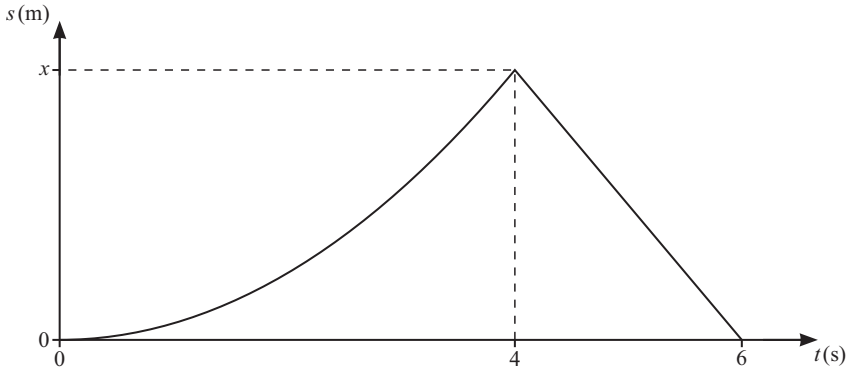
7 A particle P starts from a point O and moves in a straight line. The velocity $v\,\text{m s}^{-1}$ of P, at time t s after leaving O, is given by $v = \frac{1}{3}(2t-3)(t-4)$.

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

(b) Find the total distance travelled by P in the first 3 seconds of its motion. [5]

(c) Determine whether P returns to O. [2]

1



The diagram shows the displacement-time graph for the motion of a particle. The particle starts from rest at a point O and travels with constant acceleration $a\,\text{m s}^{-2}$, taking 4 s to move a distance of x m. The particle then returns to O with constant speed of $40\,\text{m s}^{-1}$, over a period of 2 s.

Find the value of x and the value of a. [3]

3 A car of mass 1400 kg travelling on a straight horizontal road accelerates uniformly from a speed of $15\,\text{m s}^{-1}$ to $20\,\text{m s}^{-1}$ over a distance of 175 m.

(a) Find the time taken to travel the 175 m. [2]

There is a constant resistance force of 800 N to the motion of the car.

(b) (i) Use an energy method throughout to find the average power of the car's engine as the speed increases from $15\,\text{m s}^{-1}$ to $20\,\text{m s}^{-1}$. [4]

(ii) Find the steady speed that the car could maintain on the horizontal road if the engine is working at the power found in **(b)(i)**. [2]

4 A particle P of mass 0.1 kg is projected vertically upwards with speed $30\,\text{m}\,\text{s}^{-1}$ from horizontal ground. At the same instant a particle Q of mass 0.4 kg is projected vertically upwards with speed $10\,\text{m}\,\text{s}^{-1}$ from a height of 15 m above the ground. P and Q move in the same vertical line.

(a) Find the height above the ground at which P and Q collide. [4]

When P and Q collide, they coalesce.

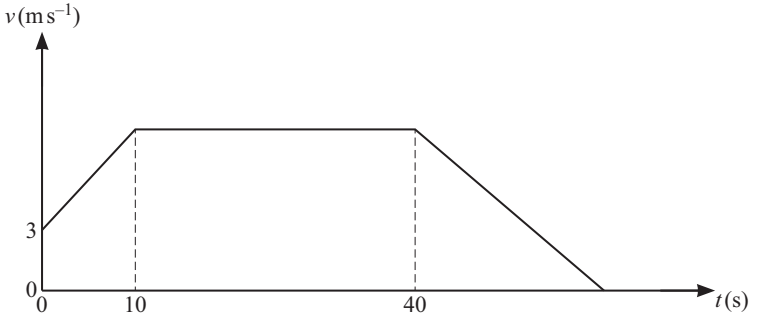
(b) Find the speed of the combined particle at the instant that it reaches the ground. [5]

6 A particle starts from rest at a point O. The acceleration of the particle at time t s after leaving O is $a\,\text{m s}^{-2}$, where

$$a = 2(t+1)^{-\frac{1}{2}} - 1 \text{ for } t \geqslant 0.$$

Find the distance that the particle travels from O until the time at which its acceleration is zero. [8]

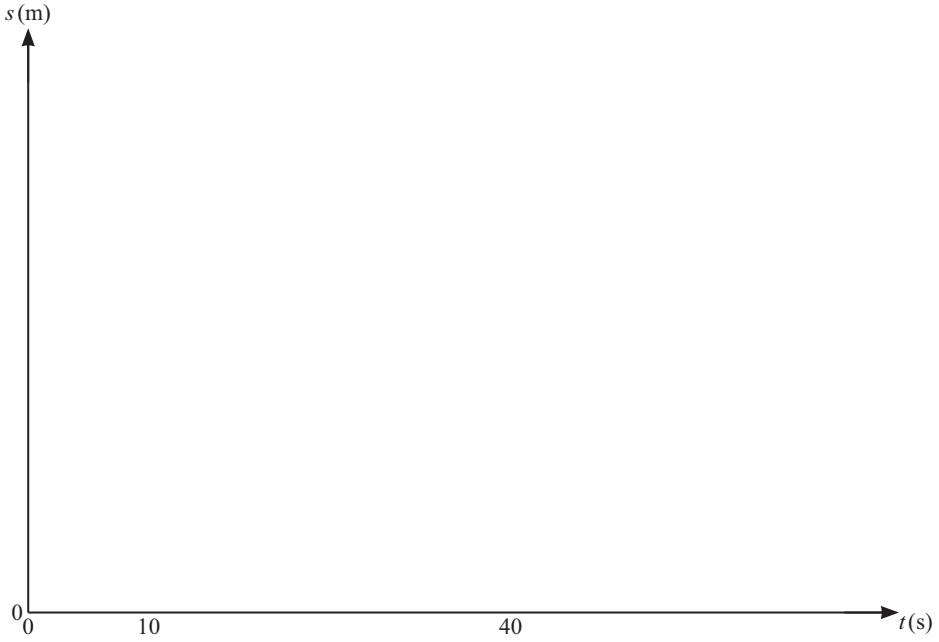
3



The diagram shows the velocity-time graph of the motion of a cyclist. The graph consists of three straight line segments. The cyclist passes a point O with speed $3\,\text{m s}^{-1}$ and then accelerates for 10 s with constant acceleration $0.5\,\text{m s}^{-2}$. He then travels at constant speed for 30 s before decelerating, coming to rest at point P, covering a distance of 80 m whilst decelerating.

(a) Find the total time taken for the journey from O to P. [3]

(b) On the given axes, sketch a displacement-time graph for the cyclist's journey from O to P, showing on your graph the distances travelled after 10 s and 40 s. [4]



7 A particle X moves along a straight track, starting from a point O at time $t = 0$. The displacement of X from O at time t s is s m, where $s = 3t^{\frac{3}{2}} - 6t$.

(a) Find the time at which X is instantaneously at rest, and hence find the total distance travelled by X between $t = 0$ and $t = 16$. [6]

A second particle Y moves along another straight track, starting from a point P at time $t = 0$. The acceleration of Y at time t s is a m s^{-2}, where $a = 0.8 - 0.6t$. The velocity of Y when it leaves P is 7.5 m s^{-1}.

(b) When the velocity of Y is -9.6 m s^{-1}, show that the displacement of X from O is equal to the displacement of Y from P. [7]

Additional page

If you use the following page to complete the answer to any question, the question number must be clearly shown.