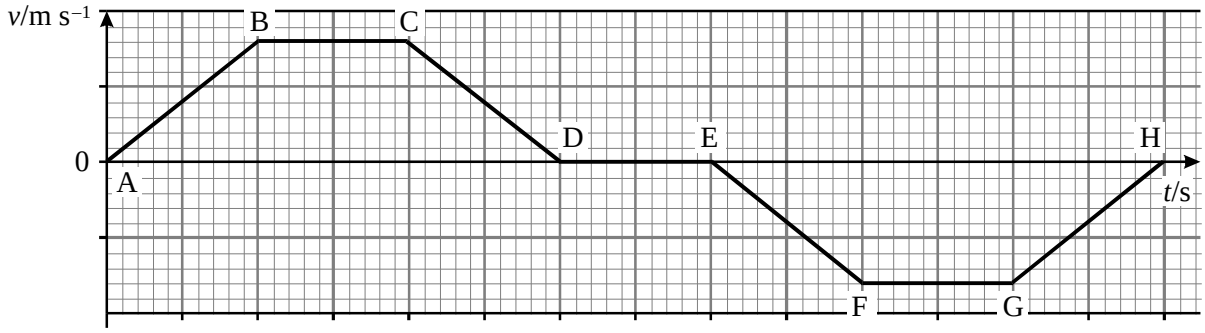
1. The graph below shows how the velocity of a toy train moving in a straight line varies over a period of time.



(a) Describe the motion of the train in the following regions of the graph.

AB .....

BC .....

CD .....

DE.....

EF .....

(5)

(b) What feature of the graph represents the displacement of the train?

.....

.....

(1)

(c) Explain, with reference to the graph, why the distance travelled by the train is different from its displacement.

.....

.....

.....

(2)

(Total 8 marks)

2. (a) Distinguish between a *scalar quantity* and a *vector quantity*.

.....

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.....

.....

(2)

(b) A car travels one complete lap around a circular track at an average speed of 100 km h^{-1}.

(i) If the lap takes 3.0 minutes, show that the length of the track is 5.0 km.

.....

.....

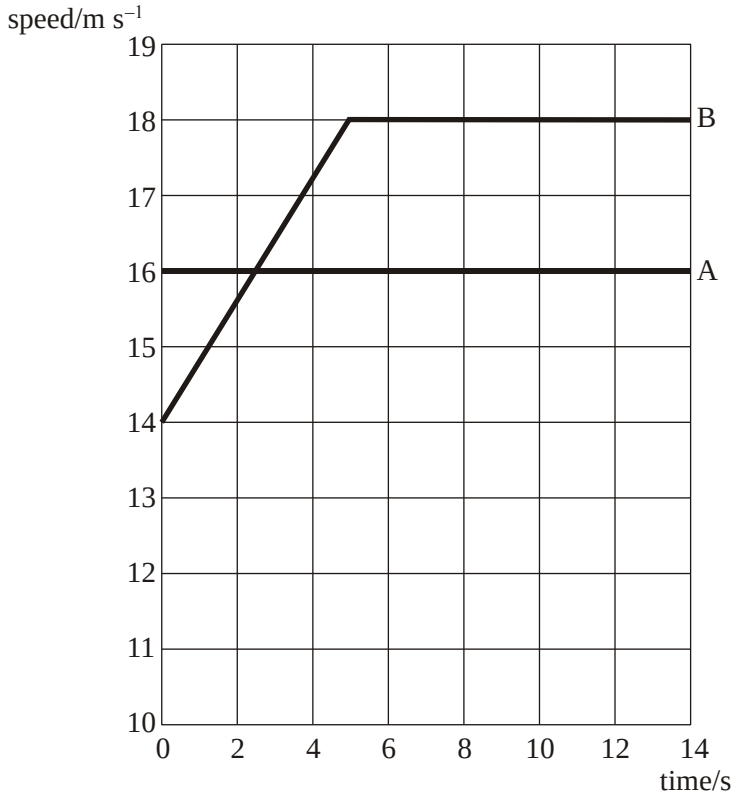
.....

(ii) What is the magnitude of displacement of the car after 1.5 minutes?

.....

(4)
(Total 6 marks)

3. The graph represents the motion of two cars, A and B, as they move along a straight, horizontal road.



(a) Describe the motion of each car as shown on the graph.

