



Variable Acceleration



REVISE THIS
TOPIC

CHECK YOUR
ANSWERS

- 1 A fixed point O lies on a straight line.
A particle, P , moves along the straight line.
At time t seconds, $0 \leq t \leq 10$, the distance, s metres, of P from O is given by

$$s = 10t - t^2$$

When $t = 1$, P is at point X .

When $t = T$, P is at point Y , where $OY = 21$ m

Find,

- (a) the distance OX . (1)
- (b) two possible values for T . (2)
- (c) the maximum distance of point P from the point O in the interval $0 \leq t \leq 10$ (2)
- (d) the total distance travelled by the point P in the interval $0 \leq t \leq 10$ (2)

(Total for Question 1 is 7 marks)

- 2 A fixed point O lies on a straight line.
A particle, P , moves along the straight line.
At time t seconds, $t \geq 0$, the distance, s metres, of P from O is given by

$$s = 36t - t^3$$

When $t = 1$, P is at point X .

When $t = 2$, P is at point Y .

When $t = T$, $T > 0$, P is at point O .

Find,

- (a) XY (2)
- (b) T (2)
- (c) the maximum distance of point P from the point O in the interval $0 \leq t \leq T$ (3)
- (d) the total distance travelled by P in the interval $0 \leq t \leq T$ (2)

(Total for Question 2 is 8 marks)





- 3 A particle, P , moves along the x -axis. At time t seconds, $t \geq 0$, the displacement, x metres, of P from the origin O , is given by $x = 4t^3 - 28t^2 + 49t$

(a) Find the velocity of P at time t seconds. (2)

(b) Find the speed of P when $t = 2$ (2)

(c) Find the values of t when P is instantaneously at rest. (3)

When $t = 0$, P is at point O .

(d) Find the other value of t when P is at point O . (2)

(e) Show that P will never move along the negative x -axis. (2)

(Total for Question 3 is 11 marks)

- 4 A fixed point O lies on a straight line.

A particle, P , moves along the straight line.

At time t seconds, $t \geq 0$, the distance, s metres, of P from O is given by

$$s = \frac{1}{3}t^3 - 4t^2 + 7t$$

Find,

(a) the maximum speed of P in the interval $0 \leq t \leq 8$ (4)

(b) the magnitude of the acceleration of P when $t = 3$ (2)

(c) The total distance travelled by P in the interval $0 \leq t \leq 8$ (4)

(Total for Question 4 is 10 marks)

- 5 A particle, P , moves along the x -axis. At time t seconds, $t \geq 0$, the displacement, x metres, of P from the origin O , is given by $x = \frac{1}{3}t^3 - 3t^2 + 5t$

At $t = 6$, P is at the point M .

(a) Find the distance OM . (2)

(b) Find the values of t for which P is at instantaneous rest. (3)

(c) Find the total distance travelled by P in the interval $0 \leq t \leq 6$ (4)

(d) Find the value of t at which the acceleration of P is zero. (2)

(Total for Question 5 is 11 marks)



- 6 A particle, P , moves along a straight line such that at time t seconds, $t \geq 0$, the velocity of P , $v \text{ ms}^{-1}$, is modelled as

$$v = t^3 + 3t^2$$

- (a) Find the velocity of P when $t = 5$ (1)
- (b) Find the acceleration of P at time t seconds. (2)
- (c) Show that P never changes direction. (2)
- (d) Find the total distance travelled by P in the interval $0 \leq t \leq 4$ (3)

(Total for Question 6 is 8 marks)

- 7 A fixed point O lies on a straight line.

A particle, P , moves along the straight line such that at time t seconds, $t \geq 0$, after passing through point O , the velocity of P , $v \text{ ms}^{-1}$ is modelled as

$$v = t^2 - 6t + 8$$

- (a) Find the range of values of t for which the velocity of P is negative. (2)
- (b) Find the greatest speed of P in the interval $0 \leq t \leq 5$ (3)
- (c) Find the magnitude of the acceleration of P the first time that P is at instantaneous rest. (4)

When $t = 3$, P is at point X .

- (d) Find the distance OX . (3)

(Total for Question 7 is 12 marks)

- 8 A particle, P , moves along a straight line such that at time t seconds, $t \geq 0$, the velocity of P , $v \text{ ms}^{-1}$, is modelled as

$$v = 4t^3 - 24t^2 + 20t$$

- (a) Find the values of t for which P is at instantaneous rest. (3)
- (b) Find the magnitude of the acceleration of P when $t = 1$. (2)

M and N are fixed points on the straight line.

When $t = 0$, the displacement of P from point M is 25 metres.

When $t = 3$, P is at point N .

