General Motion in a Straight Line (Ch 11)

3 A motorcyclist starts from rest at a point O and travels in a straight line. His velocity after t seconds is $v\,\text{m s}^{-1}$, for $0 \leqslant t \leqslant T$, where $v = 7.2t - 0.45t^2$. The motorcyclist's acceleration is zero when $t = T$.

(i) Find the value of T. [4]

(ii) Show that $v = 28.8$ when $t = T$. [1]

Jan '06

For $t \geqslant T$ the motorcyclist travels in the same direction as before, but with constant speed $28.8\,\text{m s}^{-1}$.

(iii) Find the displacement of the motorcyclist from O when $t = 31$. [6]

4 A cyclist travels along a straight road. Her velocity $v\,\text{m s}^{-1}$, at time t seconds after starting from a point O, is given by

$$v = 2 \quad \text{for } 0 \leqslant t \leqslant 10,$$
$$v = 0.03t^2 - 0.3t + 2 \quad \text{for } t \geqslant 10.$$

Jan '06

(i) Find the displacement of the cyclist from O when $t = 10$. [1]

(ii) Show that, for $t \geqslant 10$, the displacement of the cyclist from O is given by the expression $0.01t^3 - 0.15t^2 + 2t + 5$. [4]

(iii) Find the time when the acceleration of the cyclist is $0.6\,\text{m s}^{-2}$. Hence find the displacement of the cyclist from O when her acceleration is $0.6\,\text{m s}^{-2}$. [5]

4 The displacement of a particle from a fixed point O at time t seconds is $t^4 - 8t^2 + 16$ metres, where $t \geqslant 0$.

Jan '08

(i) Verify that when $t = 2$ the particle is at rest at the point O. [5]

(ii) Calculate the acceleration of the particle when $t = 2$. [3]

6 A model train travels along a straight track. At time t seconds after setting out from station A, the train has velocity $v\,\text{m s}^{-1}$ and displacement x metres from A. It is given that for $0 \leqslant t \leqslant 7$

$$x = 0.01t^4 - 0.16t^3 + 0.72t^2.$$

After leaving A the train comes to instantaneous rest at station B.

Jun '08

(i) Express v in terms of t. Verify that when $t = 2$ the velocity of the train is $1.28\,\text{m s}^{-1}$. [3]

(ii) Express the acceleration of the train in terms of t, and hence show that when the acceleration of the train is zero $t^2 - 8t + 12 = 0$. [3]

(iii) Calculate the minimum value of v. [4]

(iv) Sketch the (t, v) graph for the train, and state the direction of motion of the train when it leaves B. [4]

(v) Calculate the distance AB. [2]

5 A particle starts from rest at a point A at time $t = 0$, where t is in seconds. The particle moves in a straight line. For $0 \leqslant t \leqslant 4$ the acceleration is $1.8t$ m s^{-2}, and for $4 \leqslant t \leqslant 7$ the particle has constant acceleration 7.2 m s^{-2}.

Jan '07

(i) Find an expression for the velocity of the particle in terms of t, valid for $0 \leqslant t \leqslant 4$. [3]

(ii) Show that the displacement of the particle from A is 19.2 m when $t = 4$. [4]

(iii) Find the displacement of the particle from A when $t = 7$. [5]

6 A particle starts from rest at the point A and travels in a straight line. The displacement s m of the particle from A at time t s after leaving A is given by

$$s = 0.001t^4 - 0.04t^3 + 0.6t^2, \quad \text{for } 0 \leqslant t \leqslant 10.$$

Jun '07

(i) Show that the velocity of the particle is 4 m s^{-1} when $t = 10$. [3]

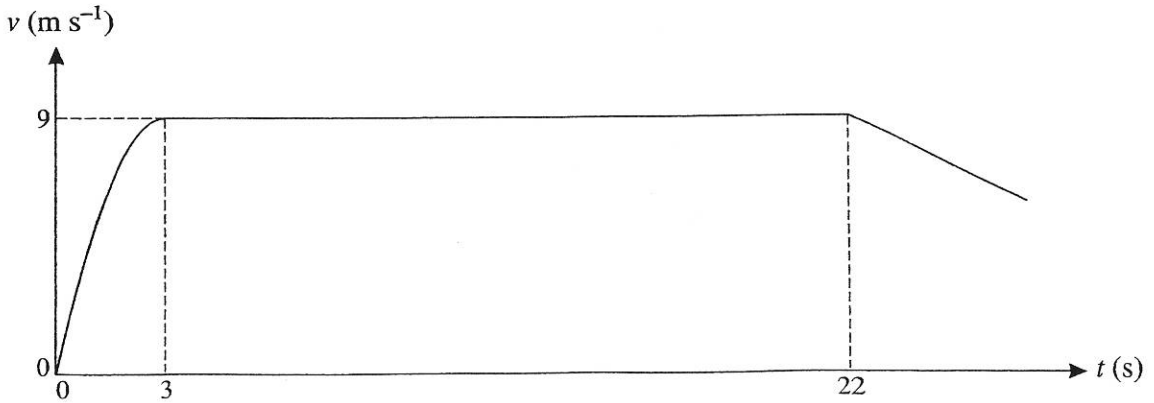
The acceleration of the particle for $t \geqslant 10$ is $(0.8 - 0.08t)$ m s^{-2}.

(ii) Show that the velocity of the particle is zero when $t = 20$. [5]

(iii) Find the displacement from A of the particle when $t = 20$. [6]

7

Jun '09



A sprinter S starts from rest at time $t = 0$, where t is in seconds, and runs in a straight line. For $0 \leqslant t \leqslant 3$, S has velocity $(6t - t^2)$ m s^{-1}. For $3 < t \leqslant 22$, S runs at a constant speed of 9 m s^{-1}. For $t > 22$, S decelerates at 0.6 m s^{-2} (see diagram).

(i) Express the acceleration of S during the first 3 seconds in terms of t. [2]

(ii) Show that S runs 18 m in the first 3 seconds of motion. [5]

(iii) Calculate the time S takes to run 100 m. [3]

(iv) Calculate the time S takes to run 200 m. [7]