

[In this question, position vectors are given relative to a fixed origin.]

A particle  $P$  is moving with constant acceleration  $(3\mathbf{i} - 2\mathbf{j})\text{ms}^{-2}$

At time  $t = 1\text{ s}$

- $P$  is at the point with position vector  $(5\mathbf{i} - 2\mathbf{j})\text{m}$
- $P$  is moving with velocity  $(-\mathbf{i} + 4\mathbf{j})\text{ms}^{-1}$

Find

(a) the exact speed of  $P$  at time  $t = 4\text{ s}$

(4)

(b) the position vector of  $P$  at time  $t = 3\text{ s}$

(3)

(a) "constant acceleration"  $\Rightarrow$  use 'suvat'

$$a = \begin{pmatrix} 3 \\ -2 \end{pmatrix} \quad \text{At } t=1, s = \begin{pmatrix} 5 \\ -2 \end{pmatrix} \quad v = \begin{pmatrix} -1 \\ 4 \end{pmatrix}$$

$t = 4$  is 3secs after  $t = 1$ , so we can consider  $t = 1$  is  $t = 0$   
and  $t = 4$  is  $t = 3$

$$v = u + at$$

$$\Rightarrow v_4 = u_1 + a(3)$$

$$\Rightarrow v_4 = \begin{pmatrix} -1 \\ 4 \end{pmatrix} + 3 \begin{pmatrix} 3 \\ -2 \end{pmatrix} = \begin{pmatrix} 8 \\ -2 \end{pmatrix} \quad (2 \text{ marks})$$

"speed" is the magnitude of velocity  $= |v_4| = \sqrt{8^2 + (-2)^2}$  (1mark)

$$= \sqrt{68} \text{ ms}^{-1} \quad (1 \text{ mark})$$

$$\underline{\text{(b)}} \quad s = ut + \frac{1}{2}at^2$$

( $t = 3$  is 2 seconds later than  $t = 1$ )

$$= \begin{pmatrix} -1 \\ 4 \end{pmatrix} 2 + \frac{1}{2} \begin{pmatrix} 3 \\ -2 \end{pmatrix} 2^2 = \begin{pmatrix} -2 \\ 8 \end{pmatrix} + \begin{pmatrix} 6 \\ -4 \end{pmatrix} = \begin{pmatrix} 4 \\ 4 \end{pmatrix} \quad (2 \text{ marks})$$

But  $\begin{pmatrix} 4 \\ 4 \end{pmatrix}$  is position relative to position at  $t = 1, \begin{pmatrix} 5 \\ -2 \end{pmatrix}$

$$\text{so position vector at } t = 3 \text{ is } \begin{pmatrix} 5 \\ -2 \end{pmatrix} + \begin{pmatrix} 4 \\ 4 \end{pmatrix} = \begin{pmatrix} 9 \\ 2 \end{pmatrix} \text{ m} \quad (1 \text{ mark})$$