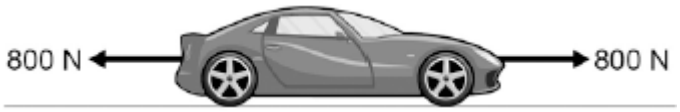
Q1. The figure below shows the horizontal forces acting on a car.



(a) Which **one** of the statements describes the motion of the car?

Tick **one** box.

It will be slowing down. ☐

It will be stationary. ☐

It will have a constant speed. ☐

It will be speeding up. ☐

(1)

(b) During part of the journey the car is driven at a constant speed for five minutes.

Which one of the equations links distance travelled, speed and time?

Tick **one** box.

distance travelled = speed + time ☐

distance travelled = speed × time ☐

distance travelled = speed − time ☐

distance travelled = speed ÷ time ☐

(1)

(c) During a different part of the journey the car accelerates from 9m / s to 18m / s in 6 s.

Use the following equation to calculate the acceleration of the car.

$$\text{acceleration} = \frac{\text{change in velociy}}{\text{time taken}}$$

.....

.....

acceleration = ... m / s^2

(2)

(d) Which equation links acceleration, mass and resultant force?

Tick **one** box.

resultant force = mass + acceleration ☐

resultant force = mass × acceleration ☐

resultant force = mass − acceleration ☐

resultant force = mass ÷ acceleration ☐

(1)

(e) The mass of the car is 1120 kg. The mass of the driver is 80 kg.

Calculate the resultant force acting on the car and driver while accelerating.

.....

.....

Resultant force = ... N

(2)

(f) Calculate the distance travelled while the car is accelerating.

Use the correct equation from the Physics Equation Sheet.

.....

.....

.....

Distance = ... m

(3)

(g) A car driver sees a fallen tree lying across the road ahead and makes an emergency stop.

The braking distance of the car depends on the speed of the car.

For the same braking force, explain what happens to the braking distance if the speed doubles.

You should refer to kinetic energy in your answer.

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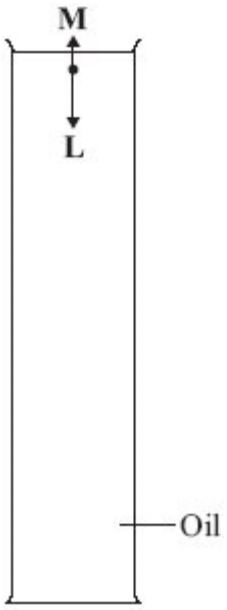
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(4)

(Total 14 marks)

Q2. (a) The diagram shows a steel ball-bearing falling through a tube of oil. The forces, **L** and **M**, act on the ball-bearing.

