Constant Acceleration Graphs

Question 1:

A car moves along a straight horizontal road from a point A to a point B, where $AB = 885$ m. The car accelerates from rest at A to a speed of 15 ms^{-1} at a constant rate of a ms^{-2}. The time for which the car accelerates is $\frac{1}{3}T$ seconds. The car maintains the speed of 15 ms^{-1} for T seconds. The car then decelerates at a constant rate of 2.5 ms^{-2}, stopping at B.

(a) Sketch a speed-time graph for the motion of the car.

[2]

(b) Find the time for which the car decelerates.

[2]

(c) Find the value of T.

[4]

(d) Find the value of a.

[2]

(e) Sketch an acceleration-time graph for the motion of the car.

[3]

Question 2:

A car is moving on a straight horizontal road. At time $t = 0$, the car is moving with speed 20 ms^{-1} and is at the point A. The car maintains the speed of 20 ms^{-1} for 25 s. The car then moves with constant deceleration 0.4 ms^{-2}, reducing its speed from 20 ms^{-1} to 8 ms^{-1}. The car then moves with constant speed 8 ms^{-1} for 60 s. The car then moves with constant acceleration until it is moving with speed 20 ms^{-1} at the point B.

(a) Sketch a speed-time graph to represent the motion of the car from A to B.

[3]

(b) Find the time for which the car is decelerating.

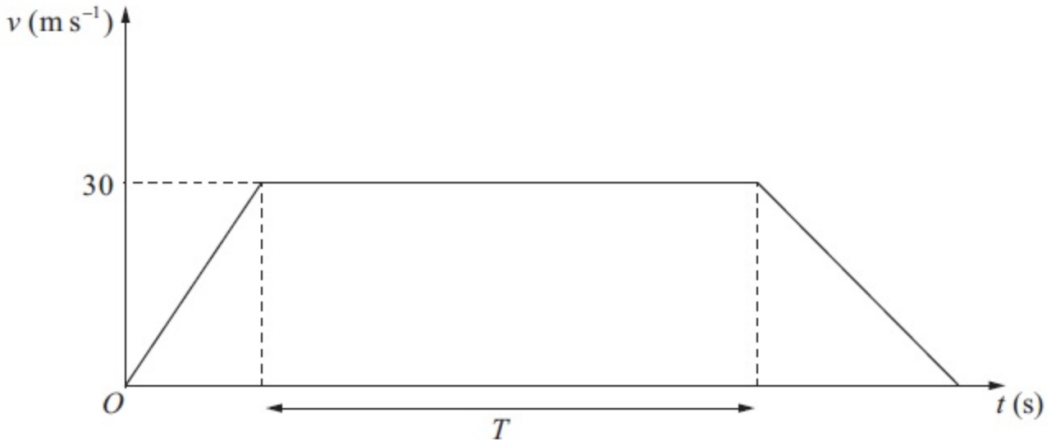
[2]

The distance from A to B is 1960 m.

(c) Find the time taken for the car to move from A to B.

[8]

Question 3:



The velocity-time graph above represents the journey of a train P travelling along a straight horizontal track between two stations which are 1.5 km apart. The train P leaves the first station, accelerating uniformly from rest for 300 m until it reaches a speed of 30 ms^{-1}. The train then maintains this speed for T seconds before decelerating uniformly at 1.25 ms^{-2}, coming to rest at the next station.

(a) Find the acceleration of P during the first 300 m of its journey.

[2]

(b) Find the value of T.

[5]

A second train Q completes the same journey in the same total time. The train leaves the first station, accelerating uniformly from rest until it reaches a speed of V ms^{-1} and then immediately decelerates uniformly until it comes to rest at the next station.

(c) On the diagram above, sketch a velocity-time graph which represents the journey of train Q.

[2]

(d) Find the value of V.

[6]

Question 4:

Two cars P and Q are moving in the same direction along the same straight horizontal road. Car P is moving with constant speed 25 ms^{-1}. At time $t = 0$, P overtakes Q which is moving with constant speed 20 ms^{-1}. From $t = T$ seconds, P decelerates uniformly, coming to rest at a point X which is 800 m from the point where P overtook Q. From $t = 25$ s, Q decelerates uniformly, coming to rest at the same point X at the same instant as P.

(a) Sketch, on the same axes, the speed-time graphs of the two cars for the period from $t = 0$ to the time when they both come to rest at the point X.

[4]

(b) Find the value of T.

