

4.

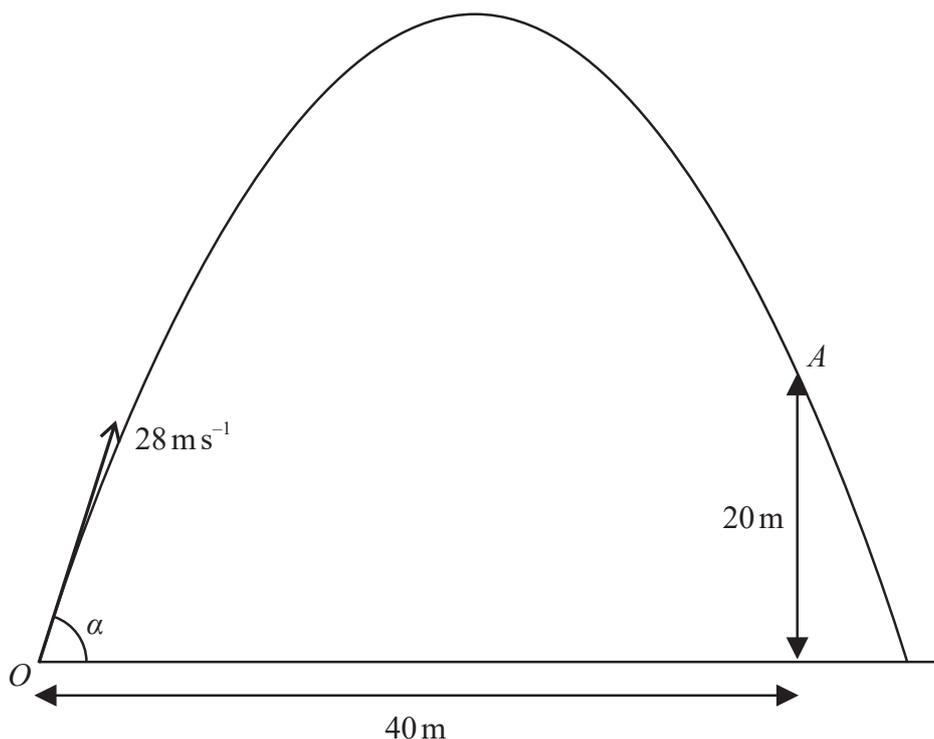


Figure 2

A small ball is projected with speed 28 m s^{-1} from a point O on horizontal ground.

After moving for T seconds, the ball passes through the point A .

The point A is 40 m horizontally and 20 m vertically from the point O , as shown in Figure 2.

The motion of the ball from O to A is modelled as that of a particle moving freely under gravity.

Given that the ball is projected at an angle α to the ground, use the model to

(a) show that $T = \frac{10}{7 \cos \alpha}$ (2)

(b) show that $\tan^2 \alpha - 4 \tan \alpha + 3 = 0$ (5)

(c) find the greatest possible height, in metres, of the ball above the ground as the ball moves from O to A . (3)

The model does not include air resistance.

(d) State one other limitation of the model. (1)

5.

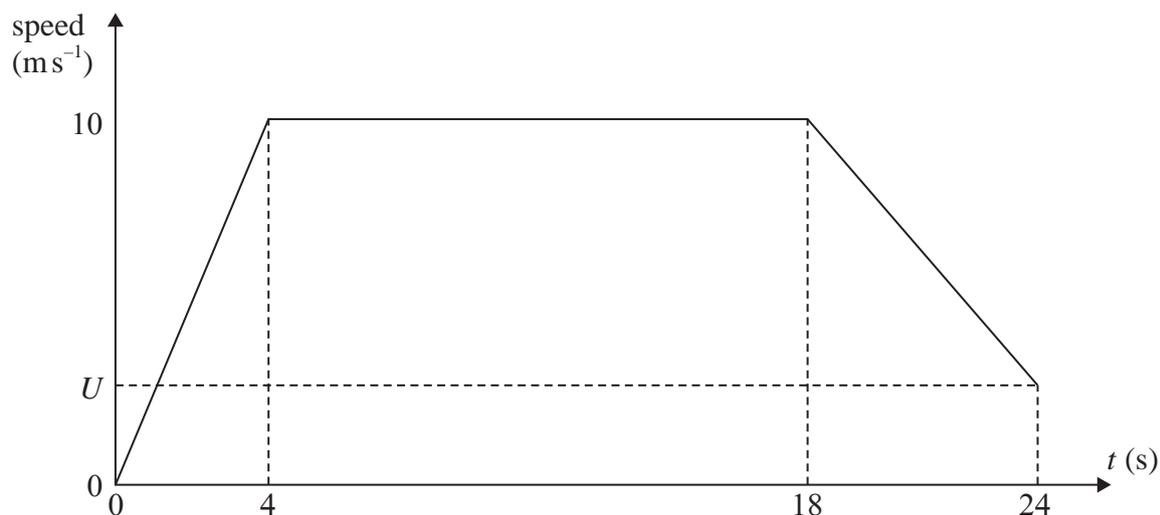


Figure 2

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 m s^{-1} at $t = 4$
- then moves at a constant speed of 10 m s^{-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 $U \text{ m s}^{-1}$

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)
