Velocity-Time Graphs

SCAN ME

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SCAN ME

1 A cyclist travels along a straight horizontal path between points A and B.

In a model of the motion of the cyclist, at time $t = 0$ the cyclist starts from rest at point A and accelerates uniformly for 5 seconds until they reach a speed of 10 ms^{-1}

For the next 30 seconds the cyclist travels at a constant speed of 10 ms^{-1} before decelerating uniformly for 2.5 seconds, coming to rest at point B.

Using the model

(a) Sketch a speed-time graph for the motion of the cyclist between points A and B. **(1)**

(b) Find the acceleration of the cyclist during the first 5 seconds. **(1)**

(c) Find the deceleration of the cyclist during the final 2.5 seconds. **(1)**

(d) Find the total distance travelled by the cyclist. **(2)**

(Total for Question 1 is 5 marks)

2

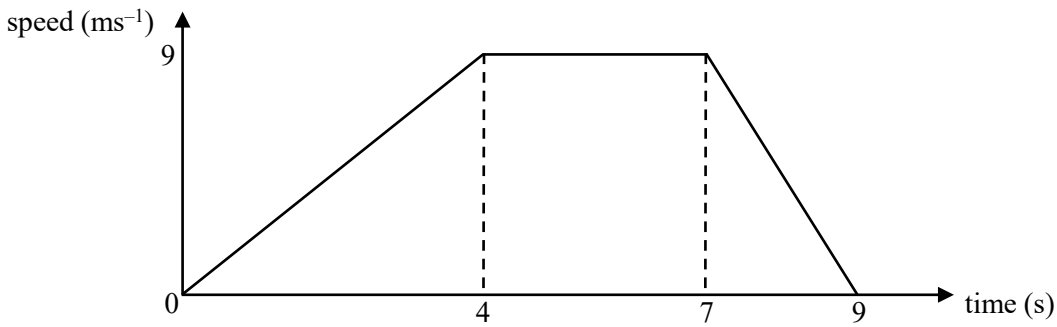


Figure 1

Figure 1 shows the speed-time graph for the journey of a dog chasing after a ball in straight line on horizontal ground.

At time $t = 0$, the dog is at rest at point P.

The dog then accelerates uniformly for 4 seconds until it reaches a speed of 9 ms^{-1}

For the next 3 seconds the dog travels at a constant speed of 9 ms^{-1}

The dog then decelerates uniformly until it comes to rest at point Q at time $t = 9$

(a) Find the acceleration of the dog during the first 4 seconds. **(1)**

(b) Find the deceleration of the dog during the final 2 seconds. **(1)**

(c) Find the distance PQ. **(2)**

(d) Find the average speed of the dog for the entire journey. **(1)**

(e) Suggest one limitation of the model which could affect your answers to parts (a) to (d) **(1)**

(Total for Question 2 is 6 marks)

3 A car travels along a straight horizontal road between points C and D.

In a model of the motion of the car, at time $t = 0$ the car starts from rest at point C and moves with constant acceleration 2.5 ms^{-2} until it reaches a speed of 18 ms^{-1}

The car then moves at a constant speed of 18 ms^{-1} before it moves with a constant deceleration for 4 seconds as it comes to rest at point D.

The total time for the journey between C and D is 40 seconds.

(a) For this model of the motion of the car between C and D,

(i) state the time for which the car is accelerating **(1)**

(ii) state the value of the constant deceleration **(1)**

(iii) sketch a speed-time graph **(1)**

(b) Find the distance between points C and D. **(2)**

(Total for Question 3 is 5 marks)

