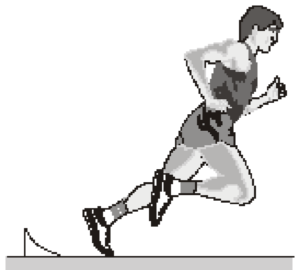
Q1. (a) The diagram shows an athlete at the start of a race. The race is along a straight track.



In the first 2 seconds, the athlete accelerates constantly and reaches a speed of 9 m/s.

(i) Use the equation in the box to calculate the acceleration of the athlete.

$$\text{accelleration} = \frac{\text{change in velocity}}{\text{time taken for change}}$$

Show clearly how you work out your answer.

....

....

....

Acceleration = ...

(2)

(ii) Which **one** of the following is the unit for acceleration?

Draw a ring around your answer.

J/s **m/s** **m/s^2** **Nm**

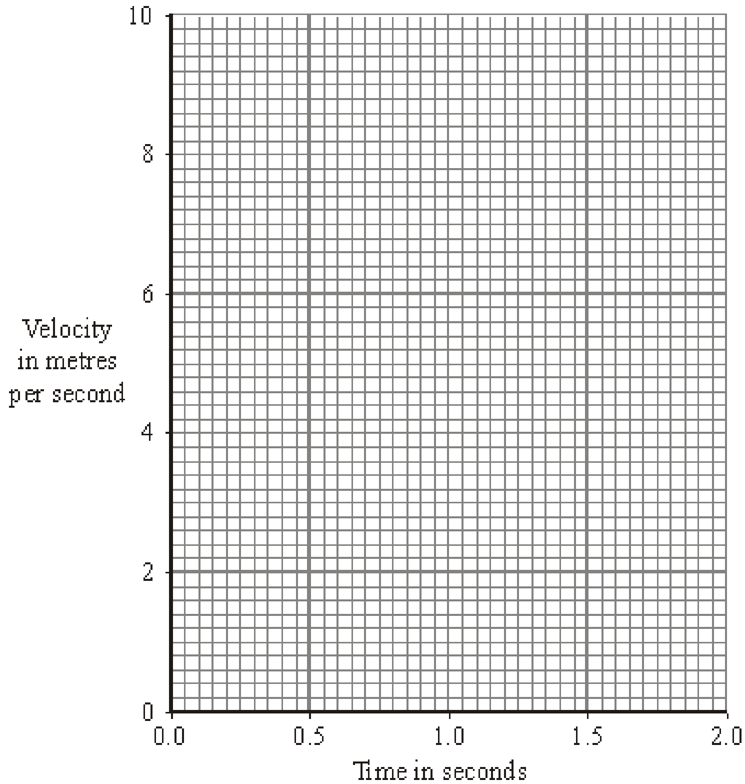
(1)

(iii) Complete the following sentence.

The velocity of the athlete is the .... of the athlete in a given direction.

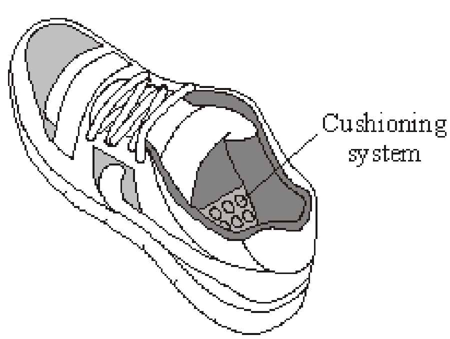
(1)

(iv) Complete the graph to show how the velocity of the athlete changes during the first 2 seconds of the race.

