4. [*In this question* **i** *and* **j** *are unit vectors, with* **i** *horizontal and* **j** *vertical*.]

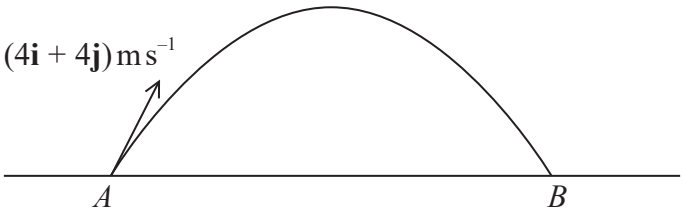


Figure 3

The fixed points A and B lie on horizontal ground.

At time $t = 0$, a particle P is projected from A with velocity $(4\mathbf{i} + 4\mathbf{j})\,\mathrm{m\,s^{-1}}$

Particle P moves freely under gravity and hits the ground at B, as shown in Figure 3.

At time T_1 seconds, P is at its highest point above the ground.

(a) Find the value of T_1

(2)

At time $t = 0$, a particle Q is also projected from A but with velocity $(5\mathbf{i} + 7\mathbf{j})\,\mathrm{m\,s^{-1}}$

Particle Q moves freely under gravity.

(b) Find the vertical distance between Q and P at time T_1 seconds, giving your answer to 2 significant figures.

(3)

At the instant when particle P reaches B, particle Q is moving at $\alpha°$ below the horizontal.

(c) Find the value of α.

(4)

At time T_2 seconds, the direction of motion of Q is perpendicular to the initial direction of motion of Q.

(d) Find the value of T_2

(3)

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Question 4 continued

(Total for Question 4 is 12 marks)