - 8 = 0$

$\Rightarrow \tan\alpha = 8$

$\Rightarrow \alpha = \tan^{-1} 8$

$= 83°$