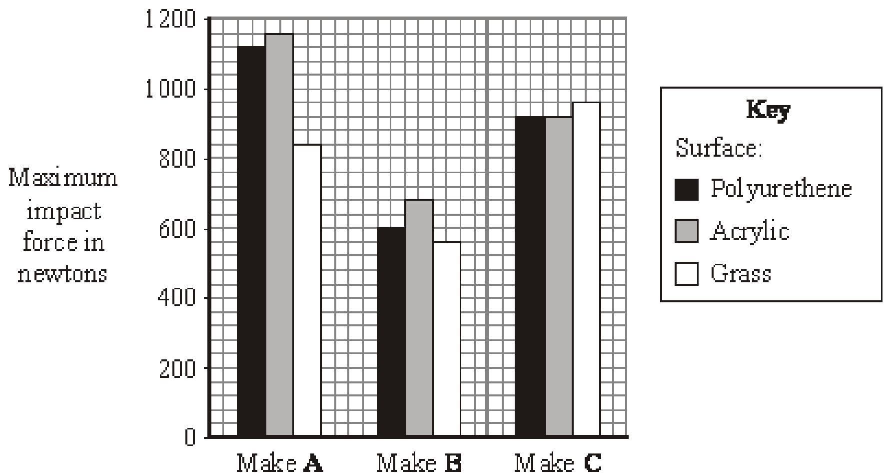


(2)

(b) Many running shoes have a cushioning system. This reduces the impact force on the athlete as the heel of the running shoe hits the ground.



The bar chart shows the maximum impact force for three different makes of running shoe used on three different types of surface.



(i) Which **one** of the three makes of running shoe, **A**, **B** or **C**, has the best cushioning system?

....

Explain the reason for your answer.

....

....

....

....

(3)

(ii) The data needed to draw the bar chart was obtained using a robotic athlete fitted with electronic sensors.

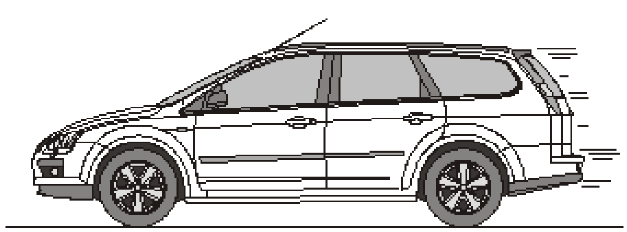
Why is this data likely to be more reliable than data obtained using human athletes?

....

....

(1)
(Total 10 marks)

Q2. (a) The diagram shows a car travelling at a speed of 12 m/s along a straight road.



(i) Use the equation in the box to calculate the momentum of the car.

momentum = mass × velocity

Mass of the car = 900 kg

Show clearly how you work out your answer.

....

....

....

....

Momentum = ... kg m/s

(2)

(ii) Momentum has direction.

Draw an arrow on the diagram to show the direction of the car’s momentum.

(1)

(b) The car stops at a set of traffic lights.

How much momentum does the car have when it is stopped at the traffic lights?

....

Give a reason for your answer.

....

....

....

....

(2)
(Total 5 marks)

Q3. (a) A car is being driven along a straight road. The diagrams, **A**, **B** and **C**, show the horizontal forces acting on the moving car at three different points along the road.

Describe the motion of the car at each of the points, **A**, **B** and **C**.

....

....

....

....

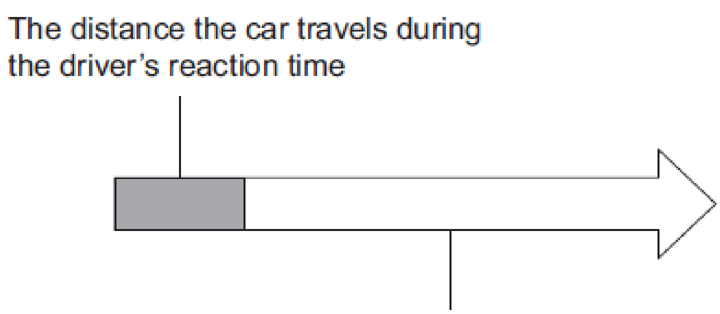
....

....

(3)

(b) The diagram below shows the stopping distance for a family car, in good condition, driven at 22 m/s on a dry road. The stopping distance has two parts.

(i) Complete the diagram below by adding an appropriate label to the second part of the stopping distance.



....

....

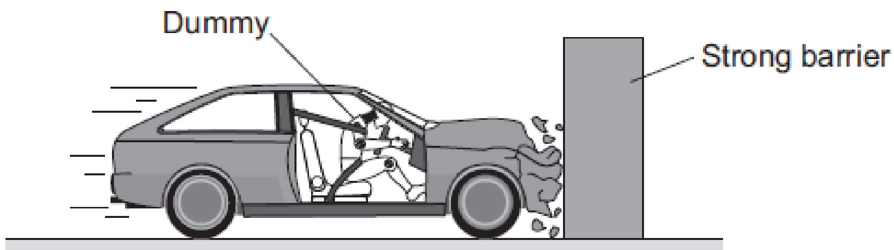
(1)

(ii) State **one** factor that changes both the first part **and** the second part of the stopping distance.