4

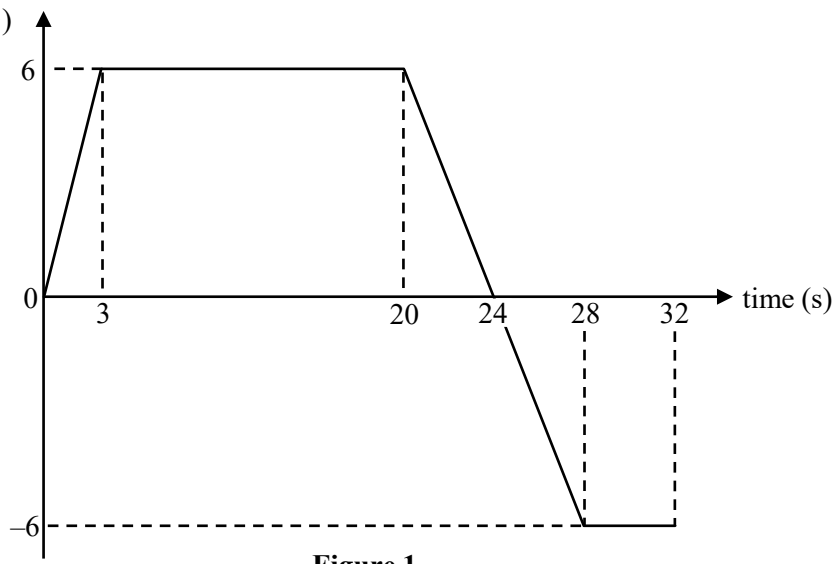


Figure 1

Figure 1 shows the velocity time graph for a model of the motion of a person riding an electric scooter along a straight horizontal road.

(a) Find the acceleration during the first 3 seconds **(1)**

(b) Find the acceleration between 20 and 28 seconds. **(1)**

(c) Find the total distance travelled during the 32 second journey. **(3)**

(d) Find the displacement of the person, from their starting point, at time $t = 30$ **(2)**

(Total for Question 4 is 7 marks)

5

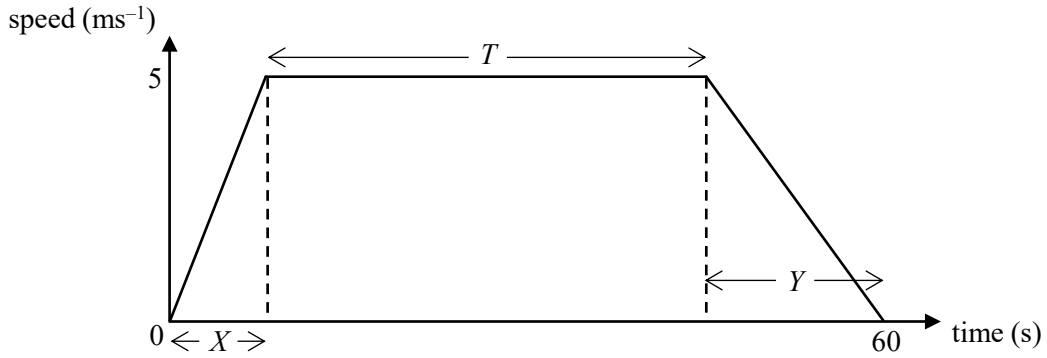


Figure 1

Figure 1 shows a sketch of the speed-time graph for a model of the motion of a runner travelling along a straight horizontal road from point A to point B in a time of 60 seconds.

The distance from point A to point B is 267 metres.

In the model of the motion, the runner

- starts from rest at A at time $t = 0$
- then moves with constant acceleration for X seconds until they reach a speed of 5 ms^{-1}
- then travels at a constant speed of 5 ms^{-1} for T seconds.
- then moves with constant deceleration for Y seconds, until coming to rest at B.

(a) Find the value of T **(3)**

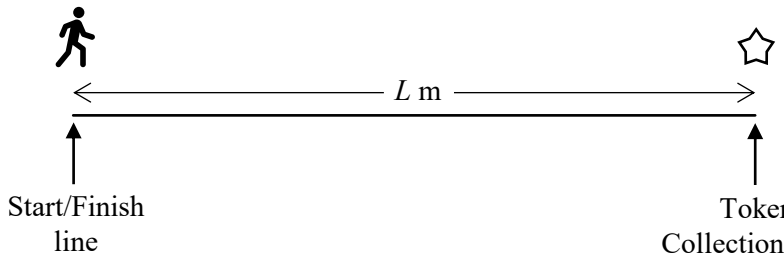
(b) Given that $Y = 2X$, find

(i) the value of X **(2)**

(ii) the acceleration during the first X seconds. **(1)**

(Total for Question 5 is 6 marks)

6 In a gameshow a contestant must run across a straight horizontal bridge of length L metres. Once they reach the other side, they must collect a token, then run back to the start/finish line.



In the model of the motion, the contestant starts from rest at the start/finish line at time $t = 0$ then accelerates at a constant rate for 3 seconds, until they reach a velocity of 6 ms^{-1}

They then maintain a constant velocity of 6 ms^{-1} for 12 seconds before decelerating at a constant rate for 3 seconds until they come to rest at the token collection point.

