

- 5 A particle  $P$  is projected with speed  $u$  at an angle  $\alpha$  above the horizontal from a point  $O$  on a horizontal plane and moves freely under gravity. The horizontal and vertical displacements of  $P$  from  $O$  at a subsequent time  $t$  are denoted by  $x$  and  $y$  respectively.

- (a)** Derive the equation of the trajectory of  $P$  in the form

$$y = x \tan \alpha - \frac{gx^2}{2u^2} \sec^2 \alpha. \quad [3]$$

This image shows a full page of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page, typical of notebook or legal stationery. There are no margins, text, or other markings on the page.

The point  $Q$  is the highest point on the trajectory of  $P$  in the case where  $\alpha = 45^\circ$ .

- (b)** Show that the  $x$ -coordinate of  $Q$  is  $\frac{u^2}{2g}$ . [3]

[illegible]

- (c) Find the other value of  $\alpha$  for which  $P$  would pass through the point  $Q$ . [4]