(i) car A: .....

.....

(ii) car B: .....

.....

(3)

(b) Calculate the distance travelled by each car during the first 5.0 s.

(i) car A: .....

.....

.....

(ii) car B: .....

.....

.....

(4)

(c) At time t = 0, the two cars are level. Explain why car A is at its maximum distance ahead of B at t = 2.5 s

.....

.....

.....

.....

.....

(3)
(Total 10 marks)

4. (a) (i) Define acceleration.

.....

(ii) State why acceleration is a vector quantity.

.....

.....

(2)

(b) State what feature of a velocity-time graph may be used to calculate

(i) acceleration,

.....

(ii) displacement.

.....

(2)

(c) The graph in **Figure 1** shows how the displacement of a runner from a fixed point, along a straight track, varies with time.

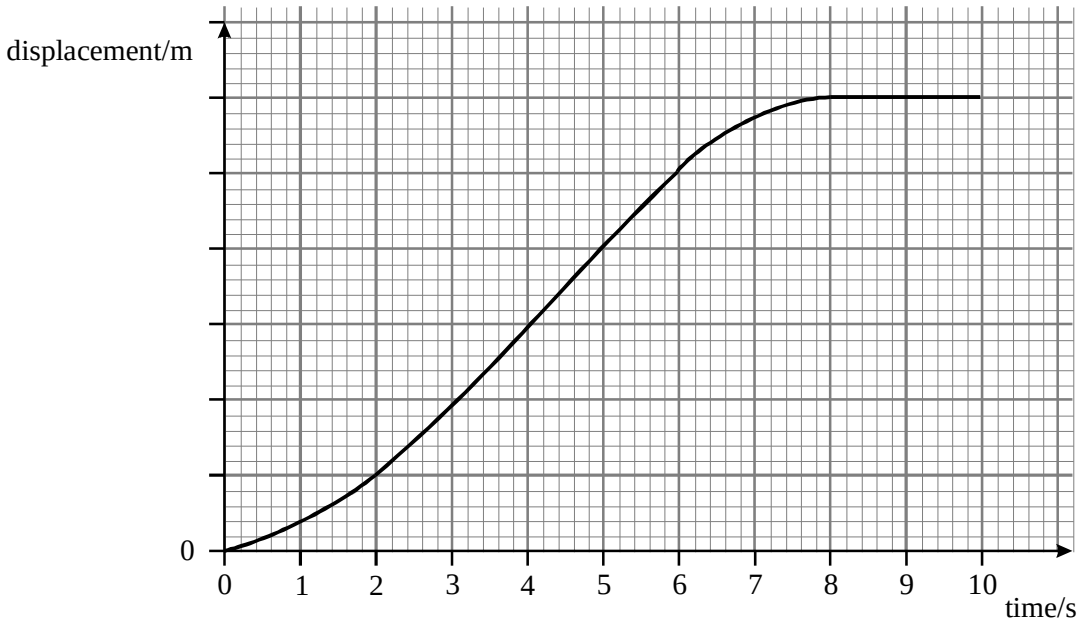


Figure 1

Without calculation, sketch on the grid in **Figure 2** a graph to show how the velocity of the same runner varies over the same period. The time scales are the same on both graphs.