It takes them 5 seconds to find the token, and then they accelerates back towards the start/finish line at a constant rate for 4 seconds until they reach a velocity of –6 ms^{-1}

They then maintain at a constant velocity of until they cross the start/finish line at time T seconds.

Figure 1 shows the velocity time graph for a model of the motion of a contestant on a gameshow.

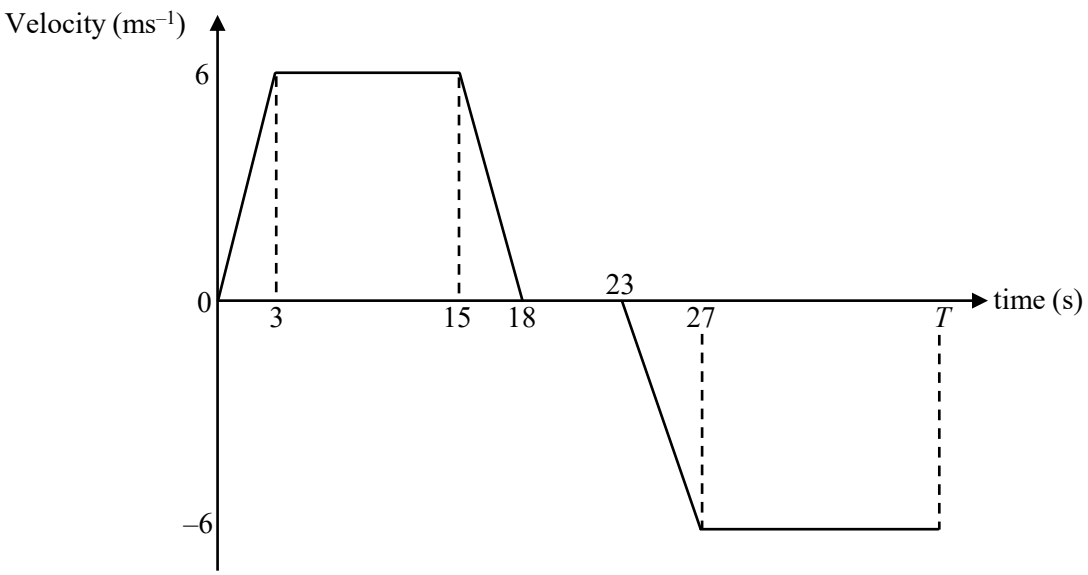


Figure 1

(a) Find the acceleration of the contestant during the first 3 seconds. Give the units of your answer. **(1)**
(b) Find the value of L **(2)**
(c) Find the value of T **(3)**

At time $t = P$ the displacement of the contestant from the start finish line is 60 m
(d) Find two possible values for P **(4)**

(Total for Question 6 is 10 marks)

7

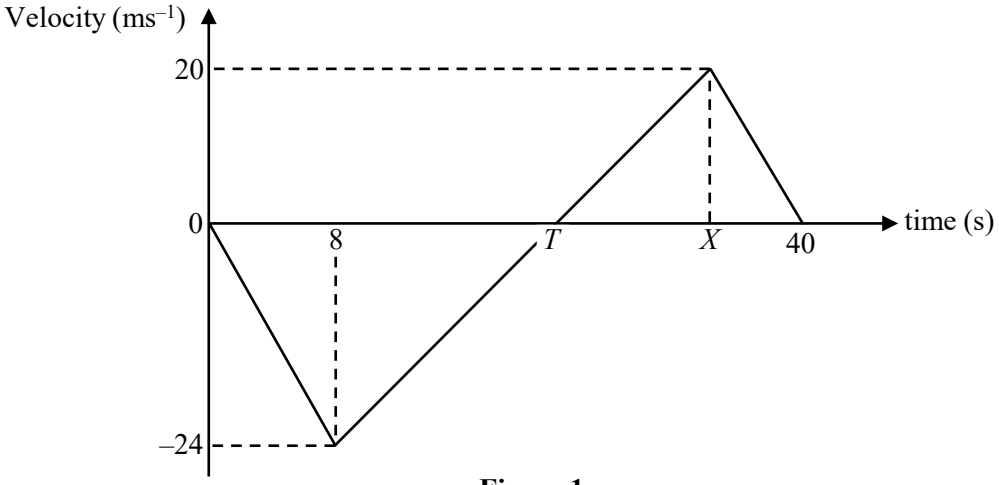


Figure 1

Figure 1 shows a sketch of the velocity-time graph for a model of the motion of a particle travelling in a straight line for 40 seconds.

