Displacement-Time Graphs

1

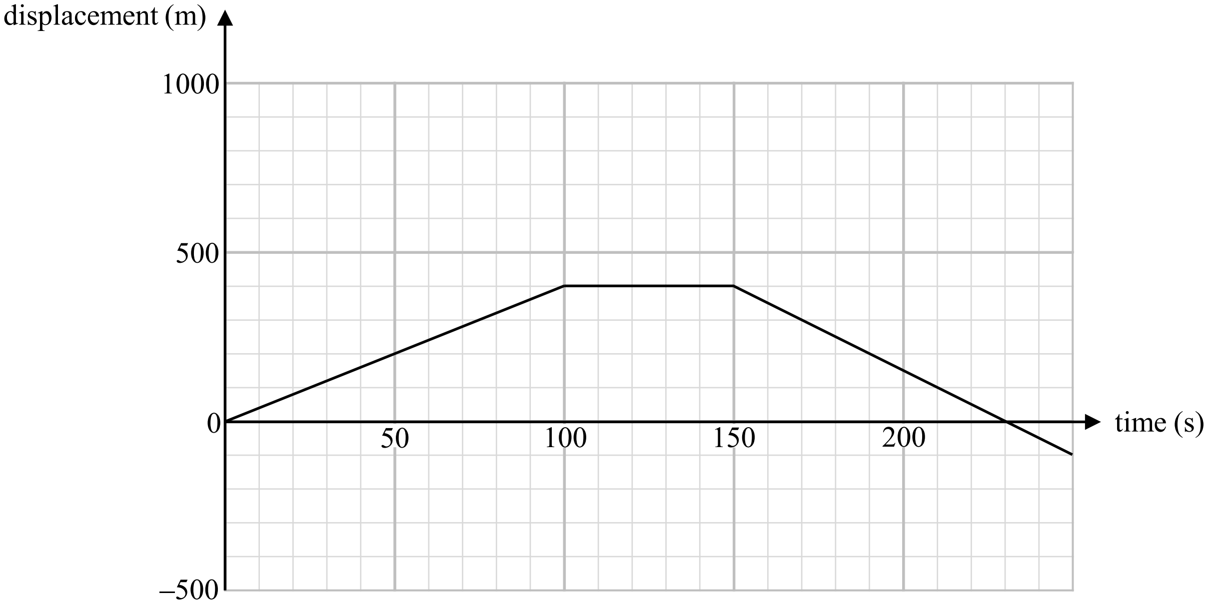

Figure 1

Figure 1 shows the displacement-time graph for a model of an athlete running on a straight horizontal track during a training session.

(a) Describe the motion of the athlete between 100 and 150 seconds. **(1)**

(b) Find the average velocity of the athlete during the first 100 seconds. **(1)**

(c) Find the average velocity of the athlete during the final 100 seconds. **(1)**

(d) Find the average speed of the athlete for the whole training session. **(1)**

(e) Find the average velocity of the athlete for the whole training session. **(1)**

(f) On Figure 2, complete a **distance**-time graph of the athlete's training session. **(2)**

(a) Stationary (not moving)

