

Kinematics P1 [66 marks]

1. [Maximum mark: 16]

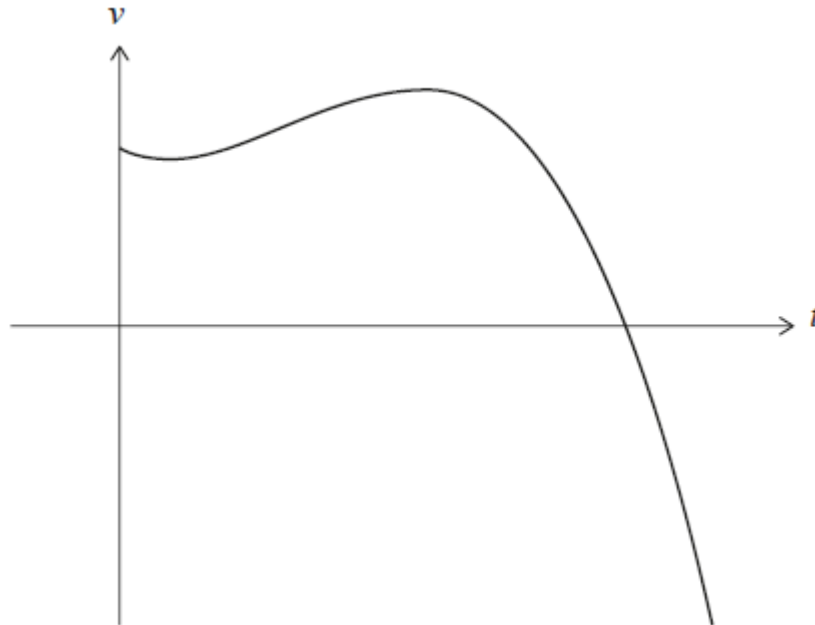
A particle P moves along the x -axis. The velocity of P is $v \text{ m s}^{-1}$ at time t seconds, where $v(t) = 4 + 4t - 3t^2$ for $0 \leq t \leq 3$. When $t = 0$, P is at the origin O .

- (a) Find the value of t when P reaches its maximum velocity. [2]
- (b) Show that the distance of P from O at this time is $\frac{88}{27}$ metres. [5]
- (c) Sketch a graph of v against t , clearly showing any points of intersection with the axes. [4]
- (d) Find the total distance travelled by P . [5]

2. [Maximum mark: 17]

An object moves along a straight line. Its velocity, $v \text{ m s}^{-1}$, at time t seconds is given by $v(t) = -t^3 + \frac{7}{2}t^2 - 2t + 6$, for $0 \leq t \leq 4$. The object first comes to rest at $t = k$.

The graph of v is shown in the following diagram.

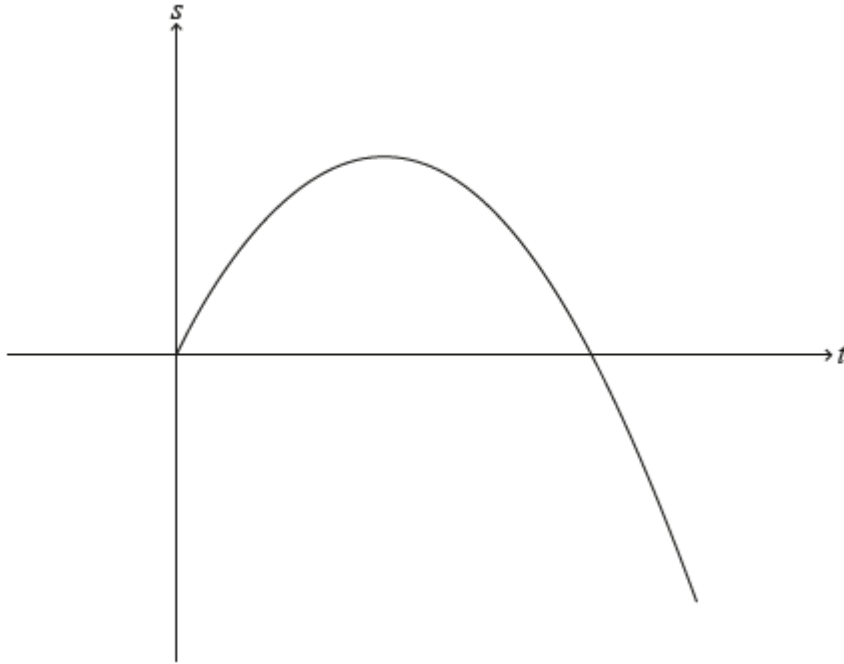


At $t = 0$, the object is at the origin.