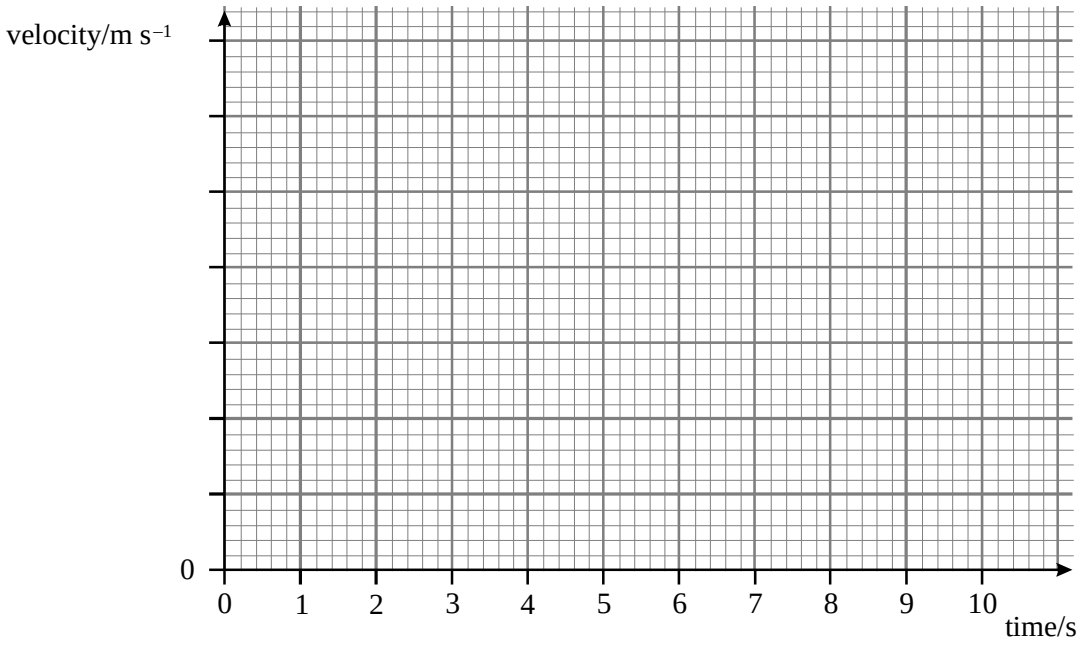
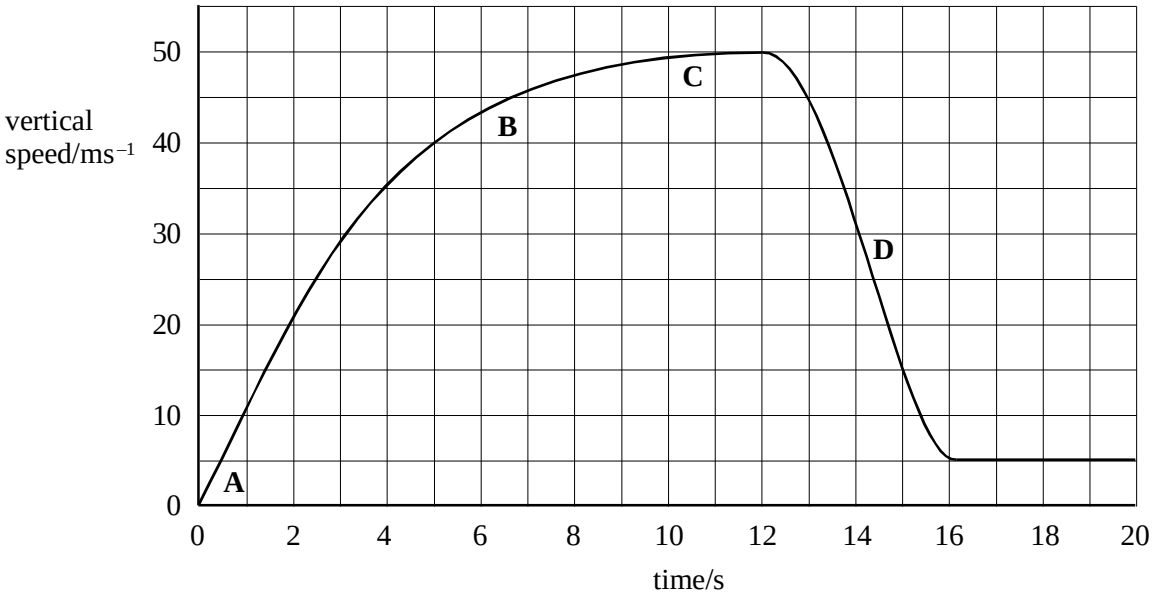


Figure 2

(4)
(Total 8 marks)

5. The graph shows how the vertical speed of a parachutist changes with time during the first 20 s of his jump. To avoid air turbulence caused by the aircraft, he waits a short time after jumping before pulling the cord to release his parachute.



(a) Regions A, B and C of the graph show the speed before the parachute has opened. With reference to the forces acting on the parachutist, explain why the graph has this shape in the region marked

(i) A, ...

.....

.....

.....

(ii) B, ...

.....

.....

(iii) C. .....

.....

.....

.....

(6)

(b) Calculate the maximum deceleration of the parachutist in the region of the graph marked D, which shows how the speed changes just after the parachute has opened. Show your method clearly,

.....

.....

.....

