Kinematics – 2021 AS

1. June/2021/Paper_9709/41/No.4

Two cyclists, Isabella and Maria, are having a race. They both travel along a straight road with constant acceleration, starting from rest at point A.

Isabella accelerates for 5 s at a constant rate $a\ \text{m s}^{-2}$. She then travels at the constant speed she has reached for 10 s, before decelerating to rest at a constant rate over a period of 5 s.

Maria accelerates at a constant rate, reaching a speed of $5\ \text{m s}^{-1}$ in a distance of 27.5 m. She then maintains this speed for a period of 10 s, before decelerating to rest at a constant rate over a period of 5 s.

(a) Given that $a = 1.1$, find which cyclist travels further. [5]

(b) Find the value of a for which the two cyclists travel the same distance. [2]

2. June/2021/Paper_9709/41/No.5

A particle moving in a straight line starts from rest at a point A and comes instantaneously to rest at a point B. The acceleration of the particle at time t s after leaving A is a m s^{-2}, where

$$a = 6t^{\frac{1}{2}} - 2t.$$

(a) Find the value of t at point B. [3]

(b) Find the distance travelled from A to the point at which the acceleration of the particle is again zero. [5]

3. June/2021/Paper_9709/42/No.7

A particle P moving in a straight line starts from rest at a point O and comes to rest 16 s later. At time t s after leaving O, the acceleration a m s^{-2} of P is given by

$$\begin{aligned} a &= 6 + 4t \qquad 0 \leqslant t < 2, \\ a &= 14 \qquad\quad 2 \leqslant t < 4, \\ a &= 16 - 2t \qquad 4 \leqslant t \leqslant 16. \end{aligned}$$

There is no sudden change in velocity at any instant.

(a) Find the values of t when the velocity of P is 55 m s^{-1}. [5]

(b) Complete the sketch of the velocity-time diagram. [2]

(c) Find the distance travelled by P when it is decelerating. [3]

4. June/2021/Paper_9709/43/No.4

A particle is projected vertically upwards with speed u m s^{-1} from a point on horizontal ground. After 2 seconds, the height of the particle above the ground is 24 m.

(a) Show that $u = 22$. [2]

(b) The height of the particle above the ground is more than h m for a period of 3.6 s.

Find h. [4]

5. June/2021/Paper_9709/43/No.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

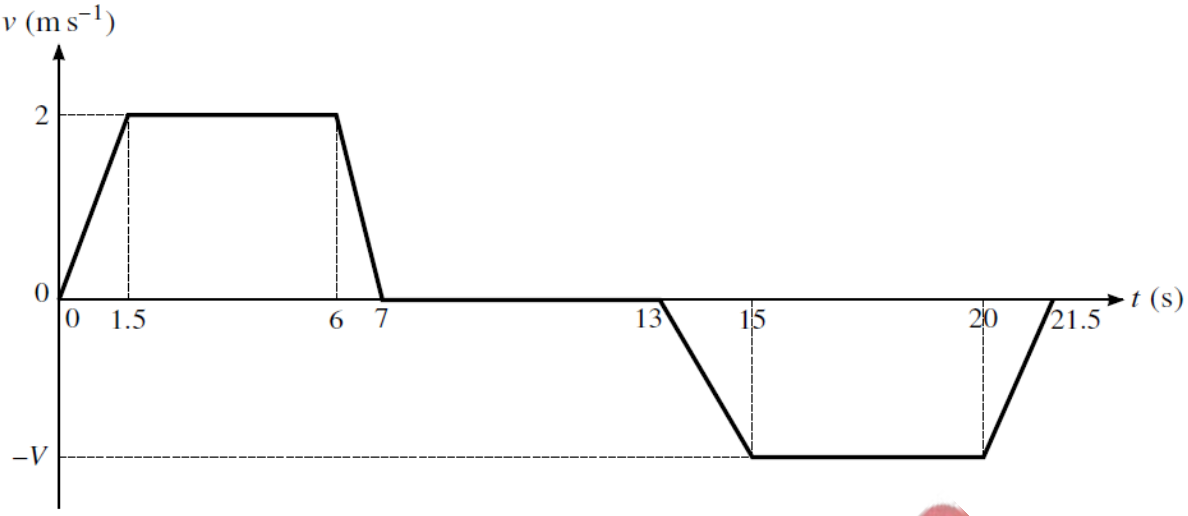
$$v = 2t^2 - 5t + 3.$$

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

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

(c) Find the distance travelled between the two times when the particle is instantaneously at rest. [3]

6. March/2021/Paper_9709/42/No.4



An elevator moves vertically, supported by a cable. The diagram shows a velocity-time graph which models the motion of the elevator. The graph consists of 7 straight line segments.

The elevator accelerates upwards from rest to a speed of 2 m s^{-1} over a period of 1.5 s and then travels at this speed for 4.5 s, before decelerating to rest over a period of 1 s.

The elevator then remains at rest for 6 s, before accelerating to a speed of V m s^{-1} downwards over a period of 2 s. The elevator travels at this speed for a period of 5 s, before decelerating to rest over a period of 1.5 s.

(a) Find the acceleration of the elevator during the first 1.5 s. [1]

(b) Given that the elevator starts and finishes its journey on the ground floor, find V. [2]

(c) The combined weight of the elevator and passengers on its upward journey is 1500 kg. Assuming that there is no resistance to motion, find the tension in the elevator cable on its upward journey when the elevator is decelerating. [3]

7. March/2021/Paper_9709/42/No.6

A particle moves in a straight line. It starts from rest from a fixed point O on the line. Its velocity at time t s after leaving O is v m s^{-1}, where $v = t^2 - 8t^{\frac{3}{2}} + 10t$.

(a) Find the displacement of the particle from O when $t = 1$. [4]

(b) Show that the minimum velocity of the particle is -125 m s^{-1}. [7]