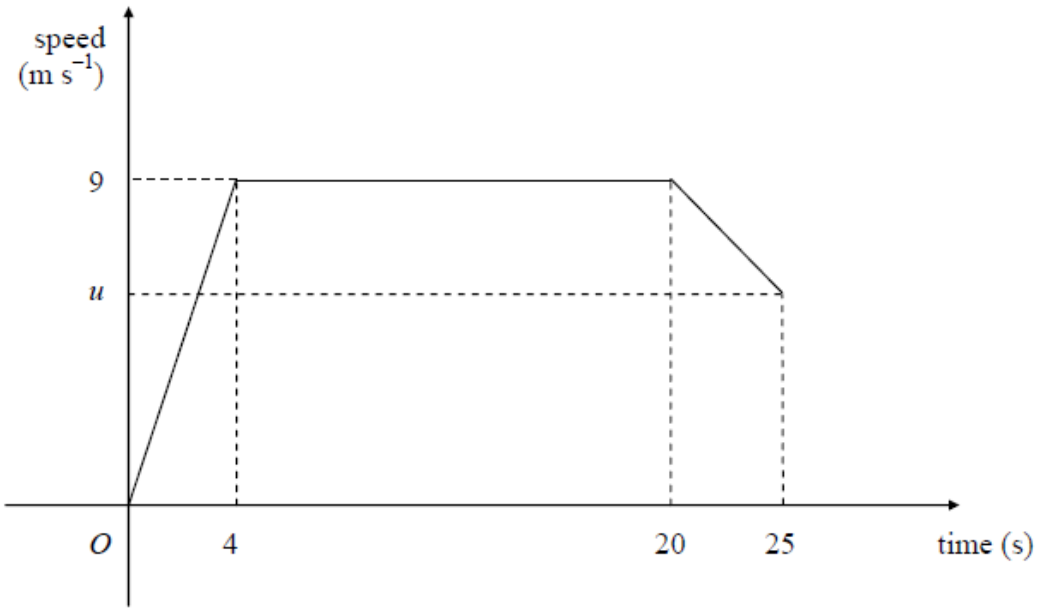
Motion Graphs 1

1.

Figure 2



A sprinter runs a race of 200 m. Her total time for running the race is 25 s. Figure 2 is a sketch of the speed-time graph for the motion of the sprinter. She starts from rest and accelerates uniformly to a speed of 9 m s^{-1} in 4 s. The speed of 9 m s^{-1} is maintained for 16 s and she then decelerates uniformly to a speed of u m s^{-1} at the end of the race. Calculate

(*a*) the distance covered by the sprinter in the first 20 s of the race,

(2)

(*b*) the value of u,

(4)

(*c*) the deceleration of the sprinter in the last 5 s of the race.

(3)

2.

A car is moving along a straight horizontal road. At time $t = 0$, the car passes a point A with speed 25 m s^{-1}. The car moves with constant speed 25 m s^{-1} until $t = 10$ s. The car then decelerates uniformly for 8 s. At time $t = 18$ s, the speed of the car is V m s^{-1} and this speed is maintained until the car reaches the point B at time $t = 30$ s.

(a) Sketch, in the space below, a speed–time graph to show the motion of the car from A to B.

(3)

Given that $AB = 526$ m, find

(b) the value of V,

(5)

(c) the deceleration of the car between $t = 10$ s and $t = 18$ s.

(3)

3.

A train starts from rest at a station A and moves along a straight horizontal track. For the first 10 s, the train moves with constant acceleration 1.2 m s^{-2}. For the next 24 s it moves at a constant acceleration 0.75 m s^{-2}. It then moves with constant speed for T seconds. Finally it slows down with constant deceleration 3 m s^{-2} until it comes to a rest at station B.

(a) Show that, 34 s after leaving A, the speed of the train is 30 m s^{-1}.

(3)

(b) Sketch a speed-time graph to illustrate the motion of the train as it moves from A to B.

(3)

(c) Find the distance moved by the train during the first 34 s of its journey from A.

(4)

The distance from A to B is 3 km.

(d) Find the value of T.

(4)

4.

A motor scooter and a van set off along a straight road. They both start from rest at the same time and level with each other. The scooter accelerates with constant acceleration until it reaches its top speed of 20 m s^{-1}. It then maintains a constant speed of 20 m s^{-1}. The van accelerates with constant acceleration for 10 s until it reaches its top speed V m s^{-1}, $V > 20$. It then maintains a constant speed of V m s^{-1}. The van draws level with the scooter when the scooter has been travelling for 40 s at its top speed. The total distance travelled by each vehicle is then 850 m.