(b) $\frac{400}{100} = 4 \text{ ms}^{-1}$

(c) $\frac{-500}{100} = -5 \text{ ms}^{-1}$

(d) $\frac{900}{250} = 3.6 \text{ ms}^{-1}$

(e) $\frac{-100}{250} = -0.4 \text{ ms}^{-1}$

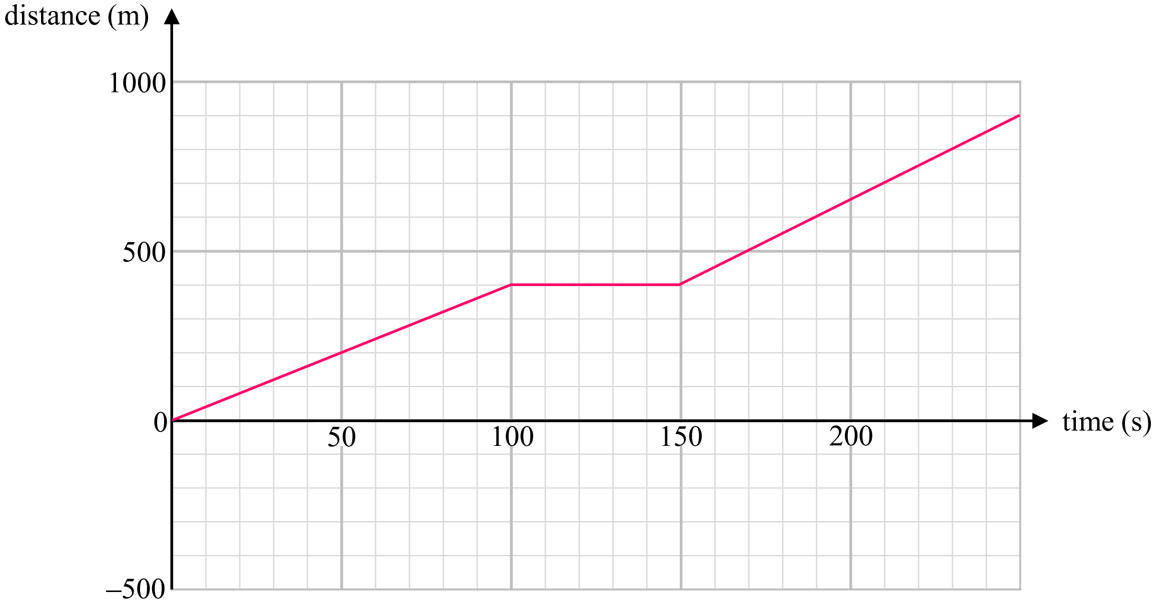

Figure 2

(Total for Question 1 is 7 marks)

2

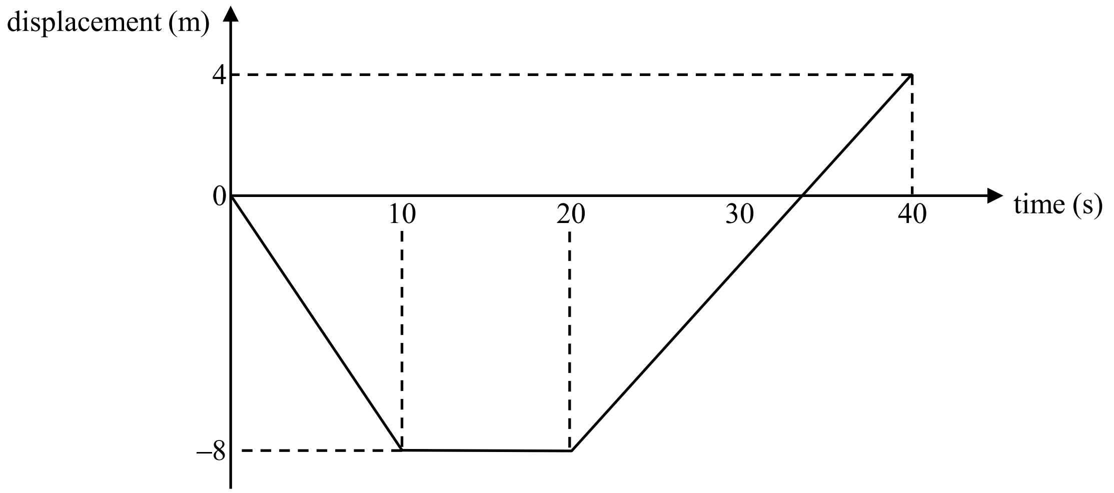

Figure 1

Figure 1 shows the displacement-time graph for a model of a lift at a hotel.

In a model of the motion:

At time $t = 0$, the lift is at the ground floor with displacement 0 m.

In the next 10 seconds, the lift descends vertically, at a constant speed, to the hotel car park.

The lift then waits 10 seconds for people to leave before ascending, at a constant speed, vertically to floor 1.