In a model of the motion, the particle

- moves with uniform acceleration A ms^{-2} between $t = 0$ and $t = 8$
- moves with uniform acceleration B ms^{-2} between $t = 8$ and $t = X$
- moves with uniform acceleration C ms^{-2} between $t = X$ and $t = 40$

(a) Find the value of A **(1)**

(b) State the maximum **speed** of the particle during the 40 second journey. **(1)**

The velocity of the particle is 0 ms^{-1} when $t = 0$, $t = T$ and $t = 40$.
The total distance travelled by the particle during the 40 second journey is 446 metres.

(c) Find the value of T **(3)**

(d) Find the average velocity for the 40 second journey. **(3)**

(e) Find the value of B **(1)**

(f) Find the value of X **(2)**

(g) Find the value of C **(1)**

(Total for Question 7 is 12 marks)

8

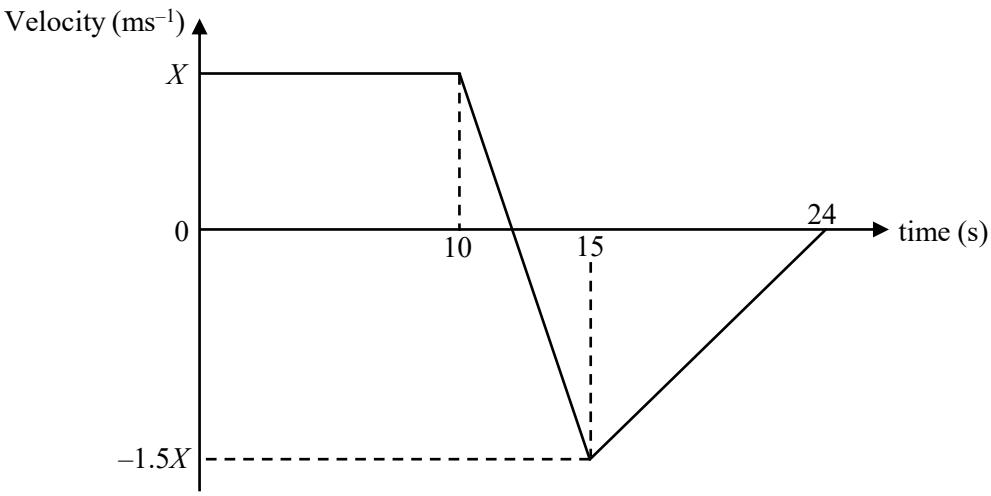


Figure 1

Figure 1 shows a sketch of the velocity-time graph for a model of the motion of a particle travelling in a straight line.

In the model of the motion, the particle

- starts travelling with constant velocity of X ms^{-1} at time $t = 0$ until time $t = 10$
- then moves with uniform acceleration a ms^{-2}, for 5 seconds until it reaches a velocity of $-1.5X$ ms^{-1}
- then moves with uniform acceleration b ms^{-2}, for 9 seconds, until coming to rest at time $t = 24$

At time $t = 24$, the displacement of the particle from its starting position is 7.2 metres.

Find the values of X, a and b. **(6)**

(Total for Question 8 is 6 marks)