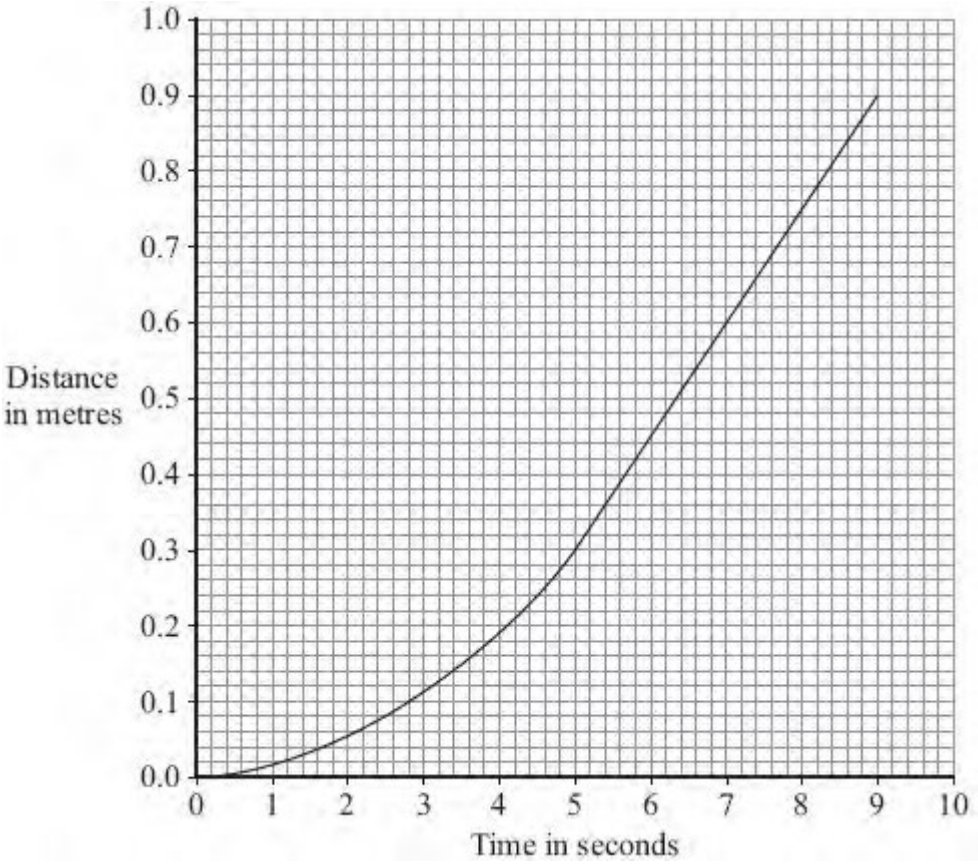


What causes force **L**?

.....

(1)

(b) The distance – time graph represents the motion of the ball-bearing as it falls through the oil.



(i) Explain, in terms of the forces, **L** and **M**, why the ball-bearing accelerates at first but then falls at constant speed.

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(3)

(ii) What name is given to the constant speed reached by the falling ball-bearing?

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(1)

(iii) Calculate the constant speed reached by the ball-bearing.

Show clearly how you use the graph to work out your answer.

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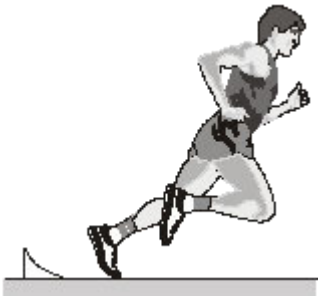
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Speed = ... m/s

(2)

(Total 7 marks)

Q3. (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) Calculate the acceleration of the athlete.

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/s²** **Nm**

(1)

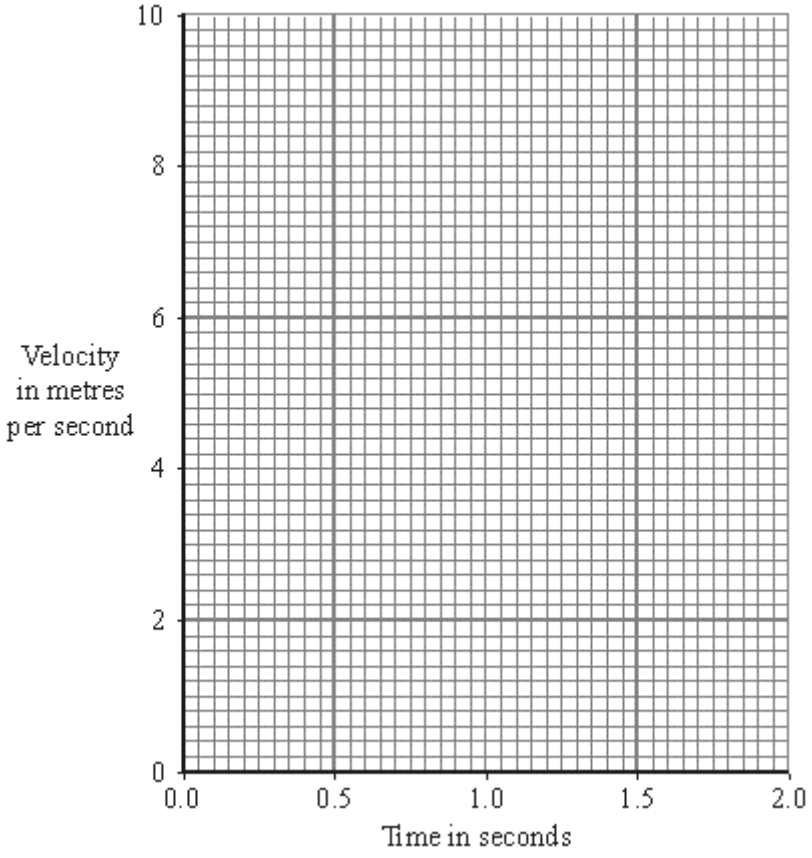
(iii) Complete the following sentence.