(2)

(c) Use the graph to find the total vertical distance fallen by the parachutist in the first 10 s of the jump. Show your method clearly.

.....

.....

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.....

.....

(4)

(d) During his descent, the parachutist drifts sideways in the wind and hits the ground with a vertical speed of 5.0 m s^{-1} and a horizontal speed of 3.0 m s^{-1}. Find

(i) the resultant speed with which he hits the ground,

.....

.....

.....

(ii) the angle his resultant velocity makes with the vertical.

.....

.....

(2)
(Total 14 marks)

6. Athlete A, competing in a 100 m race, crosses the finish line in a time of 10.2 s. At the start, the athlete accelerates uniformly to a top speed in 2.0 s and then remains at a constant speed for the remainder of the race.

(a) Calculate

(i) the average speed of the athlete over the full distance,

.....

.....

(ii) the maximum speed of the athlete if the acceleration were 5.4 m s^{-2},

.....

.....

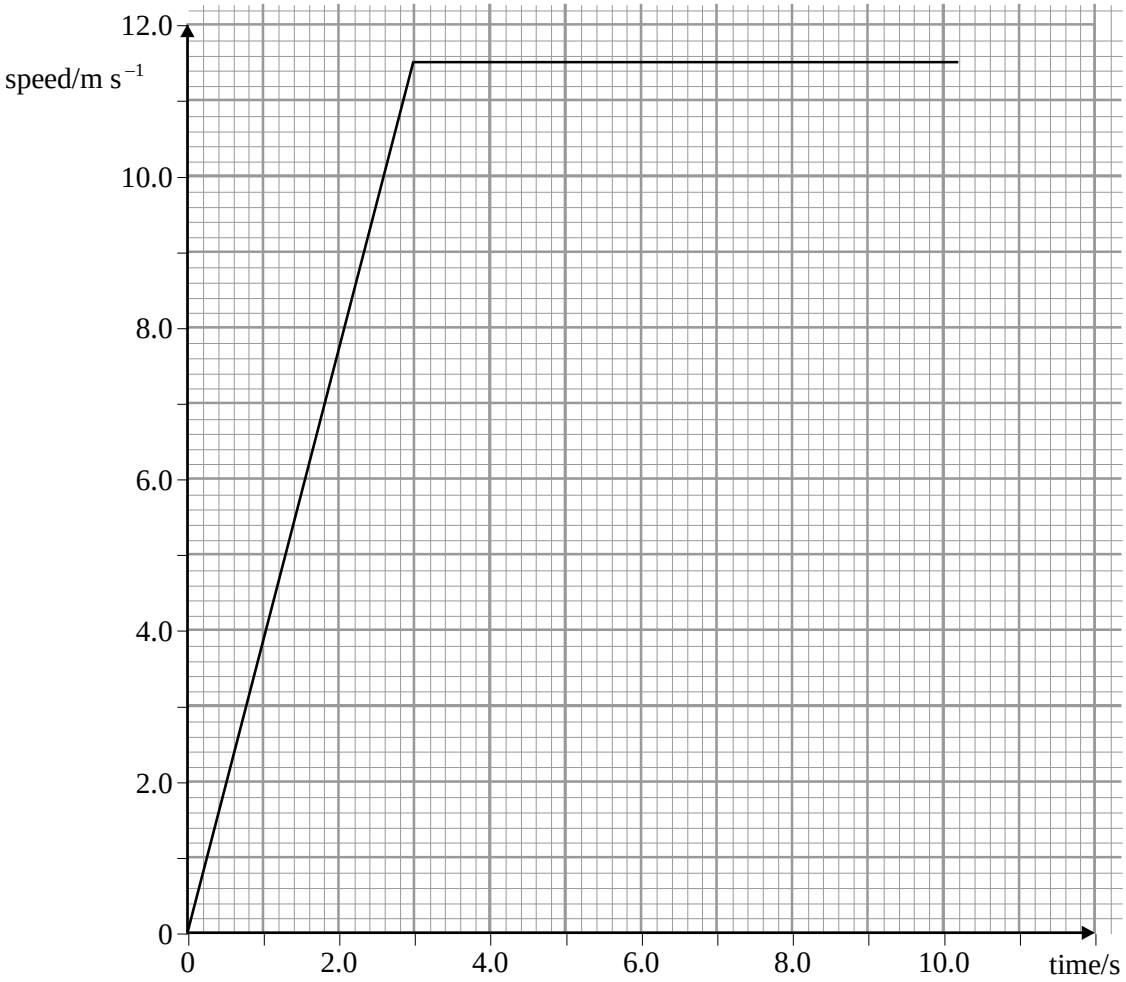
(iii) the distance travelled by the athlete whilst accelerating.

