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8. [*In this question, the unit vectors* **i** *and* **j** *are in a vertical plane, with* **i** *being horizontal and* **j** *being vertically upwards*.]

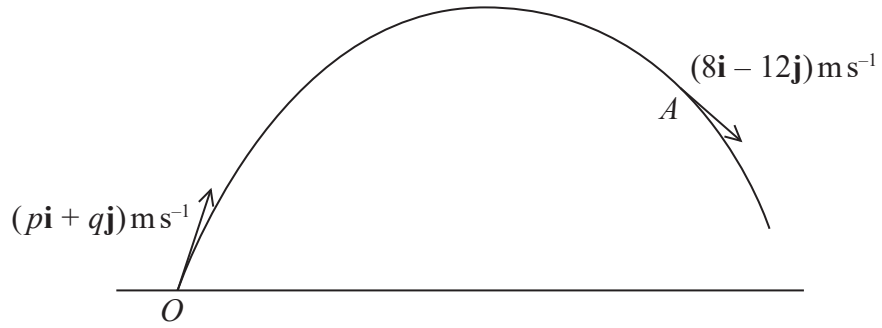


Figure 4

At time $t = 0$, a small ball is projected from a fixed point O on horizontal ground. The ball is projected from O with velocity $(p\mathbf{i} + q\mathbf{j})\,\mathrm{m\,s^{-1}}$, where p and q are positive constants. The ball moves freely under gravity.

At time $t = 3$ seconds, the ball passes through the point A with velocity $(8\mathbf{i} - 12\mathbf{j})\,\mathrm{m\,s^{-1}}$, as shown in Figure 4.

(a) Find the speed of the ball at the instant it is projected from O.

(5)

For an interval of T seconds the speed, $v\,\mathrm{m\,s^{-1}}$, of the ball is such that $v \leqslant 10$

(b) Find the value of T.

(4)

At the point B on the path of the ball, the direction of motion of the ball is perpendicular to the direction of motion of the ball at A.

(c) Find the vertical height of B above A.

(4)

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