The velocity of the athlete is the ..... of the

athlete in a given direction.

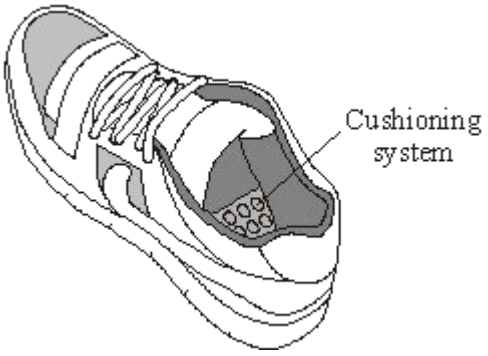
(1)

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

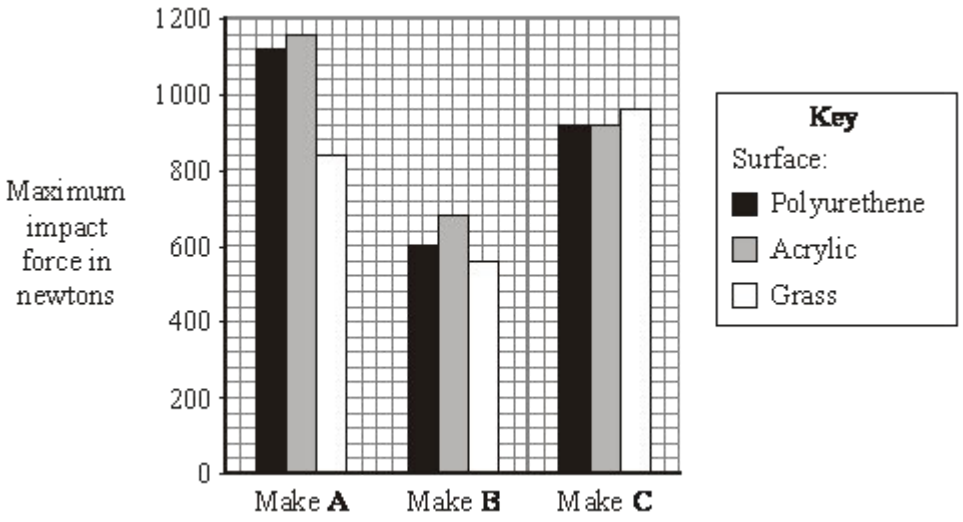


(2)

(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.

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.....

(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)

Q4. (a) The diagram shows the forces acting on a parachutist in free fall.



The parachutist has a mass of 75 kg.

Calculate the weight of the parachutist.

gravitational field strength = 10 N/kg

Show clearly how you work out your answer and give the unit.