.....

.....

(4)

(b) The graph is a speed time graph for athlete B in the same race.



Using the **same** axes, draw a speed time graph for athlete A.

(3)

(c) Some time after the start of the race the two athletes are running at the same speed. Use your graph to determine

(i) the time at which this occurs,

.....

(ii) the distance covered by the athletes up to this time,

Athlete A: .....

.....

Athlete B: .....

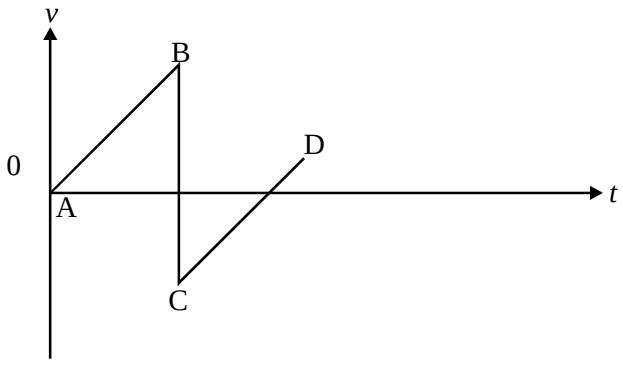
.....

(iii) how far apart the athletes are at this time.

.....

(4)
(Total 11 marks)

7. The diagram shows the velocity-time graph for a vertically bouncing ball, which is released above the ground at A and strikes the floor at B. The effects of air resistance have been neglected.



(a) (i) What does the gradient of a velocity-time graph represent?

.....

(ii) Explain why the gradient of the line CD is the same as line AB.

.....

.....

(iii) What does the area between the line AB and the time axis represent?

.....

(iv) State why the velocity at C is negative.

.....

.....

(v) State why the speed at C is less than the speed at B.

.....

.....

.....

(5)

(b) The ball has a mass of 0.15 kg and is dropped from an initial height of 1.2 m. After impact the ball rebounds to a height of 0.75 m.

Calculate

(i) the speed of the ball immediately before impact,

.....

.....

(ii) the speed of the ball immediately after impact,

.....

.....

(iii) the change in momentum of the ball as a result of the impact,

.....

.....

(iv) the magnitude of the resultant average force acting on the ball during impact if it is in contact with the floor for 0.10 s.

.....

