5.

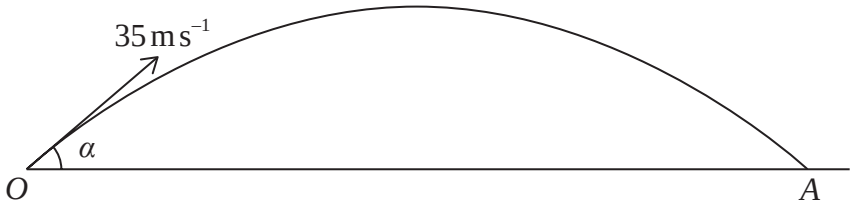

Figure 4

At time $t = 0$, a small stone is projected with velocity $35\,\text{m s}^{-1}$ from a point O on horizontal ground.

The stone is projected at an angle α to the horizontal, where $\tan\alpha = \frac{3}{4}$

In an initial model

- the stone is modelled as a particle P moving freely under gravity
- the stone hits the ground at the point A

Figure 4 shows the path of P from O to A.

For the motion of P from O to A

- at time t seconds, the horizontal distance of P from O is x metres
- at time t seconds, the vertical distance of P above the ground is y metres

(a) Using the model, show that

$$y = \frac{3}{4}x - \frac{1}{160}x^2$$

(6)

(b) Use the answer to (a), or otherwise, to find the length OA.

(2)

Using the model, the greatest height of the stone above the ground is found to be H metres.

(c) Use the answer to (a), or otherwise, to find the value of H.

(2)

- The model is refined to include air resistance.

Using this new model, the greatest height of the stone above the ground is found to be K metres.

(d) State which is greater, H or K, justifying your answer.

(1)

(e) State one limitation of this refined model.

(1)