1 A particle is travelling in a straight line. Its velocity v m s^{-1} at time t seconds is given by

$$v = 6 + 4t \quad \text{for } 0 \leqslant t \leqslant 5.$$

(i) Write down the initial velocity of the particle and find the acceleration for $0 \leqslant t \leqslant 5$. **[2]**

(ii) Write down the velocity of the particle when $t = 5$. Find the distance travelled in the first 5 seconds. **[3]**

For $5 \leqslant t \leqslant 15$, the acceleration of the particle is 3 m s^{-2}.

(iii) Find the total distance travelled by the particle during the 15 seconds. **[3]**

2

Fig. 5

A toy car is moving along the straight line Ox, where O is the origin. The time t is in seconds. At time $t = 0$ the car is at A, 3 m from O as shown in Fig. 5. The velocity of the car, v m s^{-1}, is given by

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

Calculate the distance of the car from O when its acceleration is zero. [8]

3 A particle moves along a straight line containing a point O. Its displacement, x m, from O at time t seconds is given by

$$x = 12t - t^3, \text{ where } -10 \leqslant t \leqslant 10.$$

Find the values of x for which the velocity of the particle is zero. [5]

4 A point P on a piece of machinery is moving in a vertical straight line. The displacement of P above ground level at time t seconds is y metres. The displacement-time graph for the motion during the time interval $0 \leqslant t \leqslant 4$ is shown in Fig. 7.

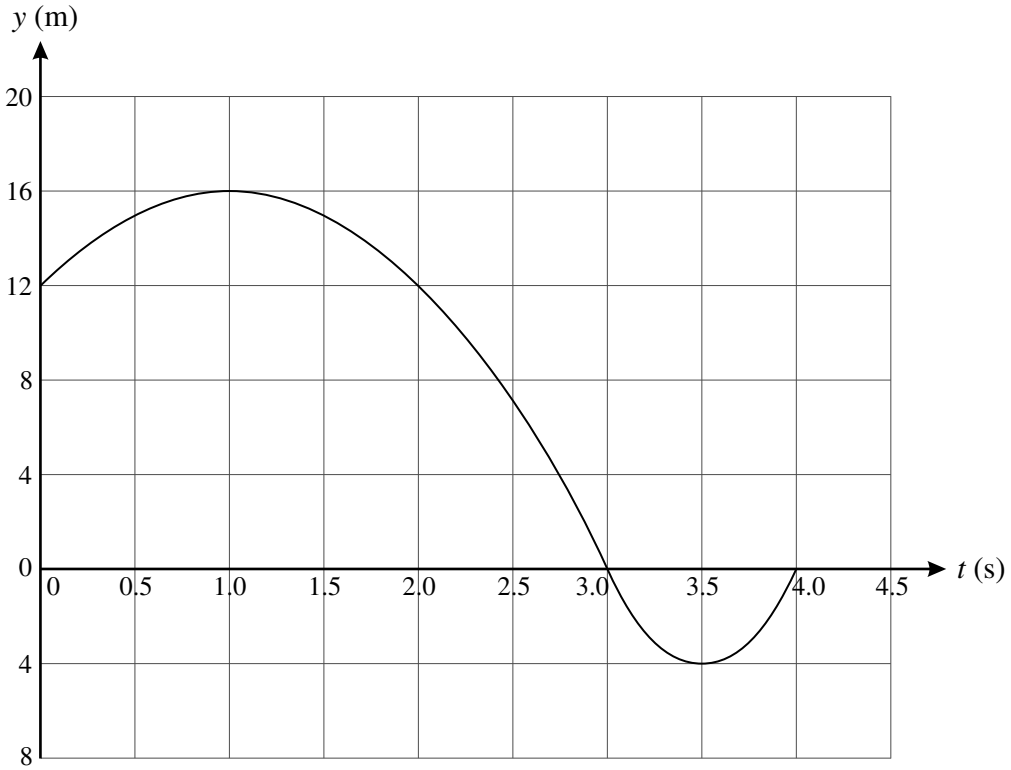

Fig. 7

(i) Using the graph, determine for the time interval $0 \leqslant t \leqslant 4$

(A) the greatest displacement of P above its position when $t = 0$,

(B) the greatest distance of P from its position when $t = 0$,

(C) the time interval in which P is moving downwards,

(D) the times when P is instantaneously at rest. **[6]**

The displacement of P in the time interval $0 \leqslant t \leqslant 3$ is given by $y = -4t^2 + 8t + 12$.