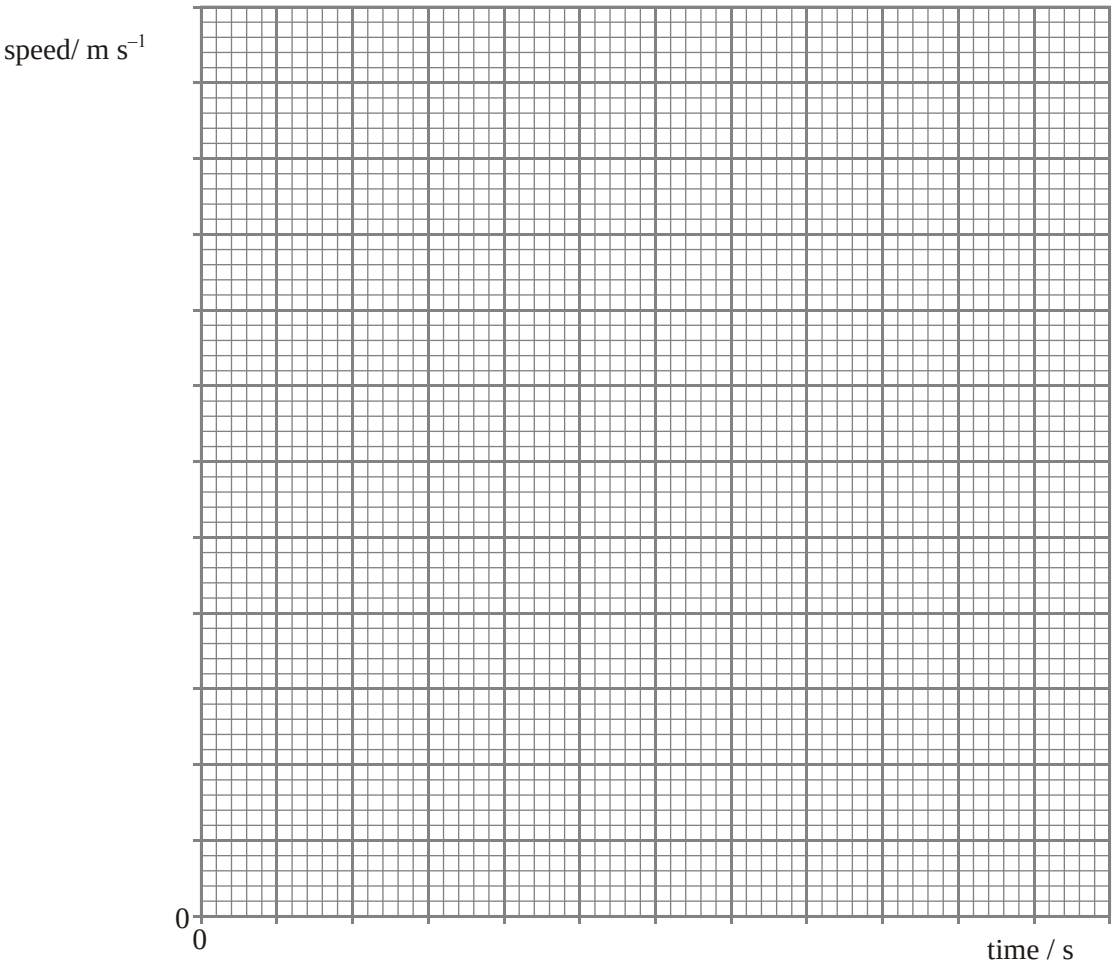
.....

(8)
(Total 13 marks)

8. A car accelerates from rest to a speed of 26 m s^{-1}. The table shows how the speed of the car varies over the first 30 seconds of motion.

time/ s	0	5.0	10.0	15.0	20.0	25.0	30.0
speed/ m s^{-1}	0	16.5	22.5	24.5	25.5	26.0	26.0

(a) Draw a graph of speed against time on the grid provided.



(3)

(b) Calculate the average acceleration of the car over the first 25 s.

.....

.....

(2)

(c) Use your graph to estimate the distance travelled by the car in the first 25 s.

.....

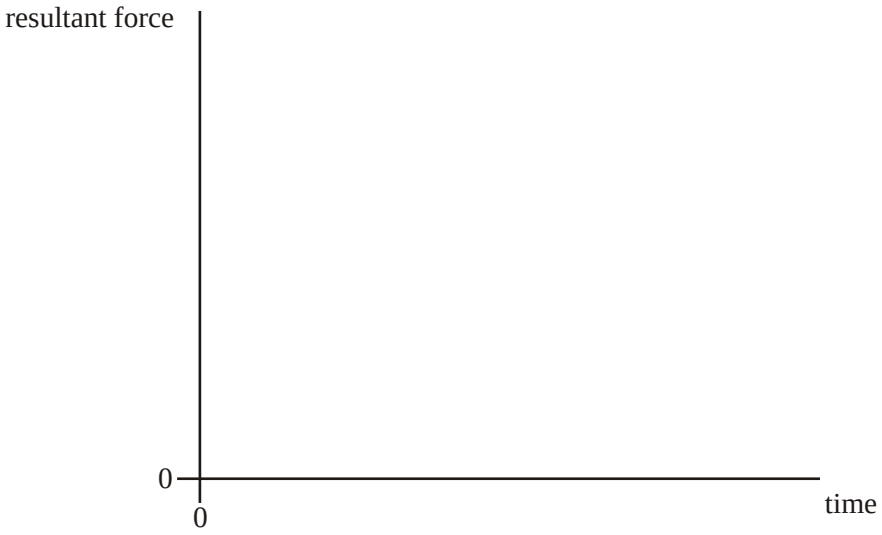
.....

.....

.....

(2)

(d) Using the axes below, sketch a graph to show how the resultant force acting on the car varies over the first 30 s of motion.



(2)

(e) Explain the shape of the graph you have sketched in part (d), with reference to the graph you plotted in part (a).

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.....

.....

(2)

(Total 11 marks)