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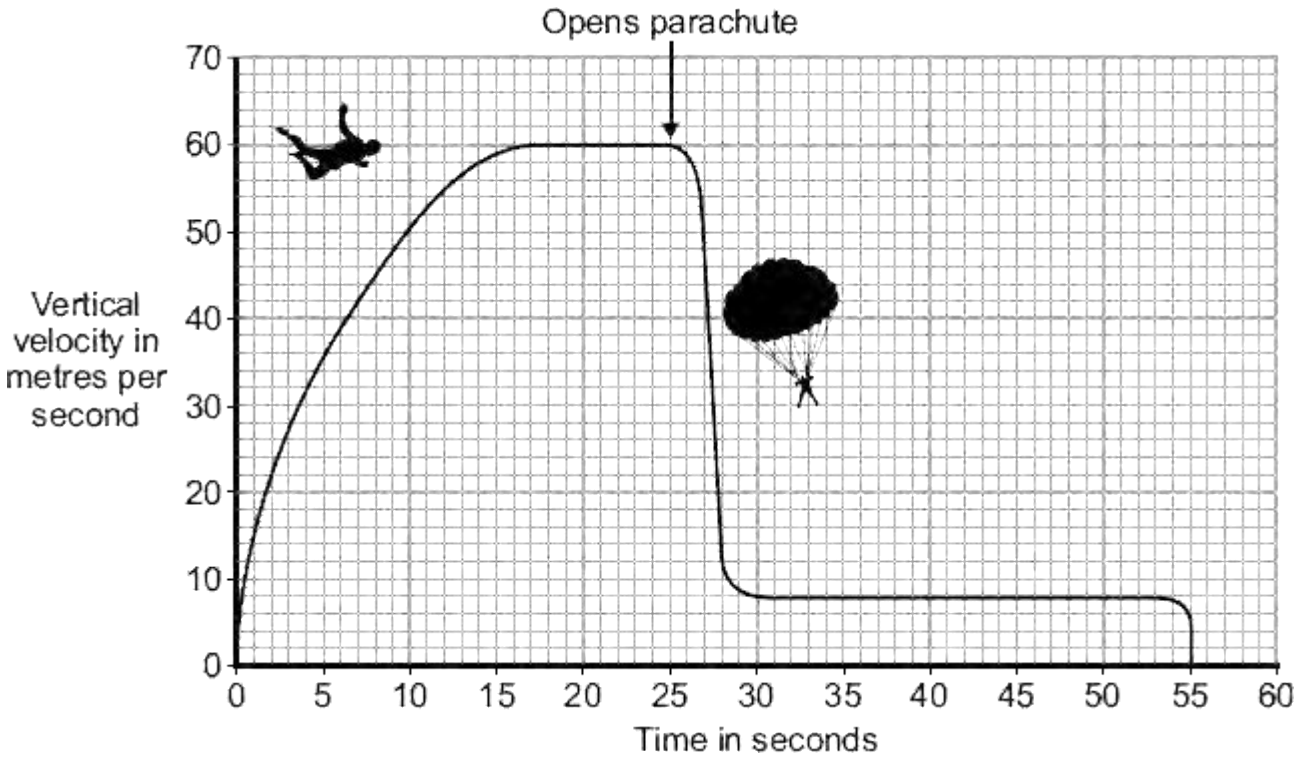
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Weight = ...

(3)

(b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

The graph shows how the vertical velocity of a parachutist changes from the moment the parachutist jumps from the aircraft until landing on the ground.



Using the idea of forces, explain why the parachutist reaches a terminal velocity and why opening the parachute reduces the terminal velocity.