- (a) Find the displacement of the object from the origin at $t = 1$. [5]
- (b) Find an expression for the acceleration of the object. [2]
- (c) Hence, find the greatest speed reached by the object before it comes to rest. [5]
- (d) Find the greatest speed reached by the object for $0 \leq t \leq 4$. [2]
- (e) Write down an expression that represents the distance travelled by the object while its speed is increasing. Do not evaluate the expression. [3]

3. [Maximum mark: 14]

Particle A travels in a straight line such that its displacement, s metres, from a fixed origin after t seconds is given by $s(t) = 8t - t^2$, for $0 \leq t \leq 10$, as shown in the following diagram.



Particle A starts at the origin and passes through the origin again when $t = p$.
 Particle A changes direction when $t = q$.

The total distance travelled by particle A is given by d .

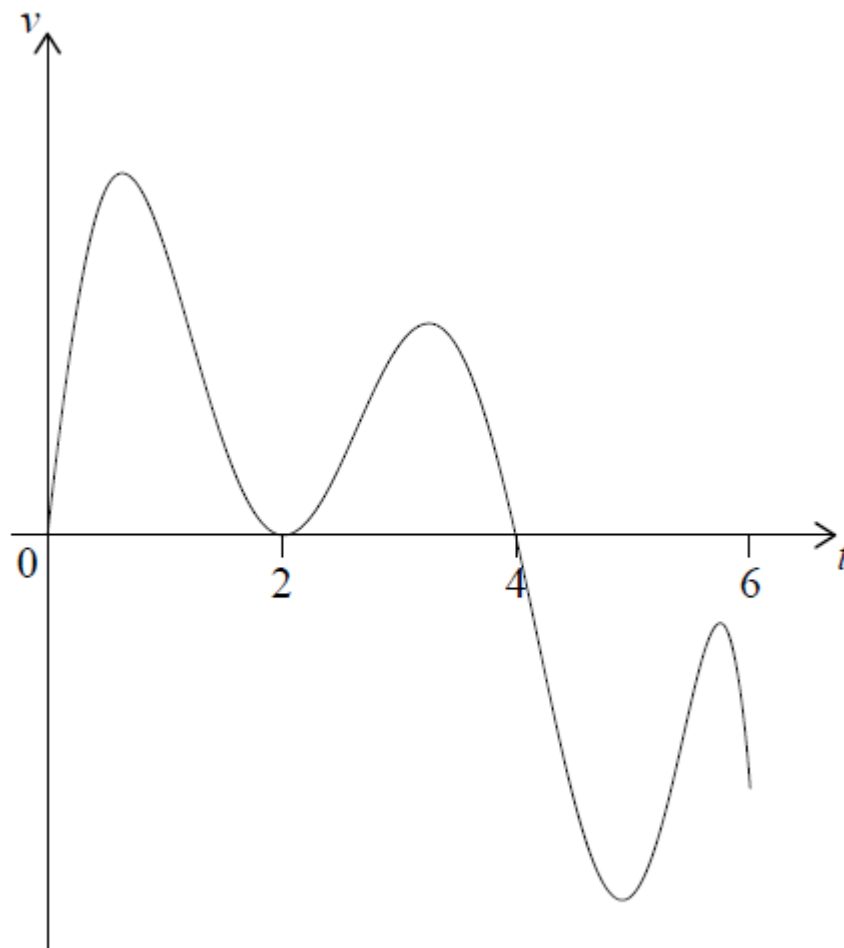
- (a) Find the value of p . [2]
- (b) Find the value of q . [2]
- (c) Find the displacement of particle A from the origin when $t = q$. [2]
- (d) Find the distance of particle A from the origin when $t = 10$. [2]
- (e) Find the value of d . [2]
- (f) A second particle, particle B, travels along the same straight line such that its velocity is given by $v(t) = 14 - 2t$, for $t \geq 0$.

When $t = k$, the distance travelled by particle B is equal to d .

Find the value of k .

4. [Maximum mark: 7]

A particle P starts from point O and moves along a straight line. The graph of its velocity, $v \text{ ms}^{-1}$ after t seconds, for $0 \leq t \leq 6$, is shown in the following diagram.



The graph of v has t -intercepts when $t = 0, 2$ and 4 .

The function $s(t)$ represents the displacement of P from O after t seconds.

It is known that P travels a distance of 15 metres in the first 2 seconds. It is also known that $s(2) = s(5)$ and $\int_2^4 v \, dt = 9$.

(a) Find the value of $s(4) - s(2)$. [2]

(b) Find the total distance travelled in the first 5 seconds. [5]

5. [Maximum mark: 5]

A particle moves in a straight line such that at time t seconds ($t \geq 0$), its velocity v , in ms^{-1} , is given by $v = 10te^{-2t}$. Find the exact distance travelled by the particle in the first half-second. [5]

6. [Maximum mark: 7]

A particle moves along a straight line. Its displacement, s metres, at time t seconds is given by $s = t + \cos 2t$, $t \geq 0$. The first two times when the particle is at rest are denoted by t_1 and t_2 , where $t_1 < t_2$.

(a) Find t_1 and t_2 . [5]

(b) Find the displacement of the particle when $t = t_1$ [2]