Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

Exam style practice papers

Exercise MM1B, Question 7

Question:

A particle is initially at rest and has position vector $(30\mathbf{i} + 400\mathbf{j})$ m, where the unit vectors **i** and **j** are east and north, respectively. The particle moves with a constant acceleration so that 10 seconds later its position is $(100\mathbf{i} + 450\mathbf{j})$ m.

(a) (i) Show that the acceleration of the particle is $(1.4\mathbf{i} + \mathbf{j})$ m s^{-2}. (3 marks)
(ii) Find the velocity of the particle after 10 s. (2 marks)
(iii) Find an expression for the position of the particle at time t s. (2 marks)

(b) After the first 10 seconds the particle stops accelerating and moves with a constant velocity. Find the position vector of the particle when it has been moving for 25 s. (4 marks)

Solution:

Displacement in 10 seconds $= 100\mathbf{i} + 450\mathbf{j} - (30\mathbf{i} + 400\mathbf{j})$
$= 70\mathbf{i} + 50\mathbf{j}$

Using s $= ut + \frac{1}{2}at^2$,

(a) (i)

$70\mathbf{i} + 50\mathbf{j} = \frac{1}{2} \times a \times (10)^2$

$a = 1.4\mathbf{i} + \mathbf{j}$

$\therefore$ Acceleration is $(1.4\mathbf{i} + \mathbf{j})$ m s^{-2}

To find v use $v = u + at$

(ii) $\therefore v = 10 \times (1.4\mathbf{i} + \mathbf{j})$

$v = 14\mathbf{i} + 10\mathbf{j}$ m s^{-1}

(iii) Using $s = ut + \frac{1}{2}at^2$,

Position vector at time t is given by

$s = ut + \frac{1}{2}at^2 + 30\mathbf{i} + 400\mathbf{j}$ since particle starts at $30\mathbf{i} + 400\mathbf{j}$

$s = \frac{1}{2}(1.4\mathbf{i} + \mathbf{j})t^2 + 30\mathbf{i} + 400\mathbf{j}$

$s = (30 + 0.7t^2)\mathbf{i} + (400 + 0.5t^2)\mathbf{j}$

(b) When the particle has moved for 25 seconds,

position vector of particle, r	= position vector (when $t = 10$) + 15 × velocity (when $t = 10$)
r	= 100i + 450j + 15 (14i + 10j)
∴ r	= 310i + 600j