

that the angle at which it meets the plane again is ϕ , where $\tan \phi = (1 - \tan \theta)/(3 - \tan \theta)$. At what angle must the particle be projected so that it is travelling horizontally at the instant when it meets the plane again? (H.S.C.)

34. A heavy particle is projected from a point O at an angle of elevation α and describes a parabola under gravity. If co-ordinate axes are taken horizontally and vertically through O, prove that the equation of the parabola is

$$y = x(1 - x/R) \tan \alpha$$

where R is the horizontal range.

If the distance between the two points on the parabola which are at the same height h above the horizontal is $2a$, show that

$$R(R - 4h \cot \alpha) = 4a^2. \quad (\text{L.A.})$$

35. A particle is projected under gravity from a point O with speed u at an acute angle α above the horizontal through O. Prove that the distance of the particle from O first increases and then, if $9 \sin^2 \alpha > 8$, decreases for a time

$$(u/g)\sqrt{(9 \sin^2 \alpha - 8)}.$$

Prove also that, if P is the position of the particle at time t , the tangent to the path at P meets the vertical through O in a point which moves with constant acceleration. (L.A.)

36. Two heavy particles A and B are projected at the same instant from the same point with equal and opposite velocities of magnitude u in a line which makes an angle a with the horizontal. Find:

- (i) the path of A relative to B;
- (ii) the distance between the particles when their velocities are at right angles. (L.A.)

37. A smooth plane is inclined at 30° to the horizontal. A small sphere is projected from a point O of the plane with velocity 1.8 ms^{-1} at right angles to the plane. Immediately after its first impact with the plane the sphere is moving horizontally. Show that the coefficient of restitution between the sphere and the plane is $\frac{2}{3}$.

Find the distance of the sphere from O when it strikes the plane a second time. (L.A.)

38. A projectile is fired with initial speed $\sqrt{(2ga)}$ to hit a target at a horizontal distance a from the point of projection and at a vertical distance $\frac{1}{2}a$ above it. Find the two possible angles of