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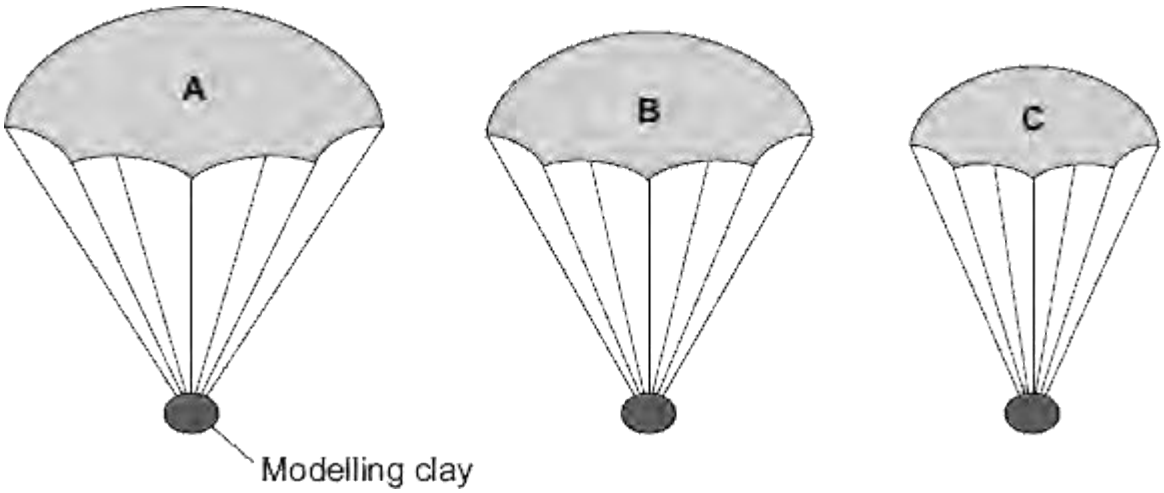
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(6)

(c) A student wrote the following hypothesis.

'*The larger the area of a parachute, the slower a parachutist falls.*'

To test this hypothesis the student made three model parachutes, **A**, **B** and **C**, from one large plastic bag. The student dropped each parachute from the same height and timed how long each parachute took to fall to the ground.



(i) The height that the student dropped the parachute from was a control variable.

Name **one** other control variable in this experiment.

.....

(1)

(ii) Use the student's hypothesis to predict which parachute, **A**, **B** or **C**, will hit the ground first.

Write your answer in the box. ☐

Give a reason for your answer.

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.....

.....

(2)

(Total 12 marks)

Q5. A cyclist travelling along a straight level road accelerates at 1.2 m/s^2 for 5 seconds. The mass of the cyclist and the bicycle is 80 kg.

(a) Calculate the resultant force needed to produce this acceleration.

Show clearly how you work out your answer and give the unit.

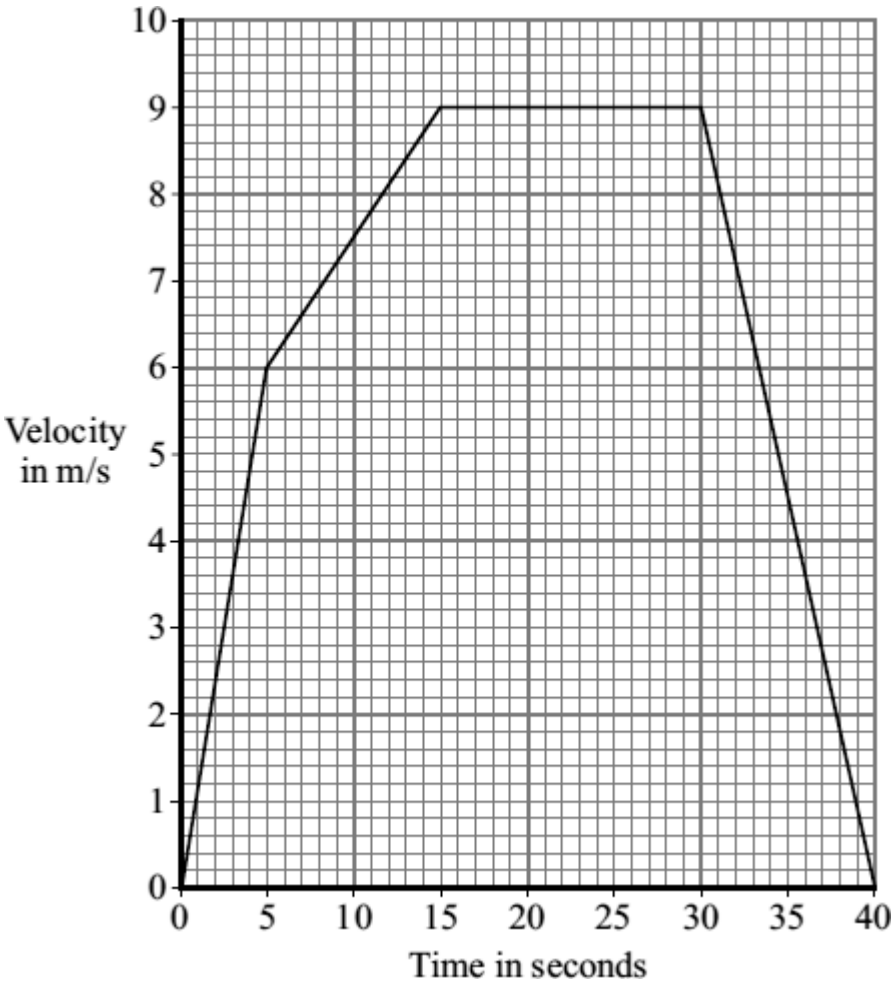
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Resultant force = ...