(ii) Use calculus to find expressions in terms of t for the velocity and for the acceleration of P in the interval $0 \leqslant t \leqslant 3$. **[3]**

(iii) At what times does P have a speed of $4\,\text{m}\,\text{s}^{-1}$ in the interval $0 \leqslant t \leqslant 3$? **[2]**

In the time interval $3 \leqslant t \leqslant 4$, P has a constant acceleration of $32\,\text{m}\,\text{s}^{-2}$. There is no sudden change in velocity when $t = 3$.

(iv) Find an expression in terms of t for the displacement of P in the interval $3 \leqslant t \leqslant 4$. **[5]**

5 Fig. 3 is a sketch of the velocity-time graph modelling the velocity of a sprinter at the start of a race.

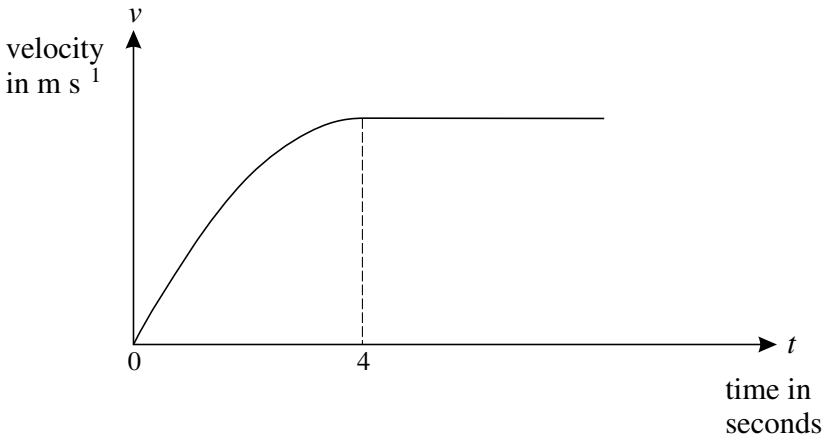

Fig. 3

(i) How can you tell from the sketch that the acceleration is not modelled as being constant for $0 \leqslant t \leqslant 4$? **[1]**

The velocity of the sprinter, v m s^{-1}, for the time interval $0 \leqslant t \leqslant 4$ is modelled by the expression

$$v = 3t - \tfrac{3}{8}t^2.$$

(ii) Find the acceleration that the model predicts for $t = 4$ and comment on what this suggests about the running of the sprinter. **[3]**

(iii) Calculate the distance run by the sprinter from $t = 1$ to $t = 4$. **[4]**

6 Fig. 7 is a sketch of part of the velocity-time graph for the motion of an insect walking in a straight line. Its velocity, v m s ^{1}, at time t seconds for the time interval $-3 \leqslant t \leqslant 5$ is given by

$$v = t^2 - 2t - 8.$$

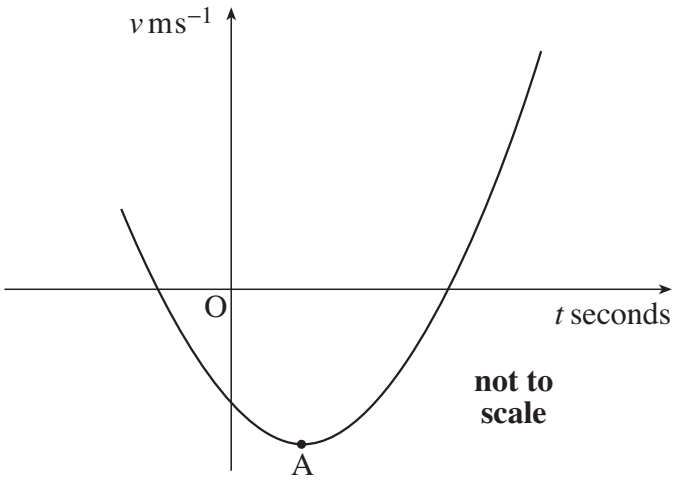

Fig. 7

(i) Write down the velocity of the insect when $t = 0$. [1]

(ii) Show that the insect is instantaneously at rest when $t = -2$ and when $t = 4$. [2]

(iii) Determine the velocity of the insect when its acceleration is zero.

Write down the coordinates of the point A shown in Fig. 7. [5]

(iv) Calculate the distance travelled by the insect from $t = 1$ to $t = 4$. [5]

(v) Write down the distance travelled by the insect in the time interval $-2 \leqslant t \leqslant 4$. [1]

(vi) How far does the insect walk in the time interval $1 \leqslant t \leqslant 5$? [3]