

Chapter 6: General Motion in Straight Line

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- 7 A particle moves in a straight line through the point O . The displacement of the particle from O at time t s is s m, where

$$s = t^2 - 3t + 2 \quad \text{for } 0 \leq t \leq 6,$$

$$s = \frac{24}{t} - \frac{t^2}{4} + 25 \quad \text{for } t \geq 6.$$

- (a) Find the value of t when the particle is instantaneously at rest during the first 6 seconds of its motion. [2]

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At $t = 6$, the particle hits a barrier at a point P and rebounds.

- (b) Find the velocity with which the particle arrives at P and also the velocity with which the particle leaves P . [3]

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6 A particle P moves in a straight line. The velocity $v \text{ m s}^{-1}$ at time $t \text{ s}$ is given by

$$\begin{aligned} v &= 2t + 1 && \text{for } 0 \leq t \leq 5, \\ v &= 36 - t^2 && \text{for } 5 \leq t \leq 7, \\ v &= 2t - 27 && \text{for } 7 \leq t \leq 13.5. \end{aligned}$$

(a) Sketch the velocity-time graph for $0 \leq t \leq 13.5$. [3]

(b) Find the acceleration at the instant when $t = 6$. [2]

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5 A particle P moves in a straight line. It starts at a point O on the line and at time t s after leaving O it has velocity v m s⁻¹, where $v = 4t^2 - 20t + 21$.

(a) Find the values of t for which P is at instantaneous rest. [2]

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(b) Find the initial acceleration of P . [2]

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(c) Find the minimum velocity of P . [2]

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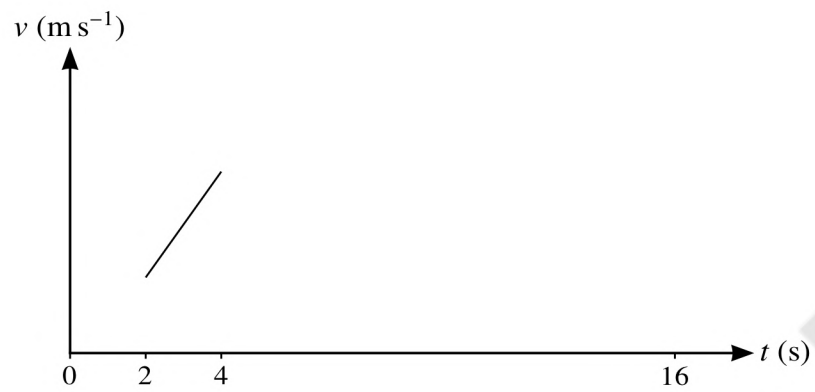
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(b) Complete the sketch of the velocity-time diagram.

[2]



(c) Find the distance travelled by *P* when it is decelerating.

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- 6 A particle moves in a straight line and passes through the point A at time $t = 0$. The velocity of the particle at time t s after leaving A is v m s⁻¹, where

$$v = 2t^2 - 5t + 3.$$

- (a) Find the times at which the particle is instantaneously at rest. Hence or otherwise find the minimum velocity of the particle. [4]

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- (b) Sketch the velocity-time graph for the first 3 seconds of motion. [3]

- 6 A particle P moves in a straight line starting from a point O and comes to rest 14 s later. At time t s after leaving O , the velocity v m s⁻¹ of P is given by

$$v = pt^2 - qt \quad 0 \leq t \leq 6,$$

$$v = 63 - 4.5t \quad 6 \leq t \leq 14,$$

where p and q are positive constants.

The acceleration of P is zero when $t = 2$.

- (a) Given that there are no instantaneous changes in velocity, find p and q . [3]

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- (b) Sketch the velocity-time graph. [3]

5 A particle P moves on the x -axis from the origin O with an initial velocity of -20 m s^{-1} . The acceleration $a\text{ m s}^{-2}$ at time $t\text{ s}$ after leaving O is given by $a = 12 - 2t$.

(a) Sketch a velocity-time graph for $0 \leq t \leq 12$, indicating the times when P is at rest. [5]

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(b) It is given instead that $AB = 36$ m.

Verify that X and Y collide after 3 s.

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3 A particle moves in a straight line starting from rest from a point O . The acceleration of the particle at time t s after leaving O is $a \text{ m s}^{-2}$, where $a = 4t^{\frac{1}{2}}$.

(a) Find the speed of the particle when $t = 9$. [2]

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(b) Find the time after leaving O at which the speed (in metres per second) and the distance travelled (in metres) are numerically equal. [3]

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- 6 A particle P starts at rest and moves in a straight line from a point O . At time t s after leaving O , the velocity of P , v m s^{-1} , is given by $v = bt + ct^{\frac{3}{2}}$, where b and c are constants. P has velocity 8 m s^{-1} when $t = 4$ and has velocity 13.5 m s^{-1} when $t = 9$.

(a) Show that $b = 3$ and $c = -0.5$. [1]

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(b) Find the acceleration of P when $t = 1$. [2]

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(c) Find the positive value of t when P is at instantaneous rest and find the distance of P from O at this instant. [5]

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5 A particle starts from rest from a point O and moves in a straight line. The acceleration of the particle at time t s after leaving O is $a \text{ m s}^{-2}$, where $a = kt^{\frac{1}{2}}$ for $0 \leq t \leq 9$ and where k is a constant. The velocity of the particle at $t = 9$ is 1.8 m s^{-1} .

(a) Show that $k = 0.1$. [3]

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For $t > 9$, the velocity $v \text{ m s}^{-1}$ of the particle is given by $v = 0.2(t - 9)^2 + 1.8$.

(b) Show that the distance travelled in the first 9 seconds is one tenth of the distance travelled between $t = 9$ and $t = 18$. [4]

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- 7 A particle X travels in a straight line. The velocity of X at time t s after leaving a fixed point O is denoted by v m s⁻¹, where

$$v = -0.1t^3 + 1.8t^2 - 6t + 5.6.$$

The acceleration of X is zero at $t = p$ and $t = q$, where $p < q$.

- (a) Find the value of p and the value of q . [4]

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It is given that the velocity of X is zero at $t = 14$.

- (b) Find the velocities of X at $t = p$ and at $t = q$, and hence sketch the velocity-time graph for the motion of X for $0 \leq t \leq 15$. [3]

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