

1.

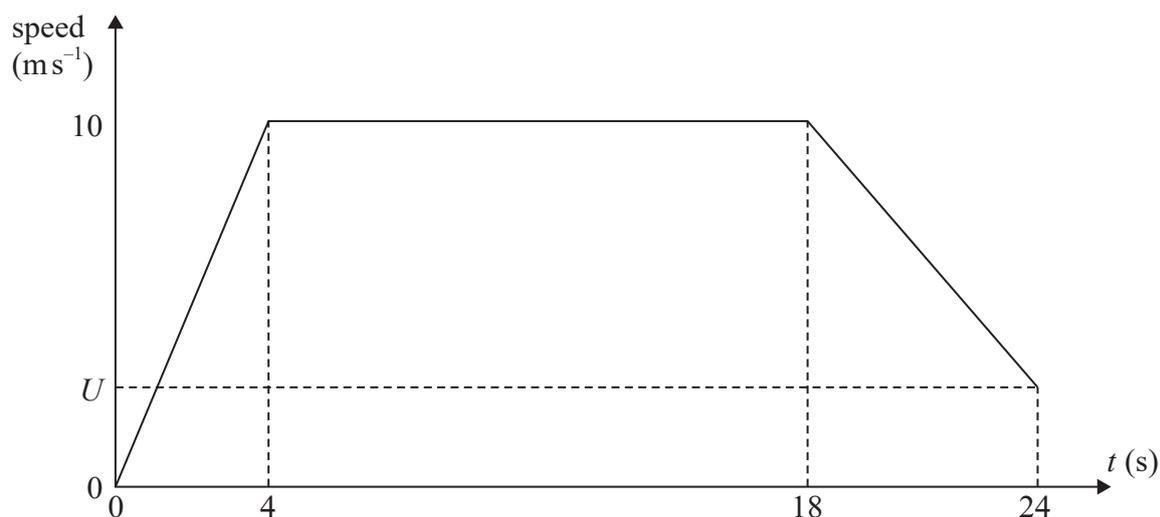


Figure 2

Figure 2 shows a speed-time graph for a model of the motion of an athlete running a **200 m** race in 24 s.

The athlete

- starts from rest at time $t = 0$ and accelerates at a constant rate, reaching a speed of 10 ms^{-1} at $t = 4$
- then moves at a constant speed of 10 ms^{-1} from $t = 4$ to $t = 18$
- then decelerates at a constant rate from $t = 18$ to $t = 24$, crossing the finishing line with speed $U \text{ ms}^{-1}$

Using the model,

(a) find the acceleration of the athlete during the first 4 s of the race, stating the units of your answer,

(2)

(b) find the distance covered by the athlete during the first 18 s of the race,

(3)

(c) find the value of U .

(3)

a) in the first 4 s,

$$v = 10, u = 0, a = ?, t = 4$$

$$v = u + at \quad \leftarrow \text{because accelerating at a constant rate}$$

$$a = \frac{v}{t} = \frac{10 \text{ ms}^{-1}}{4 \text{ s}} = 2.5 \text{ ms}^{-2}$$

b) distance covered = area under the graph

from $t=0$ to $t=4$;

$$A = \frac{1}{2} \times 4 \times 10 = 20 \text{ m } \textcircled{1}$$

from $t=4$ to $t=18$;

$$A = 10 \times (18-4) = 140 \text{ m}$$

$$\therefore \text{Total area} = \text{total distance covered} = 20 + 140 \textcircled{1}$$

$$= 160 \text{ m } \textcircled{1}$$

c) from $t=18$ to $t=24$,

athlete decelerates at a constant rate . (can use suvat)

$$s = 40$$

$$u = 10$$

$$v = U$$

$$a =$$

$$t = 6$$

total race distance

$s = 200 \text{ m} - 160 \text{ m}$ ← distance covered from $t=0$ to $t=18$

$$= 40 \text{ m } \textcircled{1}$$

$$s = \frac{1}{2} (u+v) t$$

$$40 = \frac{1}{2} (10+U) 6 \textcircled{1}$$

$$\frac{40 \times 2}{6} = 10 + U$$

$$13 \frac{1}{3} - 10 = U$$

$$U = 3 \frac{1}{3} \textcircled{1}$$