- (c) Find the distance MN . (4)

(Total for Question 8 is 9 marks)



- 9 A particle, P , moves along a straight line such that at time t seconds, $t \geq 0$, the velocity of P , $v \text{ ms}^{-1}$, is modelled as

$$v = 36t - 3t^2 - 33$$

- (a) Find the greatest speed of P in the interval $0 \leq t \leq 12$ (4)
- (b) Find the range of values of t for which the acceleration of P is positive. (3)
- (c) Find the total distance travelled by P in the interval $0 \leq t \leq 12$ (5)

(Total for Question 9 is 12 marks)

- 10 A fixed point O lies on a straight line.

A particle, P , moves along the straight line such that at time t seconds, $t \geq 0$, after passing through point O , the velocity of P , $v \text{ ms}^{-1}$ is modelled as

$$v = 8 - t^3$$

- (a) Show that the acceleration of P is never positive. (2)
- (b) Find the distance travelled by P when it is at instantaneous rest. (4)
- (c) Determine if P is moving towards or away from O when $t = 4$ (3)

(Total for Question 10 is 9 marks)

- 11 A particle, P , moves along the x -axis such that at time t seconds, $t > 0$, the velocity of P , $v \text{ ms}^{-1}$ is modelled as

$$v = 4\sqrt{t} - 5t$$

- (a) Find the magnitude of the acceleration when P is at instantaneous rest. (4)

When $t = 1$, the displacement of P from the origin is 6 metres.

- (b) Find the displacement of P from the origin at the instant when P stops accelerating. (6)

(Total for Question 11 is 10 marks)

- 12 A fixed point O lies on a straight line.

A particle, P , moves along the straight line such that at time t seconds, $t \geq 0$, after passing through point O , the velocity of P , $v \text{ ms}^{-1}$ is modelled as

$$v = t^2 - kt + 18$$

where k is a constant.

- (a) Given that P at instantaneous rest when $t = 2$, find the value of k . (2)
- (b) Find the magnitude of the acceleration of P when $t = 3$ (2)
- (c) Find the maximum distance of P from O in the interval $0 \leq t \leq 10$ (4)

(Total for Question 12 is 8 marks)





13 Particles P and Q , move along the x -axis. At time t seconds, $t \geq 0$, the displacement, x metres, of P from the origin O , is given by $x = t^3 - 20t^2 + 77t$

At time t seconds, $t \geq 0$, the acceleration of Q , $a \text{ ms}^{-2}$, is modelled as $a = 2t - 9$

When $t = 0$, Q is moving with a velocity of 12 ms^{-1}

(a) Find a range of values of t for which the velocity of Q is greater than the velocity of P . (6)

When $t = 0$, the displacement of Q from the origin O is 6 metres.

(b) Find the distance between P and Q when $t = 4$ (4)

(Total for Question 13 is 10 marks)

14 A fixed point O lies on a straight line.

A particle, P , moves along the straight line such that at time t seconds, $t \geq 0$, the acceleration of P , $a \text{ ms}^{-2}$ is modelled as

$$a = 13 - 6t$$

When $t = 0$, the velocity of P is 10 ms^{-1} and the displacement of P from point O is 2 metres.

(a) Find the value of t for which P is at instantaneous rest. (4)

(b) Find the displacement of P from O when $t = 3$ (4)

(c) Find the total distance travelled by P in the interval $0 \leq t \leq 6$ (4)

(Total for Question 14 is 12 marks)

15 An electric scooter travels along a straight horizontal road.

At time t seconds, $0 \leq t \leq k$, where k is an integer, the acceleration of the scooter, $a \text{ ms}^{-2}$ is modelled as

$$a = 2 - 0.4t$$

When $t = 0$, the velocity of the scooter is 2.2 ms^{-1}

The scooter comes to rest when $t = k$

(a) Find the value of k (4)

(b) Find the magnitude of the acceleration of the scooter when $t = k$ (2)

(c) Find the distance travelled by the scooter in the interval $0 \leq t \leq k$ (4)

(Total for Question 15 is 10 marks)





- 16 At time $t = 0$, a drone takes off from rest at ground level and moves vertically such that at time t seconds, $0 \leq t \leq 4$, the velocity of the drone, $v \text{ ms}^{-1}$ is modelled as

$$v = t^3 - 7t^2 + 12t$$

The drone is at instantaneous rest when $t = 0$

- (a) Find the other values of t for which the drone is at instantaneous rest. (2)

- (b) Find the greatest height above ground level reached by the drone in the interval $0 \leq t \leq 4$ (4)

The acceleration of the drone, $a \text{ ms}^{-2}$, is such that for $0 \leq t \leq 4$,

$$a \geq k, \text{ where } k \text{ is a constant}$$

- (c) Find the greatest possible value for k . (4)

(Total for Question 16 is 10 marks)