....

(1)

(c) The front crumple zone of a car is tested at a road traffic laboratory. This is done by using a remote control device to drive the car into a strong barrier. Electronic sensors are attached to the dummy inside the car.



(i) At the point of collision, the car exerts a force of 5000 N on the barrier.

State the size and direction of the force exerted by the barrier on the car.

....

....

(1)

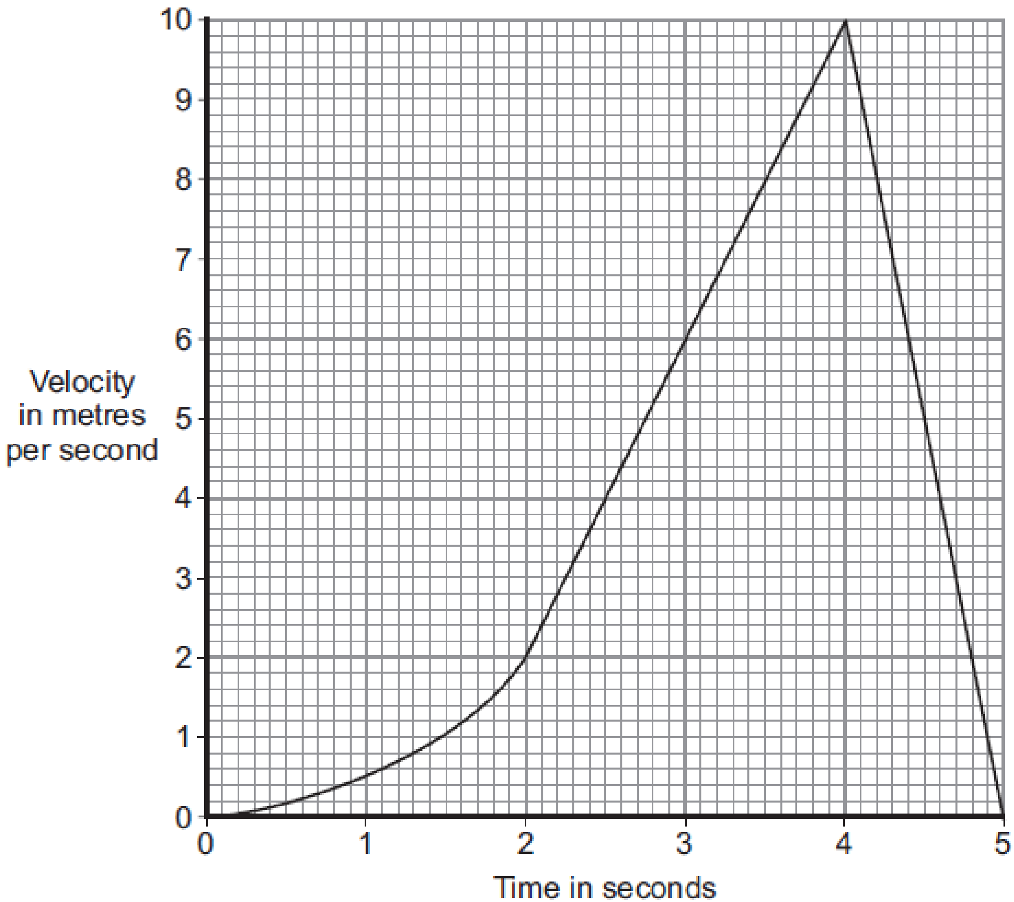
(ii) Suggest why the dummy is fitted with electronic sensors.

....

....

(1)

(iii) The graph shows how the velocity of the car changes during the test.



Use the graph to calculate the acceleration of the car just before the collision with the barrier.

Show clearly how you work out your answer, including how you use the graph, and give the unit.

....

....

....

....

Acceleration = ...

(3)
(Total 10 marks)