9

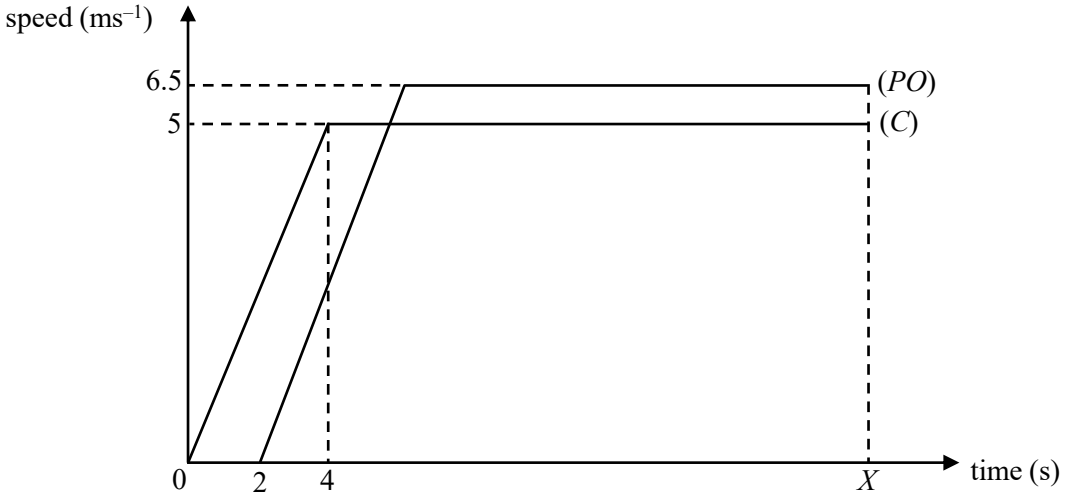


Figure 1

A police officer (PO) catches a criminal (C). The criminal manages to break free and runs away from the police officer in a straight line along a horizontal road. The police officer chases and eventually catches the criminal.

In a model of their motion, the criminal starts from rest at time $t = 0$ before travelling with constant acceleration for 4 seconds until they reach a speed of 5 ms^{-1}. The criminal maintains a constant speed of 5 ms^{-1} until they are caught by the police officer at time X seconds.

The police officer starts at rest at time $t = 0$ but remains at rest until time $t = 2$ when they accelerate with the same acceleration as the criminal until they reach a speed of 6.5 ms^{-1}. The police officer maintains a constant speed of 6.5 ms^{-1} until they catch the criminal at time X seconds.

The speed-time graphs shown in Figure 1 describe the model of the motion for the police officer and the criminal.

(a) Find the value of X. **(5)**

(b) Find the distance travelled by the criminal before they are caught. **(2)**

(c) Describe one limitation of the model that could affect your answers to parts (a) and (b) **(1)**

(Total for Question 9 is 8 marks)

10

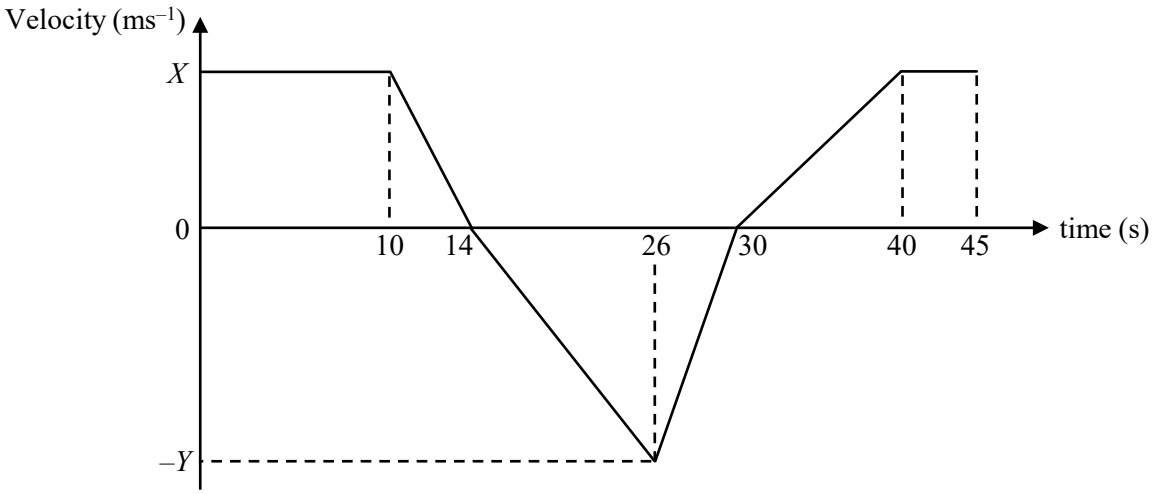


Figure 1

Figure 1 shows a sketch of the velocity-time graph for a model of the motion of a particle travelling in a straight line for 45 seconds.

In a model of the motion, the particle

- moves with constant velocity X ms^{-1}, between the following time intervals.

  $t = 0$ and $t = 10$
  $t = 40$ and $t = 45$

- moves with uniform acceleration between the following time intervals

  $t = 10$ and $t = 14$
  $t = 14$ and $t = 26$
  $t = 26$ and $t = 30$
  $t = 30$ and $t = 45$

The total displacement of the particle when $t = 30$ is 0 m
The total distance travelled by the particle for the 45 second journey is 289 m

Work out the average velocity for the 45 second journey. **(6)**

(Total for Question 10 is 6 marks)