(a) Find the maximum speed that the lift achieves during this 40 second period. **(1)**

(b) Find the average speed of the lift for the whole 40 second period. **(1)**

(c) Find the average velocity of the lift for the whole 40 second period. **(1)**

(d) Suggest one improvement that could be made to the model of the lift to make it more realistic. **(1)**

(a) $\frac{8}{10} = 0.8 \text{ ms}^{-1}$

(d) The changes in speed would be smooth rather than instantaneous.
(Or have the lift moving at variable rather than constant speed)

(b) $\frac{20}{40} = 0.5 \text{ ms}^{-1}$

(c) $\frac{4}{40} = 0.1 \text{ ms}^{-1}$

(Total for Question 2 is 4 marks)

3

3

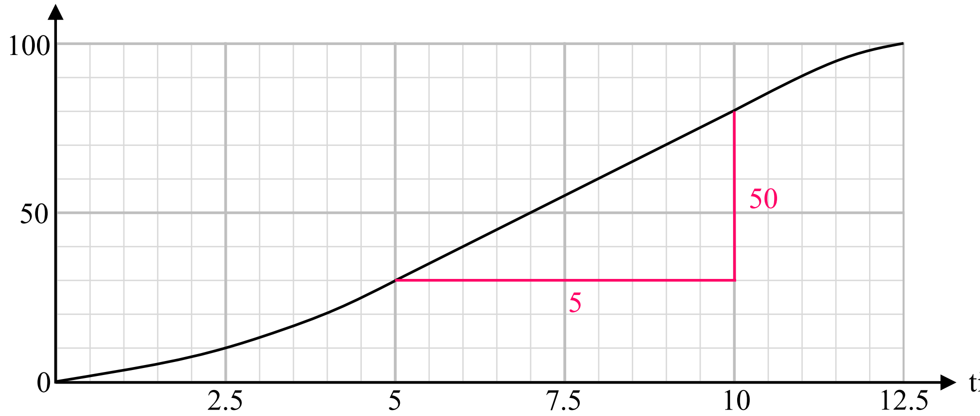

Figure 1

Figure 1 shows the displacement-time graph for a sprinter running a 100 m race on horizontal flat ground.

The displacement time graph is a straight line between $t = 5$ and $t = 11$

(a) Describe the motion of the sprinter in the first 5 seconds of the race. **(1)**

(b) Describe the motion of the sprinter in the final 1.5 seconds of the race. **(1)**

(c) Describe the motion of the sprinter between $t = 5$ and $t = 11$ **(1)**

(d) Compare the average speed of the sprinter for the entire 100 m race to their maximum speed. **(2)**

(a) Accelerating (increasing speed)

(b) Decelerating (decreasing speed)

(c) Moving at a constant speed

(d) Max Speed = $\frac{50}{5} = 10 \text{ ms}^{-1}$ Average speed = $\frac{100}{12.5} = 8 \text{ ms}^{-1}$

The maximum speed is 2 ms^{-1} greater than the average speed.

(Total for Question 3 is 5 marks)

4

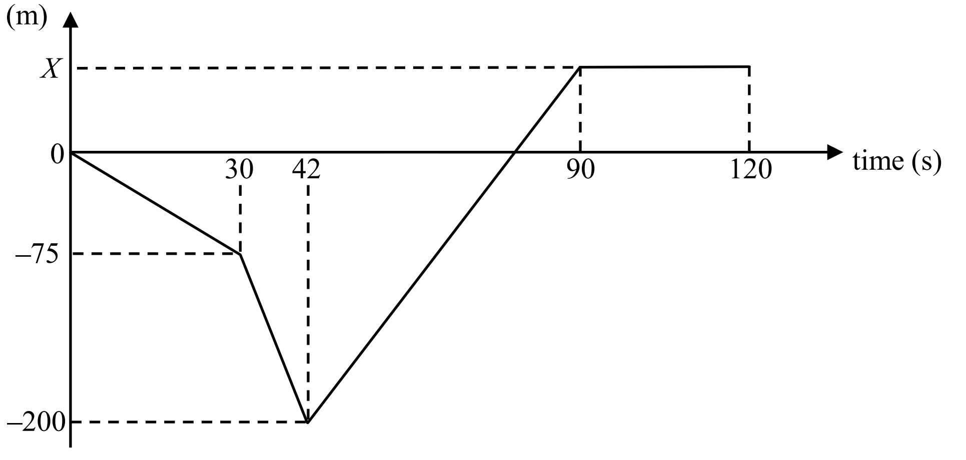

Figure 1

Figure 1 shows the displacement-time graph for a model of a particle moving along a straight horizontal path for a period of 120 seconds.

