

STEP II, 2013, Q10

- 10 A particle is projected at an angle of elevation α (where $\alpha > 0$) from a point A on horizontal ground. At a general point in its trajectory the angle of elevation of the particle from A is θ and its direction of motion is at an angle ϕ above the horizontal (with $\phi \geq 0$ for the first half of the trajectory and $\phi \leq 0$ for the second half).

Let B denote the point on the trajectory at which $\theta = \frac{1}{2}\alpha$ and let C denote the point on the trajectory at which $\phi = -\frac{1}{2}\alpha$.

- (i) Show that, at a general point on the trajectory, $2 \tan \theta = \tan \alpha + \tan \phi$.
- (ii) Show that, if B and C are the same point, then $\alpha = 60^\circ$.
- (iii) Given that $\alpha < 60^\circ$, determine whether the particle reaches the point B first or the point C first.



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