P425/2

S6 VECTOR MECHANICS

Time : 1 hour

SECTION A

1 A particle with position vector $40\boldsymbol{i} + 10\boldsymbol{j} + 20\boldsymbol{k}$ moves with a constant speed of $5ms^{-1}$ in the direction of $4\boldsymbol{i} + 7\boldsymbol{j} + 4\boldsymbol{k}$. Find its distance from the origin after 9 seconds. ***05marks***

2 A particle of mass 3kg moves under the action of forces F_1, F_2 and F_3. At time t; $F_1 = \left(\frac{1}{4}t - 1\right)\boldsymbol{i} + (t-3)\boldsymbol{j}$ N, $F_2 = \left(\frac{1}{2}t + 2\right)\boldsymbol{i} + \left(\frac{1}{2}t - 4\right)\boldsymbol{j}$ N, and $F_3 = \left(\frac{1}{4}t - 4\right)\boldsymbol{i} + \left(\frac{3}{2}t + 1\right)\boldsymbol{j}$ N. Find the acceleration of the particle when $t = 2s$. ***05marks***

3. The velocity of an insect at any time t seconds is $os2t^3\boldsymbol{i} + sin2t^2\boldsymbol{j}\ ms^{-1}$. Calculate the magnitude of the acceleration and the angle the acceleration subtends with the vertical. ***05marks***

SECTION B

3 At 9:00am , a fishing boat is 10km on a bearing of 110° from a traveller , travelling with a speed of $8kmh^{-1}$ on a bearing of 060°. If the fishing boat has a top speed of $6kmh^{-1}$, find the ***05marks***

(i) route of the fishing boat if it is to be as close to the traveller as possible

(ii) distance between the two boats at this point and the time at which it will occur. ***07marks***

4 At time $t = 0$, the position vector ,**r** and velocity vector **v** of two trains A and B are as follows:

Trains	Velocity vector	Position vector
A	$\boldsymbol{v_A} = \begin{pmatrix} -6 \\ 0 \\ 1 \end{pmatrix} ms^{-1}$	$\boldsymbol{r_A} = \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix} m$
B	$\boldsymbol{v_B} = \begin{pmatrix} -5 \\ 1 \\ 7 \end{pmatrix} ms^{-1}$	$\boldsymbol{r_B} = \begin{pmatrix} 4 \\ -14 \\ 1 \end{pmatrix} m$

If the trains maintain these velocities, find the :

(i) position of B relative to A at time t.

(ii) time that elapses before the trains are closest to each other

(iii) least distance between the trains in the subsequent motion . ***12marks***

END