(a) Find the speed of the particle between 0 and 30 seconds. **(1)**

(b) Find the velocity of the particle between 30 and 42 seconds. **(1)**

The average speed of the particle for the whole 120 second period was 3.8 ms^{-1}

(c) Find the value of X. **(1)**

(d) Find the greatest velocity that the particle achieves during the 120 second period. **(1)**

(e) Find the average velocity for the 120 second period. **(1)**

(a) $\frac{75}{30} = 2.5\ ms^{-1}$

(d) $\frac{256}{48} = 5.33\ ms^{-1}$

(b) $\frac{-125}{12} = -10.4\ ms^{-1}$

(e) $\frac{56}{120} = 0.467\ ms^{-1}$

(c) $\frac{400 + X}{120} = 3.8$

$400 + X = 456$

$X = 56$

(Total for Question 4 is 5 marks)

5

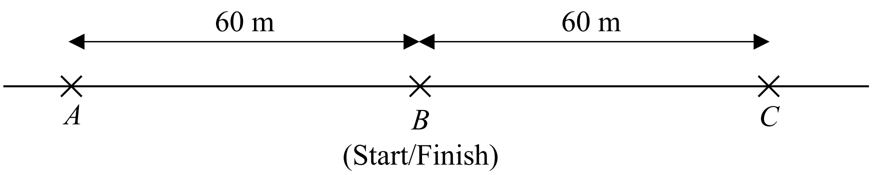

Figure 1

Figure 1 shows the layout of a course for a sports day race on horizontal ground.

Michael, Justin and Noah take part in the race.

In a model of their motion:

At $t = 0$, Michael, Justin and Noah run from the start line at point B, directly to point C.
They then turn around and run past the start line at point B, directly to point A.
They then turn around once more and run directly to point B, which is the finish line.

Figure 2 shows the displacement-time graph for the model of the race for Justin and Noah.

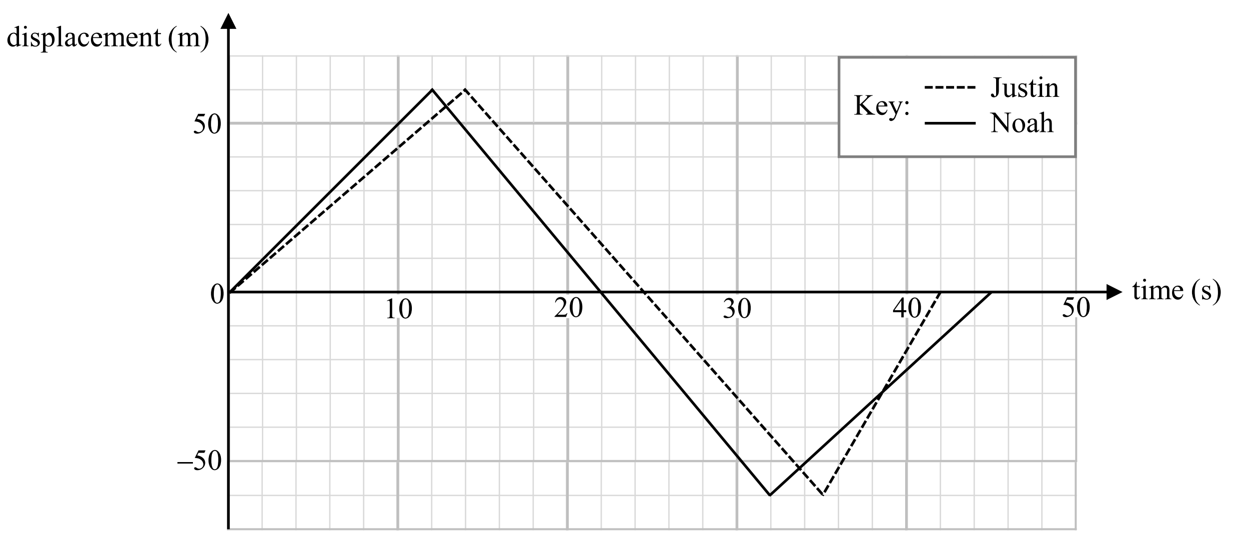

Figure 2

(a) State the number of times that Justin overtakes Noah during the race. **(1)**

