

4. [In this question the unit vectors $\mathbf{i}$ and $\mathbf{j}$ are in a vertical plane, $\mathbf{i}$ being horizontal and $\mathbf{j}$ being vertically upward.]

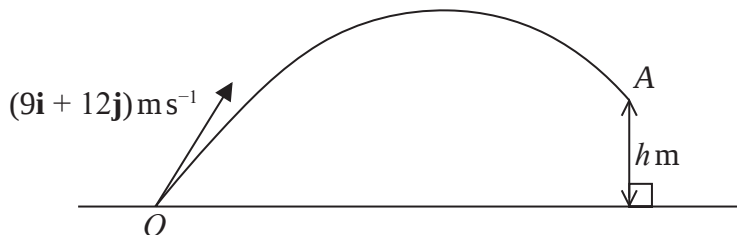


Figure 2

A small ball is projected from the fixed point O on horizontal ground with velocity $(9\mathbf{i} + 12\mathbf{j})\text{ms}^{-1}$

The ball passes through the point A which is h metres vertically above the level of O , as shown in Figure 2.

The velocity of the ball at the instant it passes through the point A is $\lambda(\mathbf{i} - \mathbf{j})\text{ms}^{-1}$, where λ is a positive constant.

The ball is modelled as a particle moving freely under gravity.

- (a) Find the value of h . (4)
- (b) State the minimum speed of the ball as it moves from O to A . (1)
- (c) Find the length of time for which the speed of the ball is less than 12ms^{-1} (4)

The model could be refined by considering air resistance.

- (d) Suggest one other refinement to the model that would make it more realistic. (1)