(3)

(b) The graph shows how the velocity of the cyclist changes with time.



(i) Complete the following sentence.

The velocity includes both the speed and the .....of the cyclist.

(1)

(ii) Why has the data for the cyclist been shown as a line graph instead of a bar chart?

.....

.....

(1)

(iii) The diagrams show the horizontal forces acting on the cyclist at three different speeds. The length of an arrow represents the size of the force.



Which **one** of the diagrams, **A**, **B** or **C**, represents the forces acting when the cyclist is travelling at a constant 9 m/s?

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Explain the reason for your choice.

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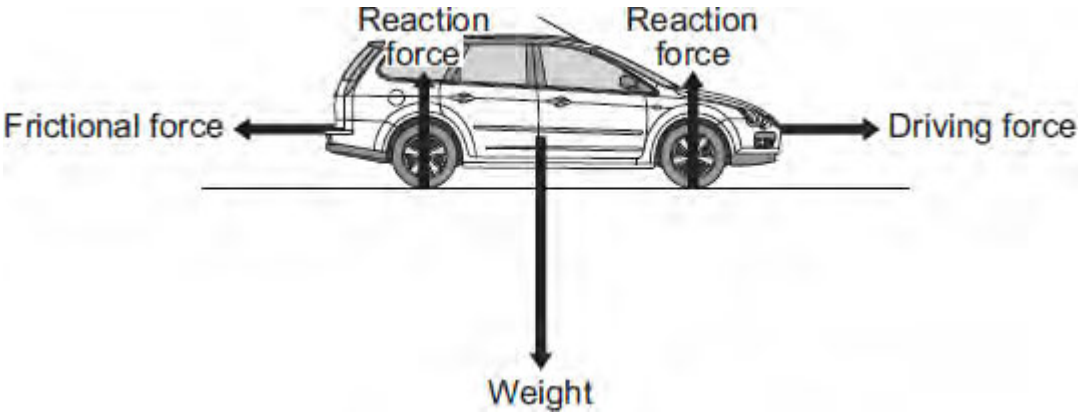
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(3)
(Total 8 marks)

Q6. The diagram shows the forces acting on a car. The car is being driven along a straight, level road at a constant speed of 12 m/s.



(a) The driver then accelerates the car to 23 m/s in 4 seconds.

Use the equation in the box to calculate the acceleration of the car.

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

Show clearly how you work out your answer and give the unit.

.....

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Acceleration = ...

(3)

(b) Describe how the horizontal forces acting on the car change during the first **two** seconds of the acceleration.

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(3)

(Total 6 marks)