(b) Find Justin's average speed for the whole race. **(1)**

(c) Find Justin's average velocity for the whole race. **(1)**

(a) 1 (around 38.5 seconds)

[careful, the other two crossing points are when they are running in different directions]

(b) $\frac{240}{42} = 5.71 \text{ ms}^{-1}$

(c) $\frac{0}{42} = 0 \text{ ms}^{-1}$

Michael runs the race at a constant speed of 5 ms^{-1}

(d) On Figure 3, complete a displacement-time graph for the model of the race for Michael. **(3)**

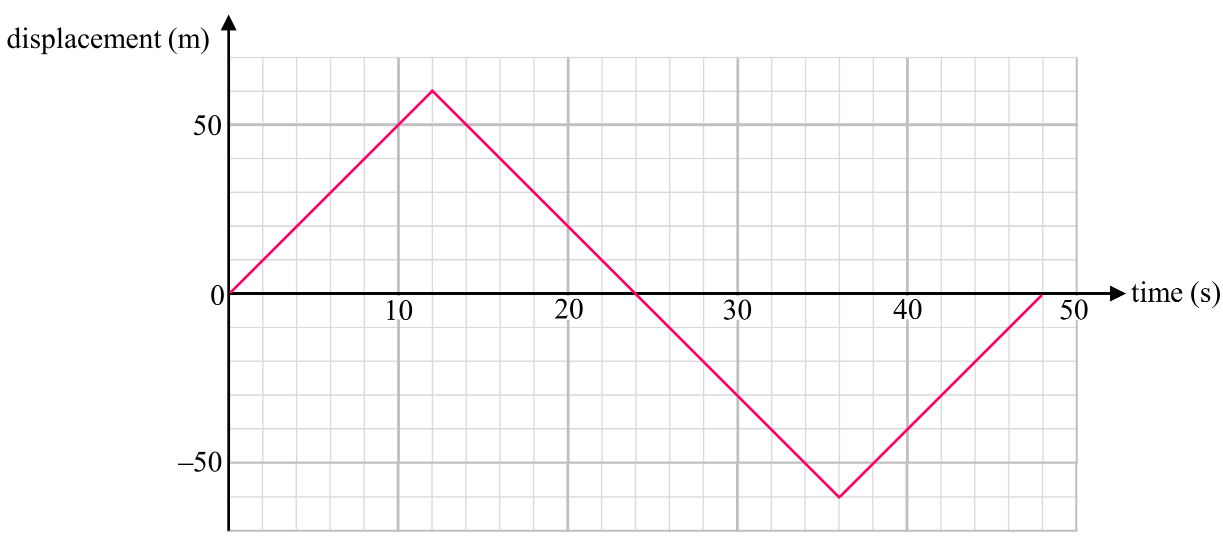

Figure 3

(d) $\frac{240}{5} = 48$ seconds $\frac{48}{4} = 12$ seconds (per 60 m)

(Total for Question 5 is 6 marks)

6

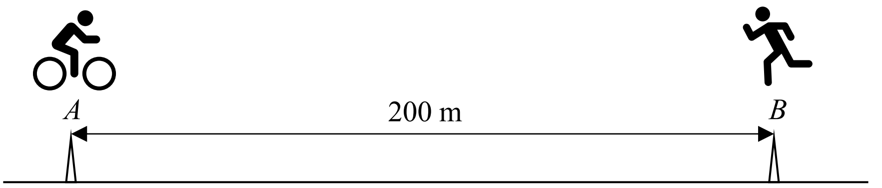

Figure 1

A cyclist and a runner are raising money for charity.

Figure 1 shows two cones, A and B, that are 200 m apart on horizontal ground.

In a model of their motion:

At $t = 0$, the cyclist starts at cone A and the runner starts at cone B.

The cyclist travels directly from cone A to cone B, and then back to cone A at a constant speed of X ms^{-1}
The runner travels directly from cone B to cone A, and then back to cone B at a constant speed of 5 ms^{-1}

Each time the cyclist or runner returns to their starting cone, they have completed a lap.
They decide to complete as many laps as possible, maintaining their constant speeds, for 4 hours.

Figure 2 shows the displacement-time graph for the model of the displacement from cone A, for the cyclist's first three laps.