[8]

Question 5:

A girl runs a 400 m race in a time of 84 s. In a model of this race, it is assumed that, starting from rest, she moves with constant acceleration for 4 s, reaching a speed of 5 ms^{-1}. She maintains this speed for 60 s and then moves with constant deceleration for 20 s, crossing the finishing line with a speed of V ms^{-1}.

(a) Sketch a speed-time graph for the motion of the girl during the whole race.

[2]

(b) Find the distance run by the girl in the first 64 s of the race.

[3]

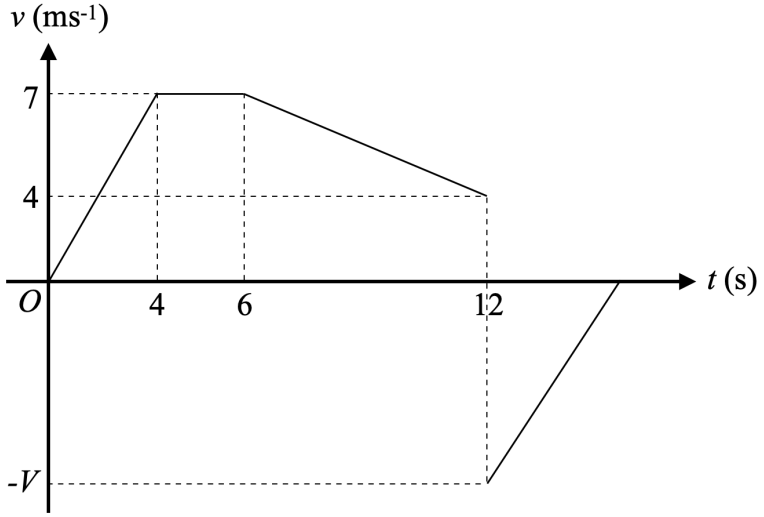
(c) Find the value of V.

[5]

(d) Find the deceleration of the girl in the final 20 s of her race.

[2]

Question 6:



At $t = 0$, particle P is released from rest at a point A on an inclined plane with variable magnitude of friction. The diagram shows the velocity-time graph for the motion of P. The particle passes through B at $t = 4$, and moves from B to C with constant velocity, passing through C at $t = 6$. The particle P has mass 0.2 kg and the frictional force acting on P between B and C has magnitude 0.4 N.

(a) By considering the motion of P from B to C or otherwise, find

(i) the inclination of the plane to the horizontal,

(ii) the magnitude of the normal component of the contact force exerted on P by the plane.

[4]

P moves from C to D with constant deceleration. P reaches D when $t = 12$ with $v = 4$.

(b) Find the magnitude of the frictional force acting on P between C and D.

[3]

Immediately after reaching D at $t = 12$, the particle P is projected with speed V ms^{-1} from D back up the line of greatest slope, and comes to rest at C.

(c) Find V.

[5]

Question 7:

Two trains M and N are moving in the same direction along parallel straight horizontal tracks. At time $t = 0$, M overtakes N whilst they are travelling with speeds 40 ms^{-1} and 30 ms^{-1} respectively. Train M overtakes train N as they pass a point X at the side of the tracks.

After overtaking N, train M maintains its speed of 40 ms^{-1} for T seconds and then decelerates uniformly, coming to rest next to a point Y at the side of the tracks.

After being overtaken, train N maintains its speed of 30 ms^{-1} for 25 s and then decelerates uniformly, also coming to rest next to the point Y.

The times taken by the trains to travel between X and Y are the same.

(a) Sketch, on the same diagram, the speed-time graphs for the motions of the two trains between X and Y.

[4]

(b) Given that $XY = 975$ m, find the value of T.

[8]

Numerical Answers:

(1) (a) Sketch
(b) $t = 6$ s
(c) $T = 48$
(d) $a = \frac{15}{16}$
(e) Sketch

(2) (a) Sketch
(b) $t = 30$ s
(c) $T = 155$ s

(3) (a) $a = 1.5$ ms^{-2}
(b) $T = 28$
(c) Sketch
(d) $V = \frac{125}{3}$

(4) (a) Sketch
(b) $T = 9$

(5) (a) Sketch
(b) $d = 310$ m
(c) $V = 4$
(d) $a = \frac{1}{20}$ ms^{-2}

(6) (a) (i) $\theta = \sin^{-1}(\frac{2}{g})$
(ii) $R = \frac{1}{5}\sqrt{g^2 - 4}$ N
(b) $F_f = 0.5$ N
(c) $V = 3\sqrt{33}$

(7) (a) Sketch
(b) $T = \frac{35}{4}$