

## **STEP II, 2014, Q10**

- 10** A particle is projected from a point  $O$  on horizontal ground with initial speed  $u$  and at an angle of  $\theta$  above the ground. The motion takes place in the  $x$ - $y$  plane, where the  $x$ -axis is horizontal, the  $y$ -axis is vertical and the origin is  $O$ . Obtain the Cartesian equation of the particle's trajectory in terms of  $u$ ,  $g$  and  $\lambda$ , where  $\lambda = \tan \theta$ .

Now consider the trajectories for different values of  $\theta$  with  $u$  fixed. Show that for a given value of  $x$ , the coordinate  $y$  can take all values up to a maximum value,  $Y$ , which you should determine as a function of  $x$ ,  $u$  and  $g$ .

Sketch a graph of  $Y$  against  $x$  and indicate on your graph the set of points that can be reached by a particle projected from  $O$  with speed  $u$ .

Hence find the furthest distance from  $O$  that can be achieved by such a projectile.



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