(a) Sketch on the same diagram the speed-time graphs of both vehicles to illustrate their motion from the time when they start to the time when the van overtakes the scooter.

(3)

(b) Find the time for which the scooter is accelerating.

(3)

(c) Find the top speed of the van.

(3)

5.

Two trains A and B run on parallel straight tracks. Initially both are at rest in a station and level with each other. At time $t = 0$, A starts to move. It moves with constant acceleration for 12 s up to a speed of 30 m s^{-1}, and then moves at a constant speed of 30 m s^{-1}. Train B starts to move in the same direction as A when $t = 40$, where t is measured in seconds. It accelerates with the same initial acceleration as A, up to a speed of 60 m s^{-1}. It then moves at a constant speed of 60 m s^{-1}. Train B overtakes A after both trains have reached their maximum speed. Train B overtakes A when $t = T$.

(a) Sketch, on the same diagram, the speed-time graphs of both trains for $0 \leq t \leq T$.

(3)

(b) Find the value of T.

(9)

6.

A cyclist travels along a straight road from the point O to the point A where he immediately turns round and returns directly to O. On the outward journey the cyclist starts from rest and accelerates uniformly for 20 s, reaching a speed of 9 m s^{-1}. He then cycles at a constant speed of 9 m s^{-1} for 82 s before decelerating uniformly for 8 s, coming to rest instantaneously at A. On the return journey the cyclist accelerates at 0.5 m s^{-2} until his speed reaches 8 m s^{-1}. He then cycles at a constant speed of 8 m s^{-1} until he reaches O.

(i) Sketch the (t, v) graph for the cyclist's whole journey (outward and return). [3]

(ii) Find the distance OA. [2]

(iii) Find the total time taken for the whole journey. [4]

7.

A man travels 360 m along a straight road. He walks for the first 120 m at 1.5 m s^{-1}, runs the next 180 m at 4.5 m s^{-1}, and then walks the final 60 m at 1.5 m s^{-1}. The man's displacement from his starting point after t seconds is x metres.

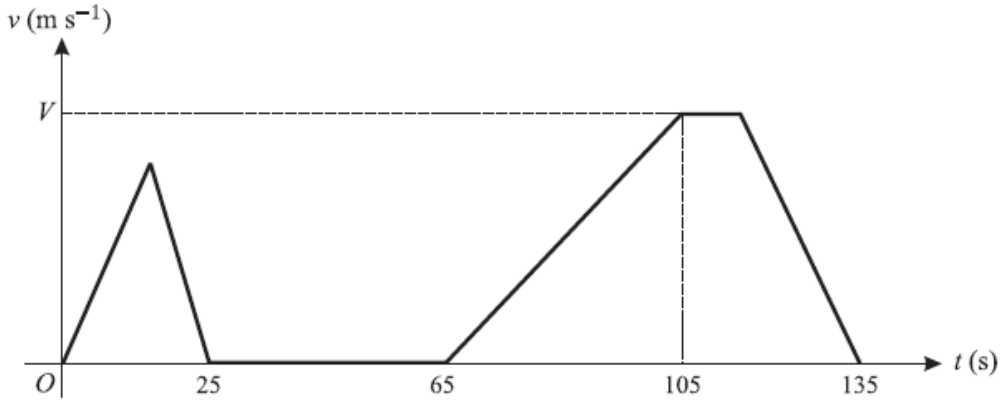
(i) Sketch the (t, x) graph for the journey, showing the values of t for which $x = 120$, 300 and 360. [5]

A woman jogs the same 360 m route at constant speed, starting at the same instant as the man and finishing at the same instant as the man.

(ii) Draw a dotted line on your (t, x) graph to represent the woman's journey. [1]

(iii) Calculate the value of t at which the man overtakes the woman. [5]

8.



The diagram shows the (t, v) graph for the motion of a hoist used to deliver materials to different levels at a building site. The hoist moves vertically. The graph consists of straight line segments. In the first stage the hoist travels upwards from ground level for 25 s, coming to rest 8 m above ground level.

(i) Find the greatest speed reached by the hoist during this stage. [2]

The second stage consists of a 40 s wait at the level reached during the first stage. In the third stage the hoist continues upwards until it comes to rest 40 m above ground level, arriving 135 s after leaving ground level. The hoist accelerates at $0.02\ \text{m s}^{-2}$ for the first 40 s of the third stage, reaching a speed of $V\ \text{m s}^{-1}$. Find

(ii) the value of V, [3]

(iii) the length of time during the third stage for which the hoist is moving at constant speed, [4]

(iv) the deceleration of the hoist in the final part of the third stage. [3]