Q 01 A bullet fired at an angle of 30° with the horizontal hits the ground 3.0 km away. By adjusting its angle of projection, can one hope to hit a target 5.0 km away? Assume the muzzle speed to the fixed, and neglect air resistance.

Sol. Given: Horizontal Range, R = 3 km = 3000 m

Angle of projection, θ = 30°

Acceleration due to gravity, $g = 9.8\mathrm{m/s^2}$

Horizontal range for the projection velocity u_0, is given by the relation:

$R = \frac{u^2 \sin 2\theta}{g}$

$3000 = \frac{u_0^2}{g} \sin 60^\circ$

$3000 = \frac{u_0^2}{g} \times \frac{\sqrt{3}}{2}$

$\frac{u_0^2}{g} = 2\sqrt{3} \times 1000$ .....(i)

The maximum range (R_{max} is achieved by the bullet when it is fired at an angle of 45° with the horizontal)

$\mathrm{R_{max}} = \frac{\mathrm{u_0^2}}{g}$ .....(ii)

On comparing equations (i) and (ii), we get:

$R_{\max} = 2\sqrt{3} \times 1000 = 2 \times 1.732 \times 1000 = 3.46\ km$

Hence by keeping the same muzzle speed u, one can not hit a target which is 5 km away just by changing projection angle.