

5. At time t seconds, a particle P has velocity \mathbf{v} m s^{-1} , where

$$\mathbf{v} = 3t^{\frac{1}{2}} \mathbf{i} - 2t \mathbf{j} \quad t > 0$$

(a) Find the acceleration of P at time t seconds, where $t > 0$ (2)

(b) Find the value of t at the instant when P is moving in the direction of $\mathbf{i} - \mathbf{j}$ (3)

At time t seconds, where $t > 0$, the position vector of P , relative to a fixed origin O , is \mathbf{r} metres.

When $t = 1$, $\mathbf{r} = -\mathbf{j}$

(c) Find an expression for \mathbf{r} in terms of t . (3)

(d) Find the exact distance of P from O at the instant when P is moving with speed 10 m s^{-1} (6)

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Answer ALL questions. Write your answers in the spaces provided.

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

At time t seconds, where $t \geq 0$, a particle, P , moves so that its velocity $v \text{ m s}^{-1}$ is given by

$$\mathbf{v} = 6t\mathbf{i} - 5t^{\frac{3}{2}}\mathbf{j}$$

When $t = 0$, the position vector of P is $(-20\mathbf{i} + 20\mathbf{j})\text{m}$.

- (a) Find the acceleration of P when $t = 4$ (3)
- (b) Find the position vector of P when $t = 4$ (3)

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3. (i) At time t seconds, where $t \geq 0$, a particle P moves so that its acceleration $\mathbf{a} \text{ m s}^{-2}$ is given by

$$\mathbf{a} = (1 - 4t)\mathbf{i} + (3 - t^2)\mathbf{j}$$

At the instant when $t = 0$, the velocity of P is $36\mathbf{i} \text{ m s}^{-1}$

(a) Find the velocity of P when $t = 4$ (3)

(b) Find the value of t at the instant when P is moving in a direction perpendicular to \mathbf{i} (3)

(ii) At time t seconds, where $t \geq 0$, a particle Q moves so that its position vector \mathbf{r} metres, relative to a fixed origin O , is given by

$$\mathbf{r} = (t^2 - t)\mathbf{i} + 3t\mathbf{j}$$

Find the value of t at the instant when the speed of Q is 5 m s^{-1} (6)

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SECTION B: MECHANICS

Answer ALL questions. Write your answers in the spaces provided.

Unless otherwise indicated, whenever a numerical value of g is required, take $g = 9.8 \text{ m s}^{-2}$ and give your answer to either 2 significant figures or 3 significant figures.

6. At time t seconds, where $t \geq 0$, a particle P moves so that its acceleration \mathbf{a} m s^{-2} is given by

$$\mathbf{a} = 5t\mathbf{i} - 15t^{\frac{1}{2}}\mathbf{j}$$

When $t = 0$, the velocity of P is $20\mathbf{i}$ m s^{-1}

Find the speed of P when $t = 4$

(6)

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6. A particle P moves on the x -axis. At time t seconds, $t \geq 0$, the acceleration of P is $(2t - 3) \text{ m s}^{-2}$ in the positive x direction. At time t seconds, the velocity of P is $v \text{ m s}^{-1}$ in the positive x direction. When $t = 3$, $v = 2$

(a) Find v in terms of t . (4)

The particle first comes to instantaneous rest at the point A and then comes to instantaneous rest again at the point B .

(b) Find the distance AB . (6)

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4. At time t seconds ($t \geq 0$), a particle P has position vector \mathbf{r} metres with respect to a fixed origin O , where

$$\mathbf{r} = \left(t^3 - \frac{9}{2}t^2 - 24t \right) \mathbf{i} + (-t^3 + 3t^2 + 12t) \mathbf{j}$$

At time T seconds, P is moving in a direction parallel to the vector $-\mathbf{i} - \mathbf{j}$

Find

- (a) the value of T , (5)

- (b) the magnitude of the acceleration of P at the instant when $t = T$. (5)

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3. A particle P moves along a straight line. At time $t = 0$, P passes the point A on the line and at time t seconds the velocity of P is $v \text{ m s}^{-1}$ where

$$v = (2t - 3)(t - 2)$$

At $t = 3$, P reaches the point B . Find the total distance moved by P as it travels from A to B .

(6)

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