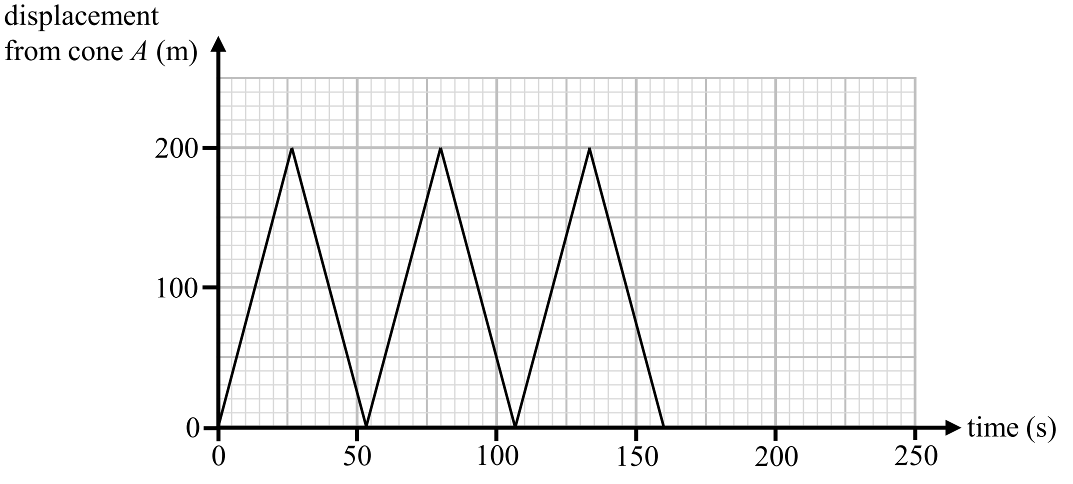

Figure 2

(a) Work out the value of X. **(1)**

$X = \frac{1200}{160} = 7.5\ \text{ms}^{-1}$

(b) On Figure 3, complete a displacement-time graph for the model of the displacement **from cone *A*** for the runner's first three laps. **(2)**

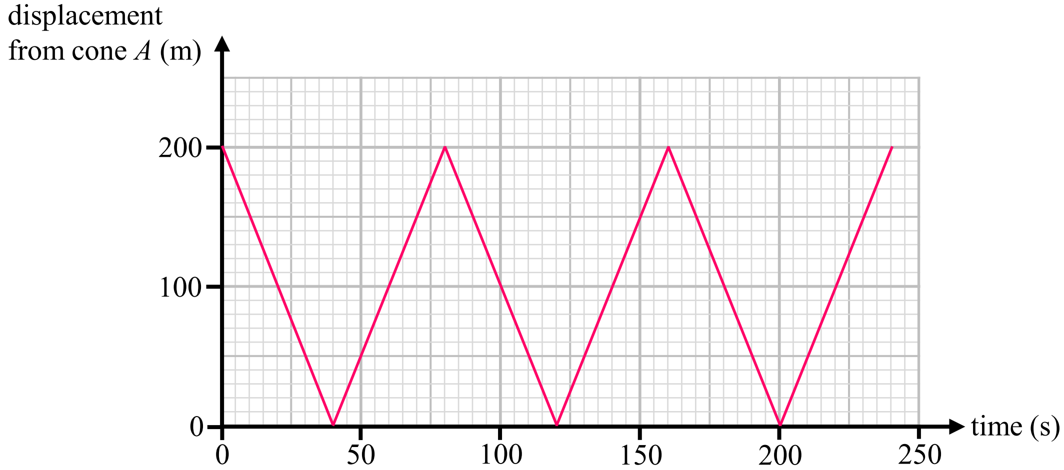

Figure 3

(c) Using the model, work out how many laps the runner will complete in 4 hours. **(2)**

(d) State **one** reason why the actual number of laps might be different from your answer to part (c). **(1)**

(e) Suggest one improvement that could be made to the model of the cyclist and the runner to make it more realistic. **(1)**

(c) One lap every 80 seconds.

$\frac{4 \times 60 \times 60}{80} = 180$ laps

(d) The runner will not be able to maintain the same average speed for 4 hours (they will fatigue).

[Even the most elite ultra runners cannot maintain this speed for that long]

(e) The changes in speed would be smooth rather than instantaneous.

(Total for Question 6 is 7 marks)